Bhagwan Mahavir College of Engg. & Tech.,Surat

Department of Mechanical Engineering

B.E. Semester – IV

Machine Design & Industrial Drafting (2141907)

Batch: _____ **Enrollment No.**: _____

List of Assignments

Sr. No.	Title	Start Date	End Date	Sign	Remark
1.	Design Against Static Load				
2.	Design of Cotter and Knuckle Joints				SHEET NO 1 &2
3.	Design and Analysis of Levers				SHEET NO.3
4.	Design of Beams				
5.	Design of Columns				
6.	Design of Shaft, Keys and Couplings				
7.	Design of Threaded Joints				
8.	Design of Welded Joints				SHEET NO.4
9.	Design of Riveted Joints				SHEET NO.5
10.	Introduction of Limits, Fits and Tolerances				

ASSIGNMENT – 1 DESIGN AGAINST STATIC LOAD

Theory

1. What is stress concentration? Explain methods to relieve stress concentration? Explain any two stresses with simple sketches
2. Define factor of safety and state the important factors affecting the factor of safety.
3. Define following:(1) Proof Resilience (2)Preferred number (3)Principle stress
4. Explain the following principle theories of elastic failure:

   [1] Max. Principle stress theory (Rankine theory)

   [2] Max. shear stress theory (Coulomb theory or Tresca and Guest theory)

   [3] Distortion energy theory (Von Mises and Hencky theory)

   [4] Selection and use of failure theories

5. Distinguish clearly between bending and bearing stress.
6. Explain the following terms with neat sketches:(1)Tensile stress(2) Compressive stress(3)Principle Stress (4) Bearing pressure
7. Classify the different types of load & explain each In brief.

Examples

1. Determine the thickness of a 120 mm wide uniform plate for safe continuous operation of the plate is to be subjected to tensile load that has maximum value of 250 KN and minimum value of 100 KN. The properties of the plate material are as follows:
   Endurance limit=225 N/mm^2,
   Yield point stress=300 N/mm^2, Factor of safety=1.5

2. Determine the minimum size of a circular hole that can be punched in a M.S. plate, 5 mm thick and having ultimate shear strength of 300 MPa. Take compressive strength of punch as 360 MPa.

ASSIGNMENT – 2 DESIGN OF COTTER AND KNUCKLE JOINT

Theory

1. Explain the design process for spigot and socket cotter joint with neat sketch.
2. What are the uses of cotter joint? Why is taper provided on the cotter? What is the purpose of clearance in Cotter Joints?
3. Write the advantages of cotter joint. State the different applications of the cotter joint.
4. Explain the design process for knuckle joint with neat sketch.
5. Write the advantages of knuckle joint. State the different applications of the knuckle joint.

Examples

1. Design a socket and spigot joint to resist a tensile load of 28 KN. All the parts of the joint are made from same material with following allowable stresses: σ_t=50 N/mm^2, σ_c=60N/mm^2, τ=35 N/mm^2, σ_b =50 N/mm^2.(SHEET NO.1)

2. It is required to design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile load of 50 kN. The permissible stresses are 67 MPa in tension, 34 MPa in shear and 134 MPa in crushing for all the parts.

3. Design a knuckle joint to connect two rods subjected to tensile force of 50 KN. The rods and pin are made of plain carbon steel 30C8. The permissible stresses are $\sigma_t = \sigma_c$ = 80 MPa and τ = 40 MPa

4. It is required to design knuckle joint to connect two mild steel roads of equal diameter. Each rod is subjected to an axil tensile load 50 KN. The permissible stresses are 80 MPa in tension and crushing and 40 MPa in shear for all parts.

5. Design a knuckle joint to connect two mild steel bars under a tensile load of 25 kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing. Standard diameter of solid bars are 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40 mm. Check failure of knuckle pin in shear, failure of rod end & forked end in tension, shearing and crushing.(SHEET NO.2)

ASSIGNMENT – 3 DESIGN OF LEVER

Theory

1. Explain the basic types of levers with the help of neat sketches & examples.
2. Define following : (1)Arm of lever,(2) Leverage, (3)Displacement ratio (4) mechanical advantage
3. Differentiate between simple and compound lever. Why a boss is generally needed at the fulcrum of the levers?
4. State the application of hand and foot levers.
5. State and explain the different functions of levers. Why the levers are generally made tapers?
6. What is lever? Explain the principle on which it works.
7. Briefly explain general procedure for lever design.

Examples

1. Design a bell crank lever to apply a load of 5 kN (vertical) at the end A of an horizontal arm of length 400 mm. The end of the vertical arm C and the fulcrum B are to be fixed with the help of pins inside forked shaped supports. The end A is itself forked. Determine the cross-section of the arms and the dimensions of the pins. The lever is to have mechanical advantage of 4 with a shorter vertical arm BC. The ultimate stresses in shear and tension for the lever and pins are 400 MPa and 500 MPa respectively. The allowable bearing pressure for the pins is 12 N/mm^2. Assume a factor of safety as 4 and the cross-section of the lever as rectangular with depth (b) as three times the thickness (t). (SHEET NO.3)
2. Design a lever of a lever loaded safety valve based on following data:
   Steam pressure acting on the valve = 1.2 MPa
   Valve diameter = 60 mm.
   Width to thickness ratio for lever = 3:1
   Length to diameter ratio for pins = 1.25:1
   The material used is forged steel with *t*
   s =80MPa, t =50 Mpa,
   s =100 Mpa, Pb = 20 Mpa
   The lever has a rectangular cross section. The distance between the fulcrums and the dead weights on lever is 800 mm and distance between the fulcrum and the pin connecting the spindle of the valve to the lever is 100 mm.
   Calculate: (i) the length and the diameter of the pin connecting the valve spindle to the lever (ii) the lever cross sectional dimension(SHEET NO.3)

ASSIGNMENT – 4 DESIGN OF BEAMS

Theory

1. Distinguish between beams, columns and strut giving suitable examples.
2. Explain types of beams with neat sketch.
3. Explain types of supports (or end conditions) of beam with neat sketch.
4. Explain types of loads on beam with neat sketch.
5. Define following with reference to beam with neat sketch: (i) Deflection, (ii) Slope and (iii) Flexural rigidity.

Examples

1. A 2 metres long cantilever beam is having 100 mm width and 200 mm depth, carrying point load at free end. If deflection at free end is 6 mm, calculate point load at free end. Take $E = 2 \times 10^5$ N/mm^2.
2. A cantilever beam of span 1.5 metres carries a point load of 20 kN at its free end. Find maximum slope of beam. Flexural rigidity (EI) = 2×10^4 kN.m^2.
3. A hollow rectangular section 200 mm x 450 mm external and 15 mm thickness is used for 2.7 metres cantilever beam, subjected to UDL of 64 kN/m and point load of 60 kN at free end, both downward. Find maximum slope and deflection. Take E = 200 GPa.
4. A simply supported beam 3 metres in span is subjected to UDL of 10 kN/m over entire span with central point load 5 kN. The cross section of beam is 150 mm wide x 300 mm depth. Calculate the maximum slope & deflection for the beam.
5. A cantilever beam 120 mm x 200 mm is 2.5 metres long. What UDL should the beam carry to produce a deflection of 5 mm at free end? Take $E = 2 \times 10^5$ N/mm^2.

ASSIGNMENT – 5 DESIGN OF COLUMNS

Theory

1. What is Slenderness ratio? State the assumptions used in Euler's Column theory.

2. Describe the use of Johnson's formula & Euler's formula by graph.

3. Explain & derive the equation for Rankine formula for column.
4. Explain theory about design of connecting rod. Also derive that I xx = 3.2 for I-section Iyy of connecting rod.

Examples

1. Calculate the diameter of a piston rod for a cylinder of 1.5 m diameter in which the greatest difference of steam pressure on the two sides of the piston may be assumed to be 0.2 N/mm^2. The rod is made of mild steel and is secured to the piston by a tapered rod and nut and to the crosshead by a cotter. Assume modulus of elasticity as 200 kN/mm^2 and factor of safety as 8. The length of rod may be assumed as 3 metres.

2. A connecting rod of length *l* may be considered as a strut with the ends free to turn on the crank pin and the gudgeon pin. In the directions of the axes of these pins, however, it may be considered as having fixed ends. Assuming that Euler's formula is applicable, determine the ratio of the sides of the rectangular cross – section so that the connecting rod is equally strong in both planes of buckling.

ASSIGNMENT – 6 DESIGN OF SHAFTS, KEYS AND COUPLINGS

Theory

SHAFTS

1. Explain functions and classification of shaft.
2. Define – Shaft, Axle and Spindle. Also state the difference between shaft, axle and spindle.
3. Explain the design of shaft based on strength basis.
4. Explain torsional rigidity and lateral rigidity in detail.
5. Explain the ASME code for shaft design.
6. Explain critical speed of shaft in details.

KEYS

1. What are the basic functions of the key? Explain different types of keys with its applications.
2. What are the different types of Sunk key? Explain each with application.
3. Derive strength equations of sunk key based on shear and crushing (or compression) failures. Show that square key is equally strong in shearing and crushing compare to rectangular key.
4. What is splined shaft? State the applications of splined shaft. Explain the design of splined shaft.

COUPLINGS

1. Explain the purpose, requirements and applications of shaft coupling.
2. How does the working of a clamp coupling differ from that of a muff coupling?
3. Differentiate between flexible coupling and rigid coupling.
4. Draw a neat sketch of a protected type flanged coupling and write the design procedure with the design equations for different failure criteria.

Examples

1. Compare the weight, strength and rigidity of a hollow shaft of same external diameter as that of solid shafts, both the shafts are made of same material. Assume that diameter ratio for the hollow shaft is $d_i/d_o = 0.6$.

2. A steel spindle transmits 4 KW at 800 r.p.m. The angular deflection should not exceed 0.25^0 per metre of the spindle. If the modulus of rigidity for the material of the spindle is 84×10^3 N/mm^2, find the diameter of the spindle and the shear stress induced in the spindle

3. Determine the diameter below which the angle of twist of a shaft is the controlling factor in design of solid shaft in torsion. The allowable shear stress is 56 MPa and the maximum allowable twist is ¼ degree per meter. Take G = 84 GPa.

4. Find the diameter of a solid shaft to transmit 30 kW at 230 rpm. The shear stress is 50 MPa. If a hollow shaft is to be used in place of solid shaft, find the inside and outside diameters when the ratio of inside to outside diameter is 6:8.

5. A line shaft is driven by means of a motor placed vertically below it. The pulley on the line shaft is 1.5 meter in diameter and has belt tensions 5.4 kN and 1.8 kN on the tight side and slack side of the belt respectively. Both these tensions may be assumed to be vertical. If the pulley be overhang from the shaft, the distance of the centre line of the pulley from the centre line of the bearing being 400 mm, find the diameter of the shaft. Assume maximum allowable shear stress of 42 MPa.

6. A 45 mm diameter shaft is made of steel with yield strength of 400 N/mm^2. A parallel key of size 14 mm wide and 9 mm thick made of steel with yield strength of 340 N/mm^2 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 factor of safety of 2

7. Design 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.

ASSIGNMENT – 7 Design of Threaded Joints

Theory

1. Explain the different types of screw threads used in power screw stating their applications.
2. What do you understand by the single start and double start threads? Define following terms: (a) Major diameter, (b) Minor diameter, (c) Pitch and (d) Lead.
3. Derive an equation for torque required to raise (lift) load by square threaded screw.
4. Derive an equation for torque required to lower load by square threaded screw.
5. Derive an equation for efficiency of square threaded screw and maximum efficiency of a square threaded screw.
6. What is self-locking and over-hauling of power screw? What is significance of these properties? Show that the efficiency of self-locking screws is less than 50%.
7. Discuss on bolts of uniform strength giving examples of practical applications of such bolts.
8. Explain the purpose of a turn buckle (or Coupler) with neat sketch and describe its design procedure.

Examples

1. The mean diameter of the square threaded screw having pitch of 10 mm is 50 mm. A load of 20 KN is lifted through 170 mm. The external and internal diameters of the bearing surface of the loose head are 60 mm and 10 mm respectively. The coefficient of friction for the screw and the bearing surface may be taken as 0.08.
   Find the work done in lifting the load and the efficiency of the screw, when
   a) The load rotates with the screw, and
   b) The load rests on the loose head which does not rotate with the screw.
2. The lead screw of a lathe machine has single start trapezoidal threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2 kN in order to drive the tool carriage, during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of co-efficient of friction at the screw threads and the collar are 0.15 and 0.12 respectively. The lead screw rotates at 30 rpm. Calculate:
   a) The power required to drive the lead screw, b) The efficiency of the screw.

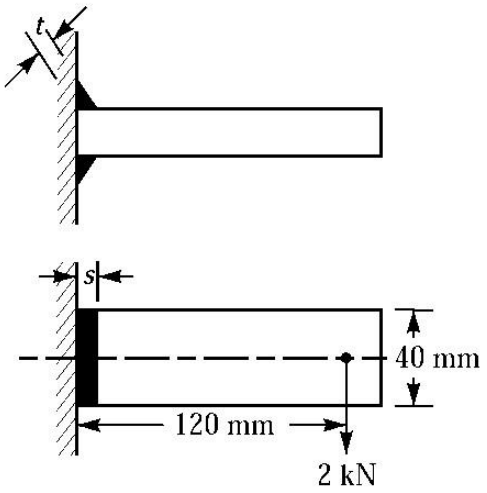
ASSIGNMENT – 8 Design of Welded Joints

Theory

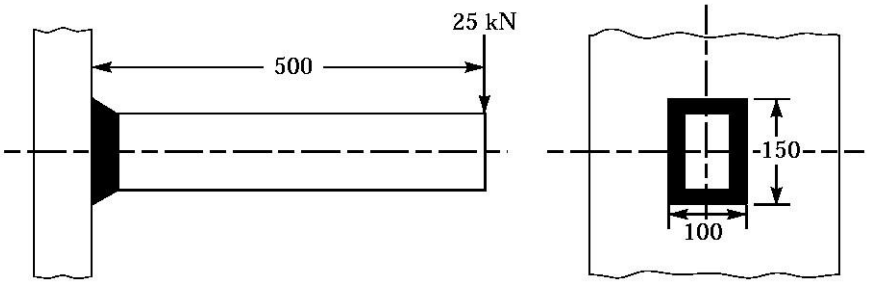
1. What do you understand by the term welded joint? Explain advantages and disadvantages of welded joints over riveted joints.
2. Classify and explain the types of welded joints with neat sketches and weld symbols.
3. Discuss the standard location of elements of a welding symbol.
4. Derive equations of strength for transverse and parallel fillet welded joints with neat sketches.
5. What do you mean by eccentric loaded welded joint? Write the detail design procedure for designing such a joint.

Examples

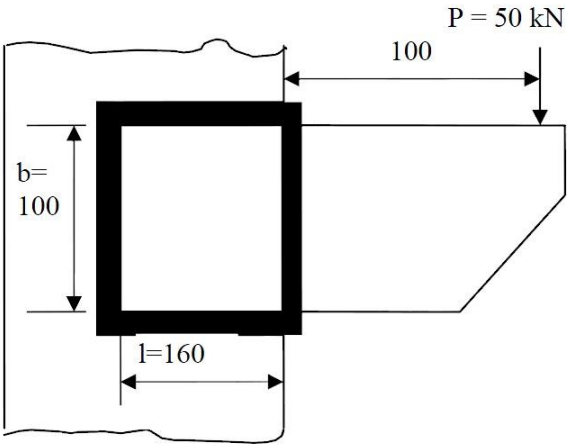
1. A plate 60 mm wide and 80 mm thick. It is welded with another plate by means of single transverse and double parallel fillet welds. Find the length of each parallel fillet if allowable tensile and shear stresses in the weld material are 80 and 60 MPa respectively.
2. A circular shaft, 75 mm in diameter, is welded to the support by means of a circumferential fillet weld. It is subjected to a torsional moment of 3000 N-m. Determine the size of weld, if the maximum shear stress in the weld is not to exceed 70 N/mm^2.
3. A welded joint as shown in figure, is subjected to an eccentric load of 2 KN. Find the size of weld, if the maximum shear stress in the weld is 25 N/mm^2.(SHEET NO.4)



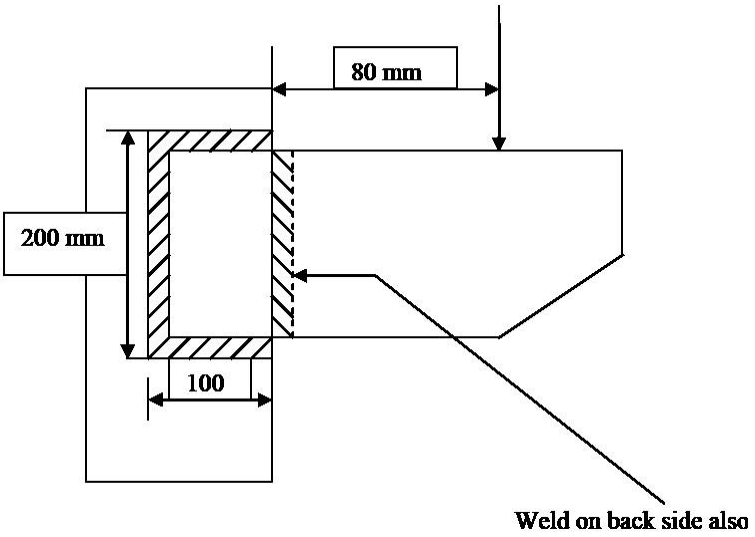
4. A shaft of rectangular cross-section is welded to a support by means of fillet welds, as shown in fig. Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 N/mm^2. (SHEET NO.4)



5. A bracket is fillet welded to a structure as shown in figure, which is subjected to a load of 50 kN. Find the size of weld required if allowable shear stress is not to exceed 75 MPa.



6. A welded joint has to support a load of 80 kN. Suggest a suitable size of fillet weld if the safe shear stress for the weld material is 80 MPa. Refer the given figure.(SHEET NO.4)



7. A bracket carrying a load of 15 KN is to be fillet welded as shown in Fig. Find the size of weld required if the allowable shear stress is not to exceed 80 MPa.

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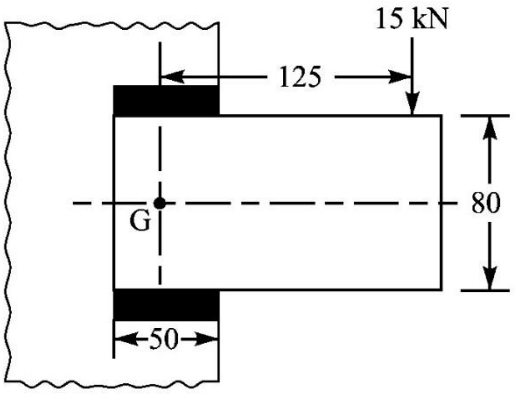


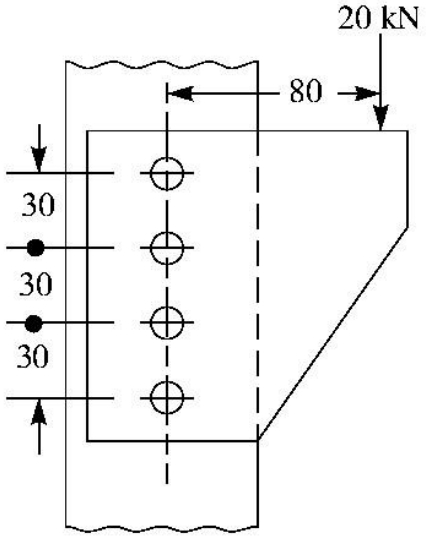
ASSIGNMENT – 9 Design of Riveted Joints

Theory

1. Define riveted joints. Classify and explain the different types of riveted joints with neat sketches.
2. Explain the following terms related to riveted joints:
   a) Pitch, b) Margin, c) Diagonal pitch and d) Transverse pitch.
3. Explain caulking & fullering in terms of riveted joint.
4. Discuss the different types of failures in riveted joint (or the various ways in which a riveted joint may fail).

Examples

1. Find the efficiency of the double riveted lap joints with zig-zag riveting is to be designed for 13 mm thick plates. Assume 80 MPa, 60 MPa and 120 MPa in tension, Shear and crushing respectively. Also calculate pitch of rivets.
2. Design a double riveted, double strap, chain type butt joint for plates having 10 mm thickness. Also find efficiency of the joint. Take σ_t = 95 N/mm^2, σ_c =155 N/mm^2 and τ =80 N/mm^2.
3. A double riveted double cover butt joint in plates 20 mm thick is made with 25 mm diameter. Rivets at 100 mm pitch. The permissible stress are σ_t =120 N/mm^2, Shear stress= 100 N/mm^2, σ_c= 150 N/mm^2. Find the Efficiency of joint, taking the strength of the rivets in double shear as twice than that of single shear. (SHEET NO.5)
4. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume joint efficiency as 75%, allowable tensile stress in the plate 90 MPa, .(SHEET NO.5)
   Compressive stress 140 MPa & shear stress in the rivet 56 MPa.
5. A bracket is supported by means of four rivets of same size as shown in Fig. Determine the diameter of rivet if the maximum shear stress is 140 MPa.(SHEET NO.5)



ASSIGNMENT 10 – INTRODUCTION TO LIMITS FITS AND TOLERANCES

Theory

1. Explain types of tolerances with neat sketch and explain applications for it.
2. Explain types of deviations with neat sketch and explain applications for it.
3. Explain types of clearances with neat sketch and explain applications for it.
4. Explain types of fits with neat sketch and explain applications for it.
5. What is surface roughness? How it is indicated on drawing with the help of various symbols? Explain importance of it.
6. Explain the various machining symbols with all parameters.
7. Explain hole-based and shaft based limit system with neat sketch. Give appropriate examples also.
8. Give symbols for following various geometrical tolerances and explain it: Straightness, Flatness, Circularity, Parallelism, Perpendicularity, Cylindricity, Symmetry, Angularity and Concentricity.