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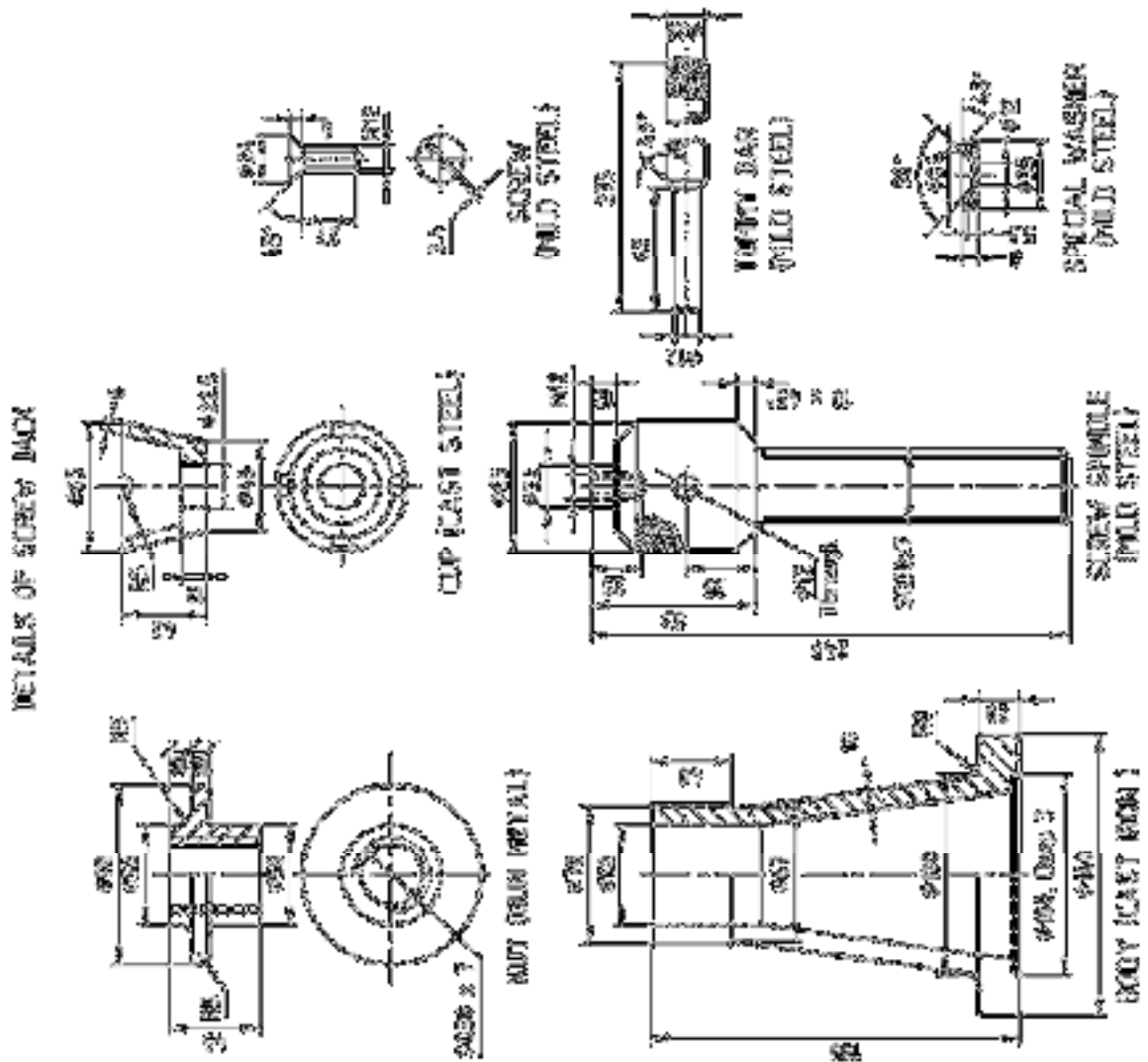*Subject Name: Fundamentals of Machine Design (3141907)   Sem: 4th*

Practical-1

Detail and assembly of mechanism/machine.

CUP (CAST STEEL)

SCREW (MILD STEEL)

SPECIAL WASHER (MILD STEEL)

SCREW SPINDLE (MILD STEEL)

TOMMY BAR (MILD STEEL)

NUT (GUN METAL)

BODY (CAST IRON)

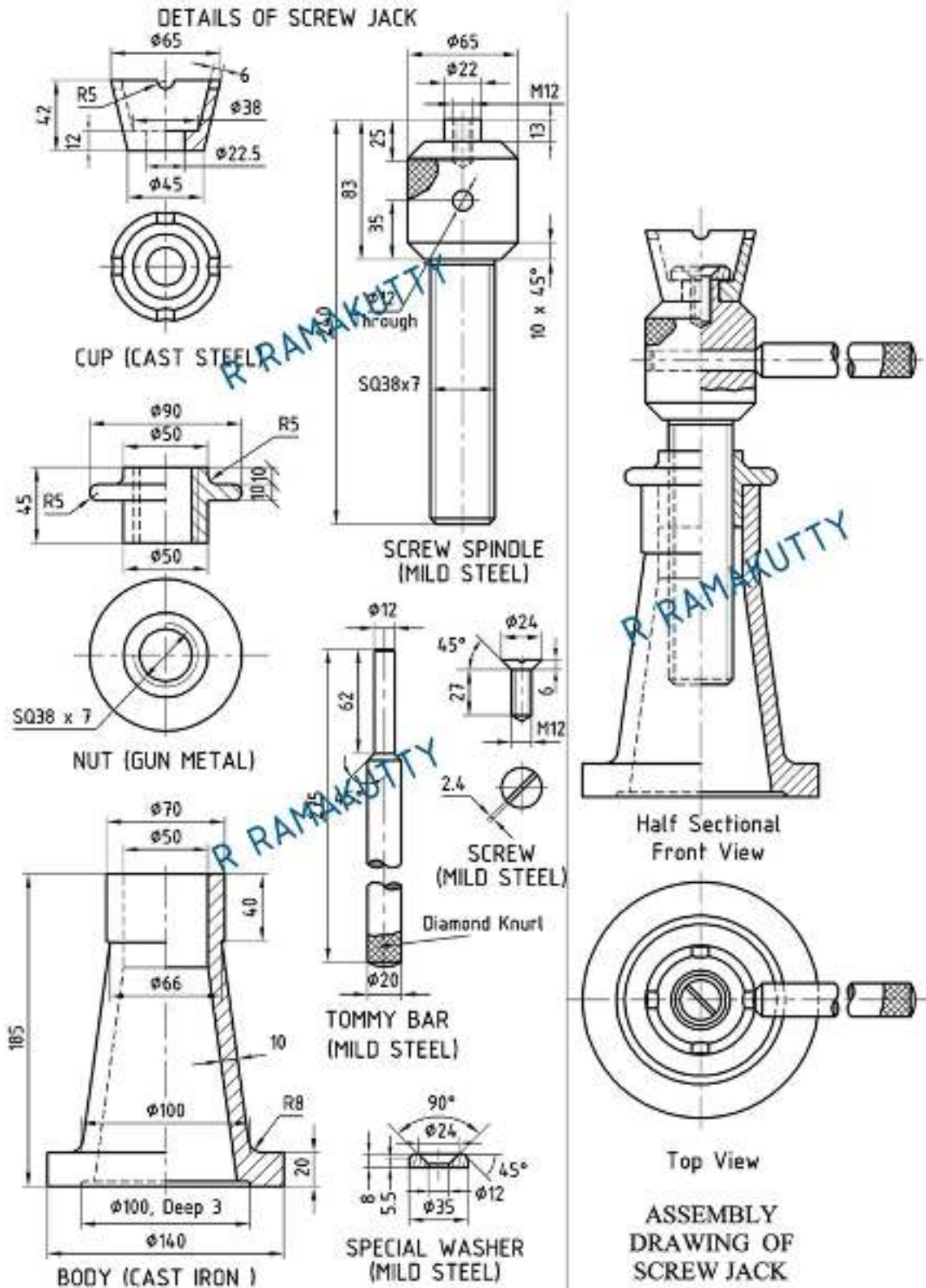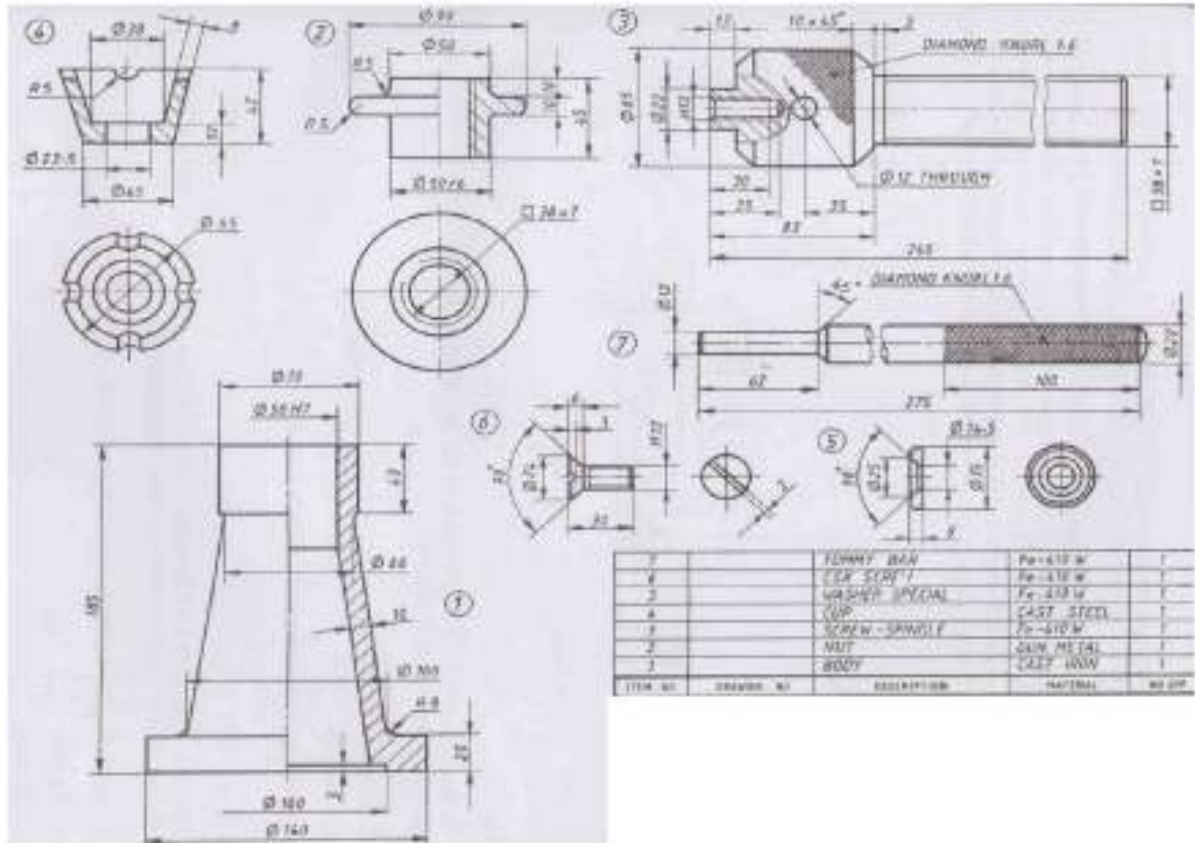# VIDHYADEEP INSTITUTE OF ENGINEERING AND TECHNOLOGY

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DETAILS OF SCREW JACK

Ø65
6
R5
Ø38
42
12
Ø22.5
Ø45

CUP (CAST STEEL)

Ø90
Ø50
R5
45
R5
10 10
Ø50
SQ38 x 7

NUT (GUN METAL)

Ø70
Ø50
40
Ø66
185
Ø100
R8
20
Ø100, Deep 3
Ø140

BODY (CAST IRON)

Ø65
Ø22
M12
25
83
35
13
through
SQ38x7
10 x 45°

SCREW SPINDLE (MILD STEEL)

Ø12
62
Ø20
Diamond Knurl

TOMMY BAR (MILD STEEL)

Ø24
45°
27
6
M12

2.4

SCREW (MILD STEEL)

90°
Ø24
45°
8
5.5
Ø35
Ø12

SPECIAL WASHER (MILD STEEL)

Half Sectional Front View

Top View

ASSEMBLY DRAWING OF SCREW JACK

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Practical-2

Problems related to fundamentals of design (chapter no. 1 to 4)

Basics of stress and strain

Q.1 Define (1) Poisson's ratio (2) Volumetric Strain (3) Modulus of rigidity (4) Bulk Modulus (5) compressive strain (6) shear strain

Q.2 Derive relation between bulk modulus (K), poission's ratio (1/m), and modulus of elasticity (E).

Q.3 Derive the relation between bulk modulus and modulus of rigidity.

Q.4 State 'Hooks Law'. Derive formula to determine change in length (δL) for the uniform, homogeneous axially loaded member of length (L), c/s area (A) and modulus of elasticity (E), subjected to axial tensile force (P).

Q.5 A stepped circular bar ABCD is axially loaded as shown in fig. (ii) is in equilibrium. Find unknown force P, and calculate stresses in each part and total change in length of the bar. Take Ecopper= 100 GPa, Ebrass= 80 GPa and Esteel= 200 GPa.
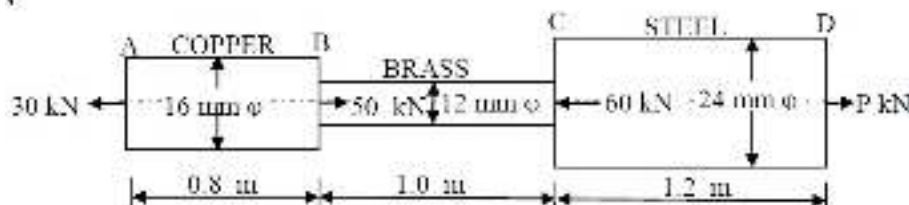
Q.6 A short concrete column 450mm x 450mm in section is axially loaded to 500 kN. The column is strengthened by four, 16mm diameter steel bars each one at corner. Calculate stresses in concrete and steel. Take Ec = 14 GPa and Es = 210 Gpa

Q.7 In an assembly of steel rod of 20 mm diameter passes centrally through a copper tube 40 mm external diameter and 30 mm internal diameter. The tube is closed at both ends by rigid plates of negligible thickness, is initially stress free. If the temperature of the assembly is raised by 60„a C, calculate stresses developed in copper and steel. Take Modulus of elasticity E for steel = 200 MPa and for copper = 100 MPa, Co efficient of thermal expansion for steel = 12 x 10-6 per ºC and for copper = 18 x 10-6 per °C.

Q.8 A stepped circular bar ABC is axially loaded as shown in fig. (i), is in equilibrium. The diameter of part AB is 50 mm throughout its length, whereas diameter part

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BC is uniform decreasing from 40 mm at B to 30 mm at C. Determine (i) magnitude of unknown force 'P' (ii) stress in part AB and (iii) change in length of part BC. Take modulus of elasticity = 2 x 105 N/mm2.
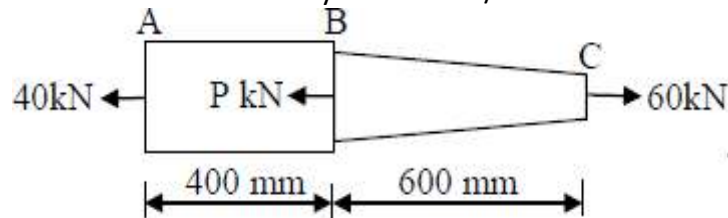

Fig. (i) Q.1(c)

Q.9 A reinforced concrete column 500 mm x 500 mm in section is reinforced with four steel bars of 25 mm diameter, one in each corner. The column is carrying an axial load of 1000 kN. Find the stresses in concrete and steel bars. Take E for steel = 210 GPa and E for concrete = 14 GPa.

Q.10 A steel circular bar of 16 mm diameter is placed inside a copper tube, having internal diameter of 20 mm and thickness of 2.5 mm as shown in fig. (vii). Both the ends are rigidly fixed and initially stress free. If the temperature of assembly is increased by 50ºC, compute magnitude and nature of stresses produced in each material. Take modulus of elasticity of steel and copper as 200 GPa and 100 GPa respectively. Take coefficient of thermal expansion (per ºC) for steel and copper as 12 x 10-6 and 18 x 10-6 respectively.

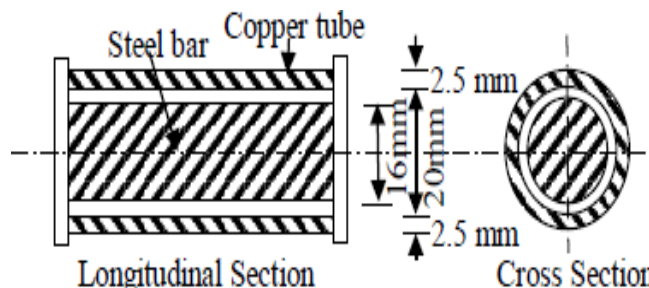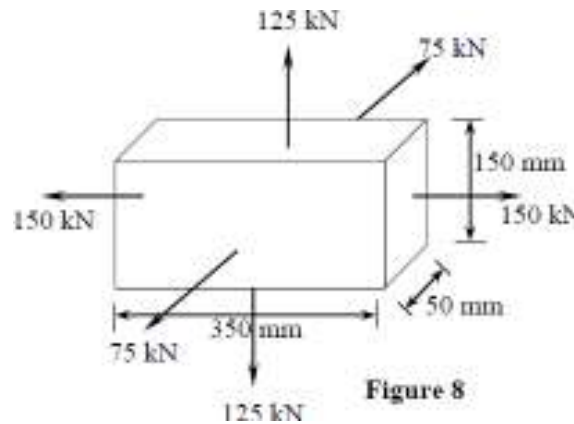

Fig. (vii) Q.4(a) OR

Q.11 A rectangular block of size 350mm (l) x 50mm (b) x 150mm (h) is subjected to forces shown in figure 8. E = 2 x 105 N/mm2 and Poisson's ratio is 0.28, calculate the Change in volume of block.

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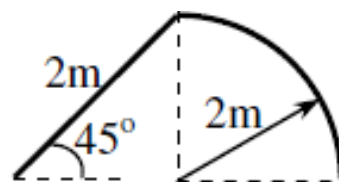**Vidhyadeep Campus, Anita (Kim), Ta. Olpad, Dist. Surat**

Figure 8

Moment of inertia of planar cross -sections

Q.1 State pappus –Guldinus theorems. Using these theorems derive the formula for surface area (A) and volume (V) for sphere of radius "r".

Q.2 State PappusGuldinus Theorem for surface of revolution.

Q.3 State Parallel axis theorem and perpendicular axis theorem. Derive formula for moment of Inertia of a rectangular section about horizontal centroidal axis from first fundamental. Using parallel axis theorem, derive formula for moment of inertia about base of the section.

Q.4 Locate the centroid of composite line ABCD as shown in figure.
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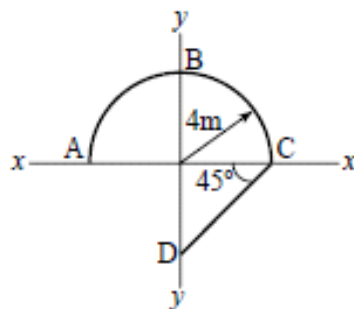
Q.5 Determine the centroid of the wire shown in figure.

Q. 6 Determine moment of inertia about horizontal centroidal axis for the section shown in fig.
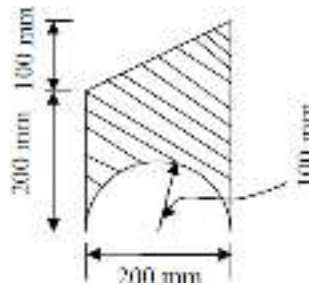
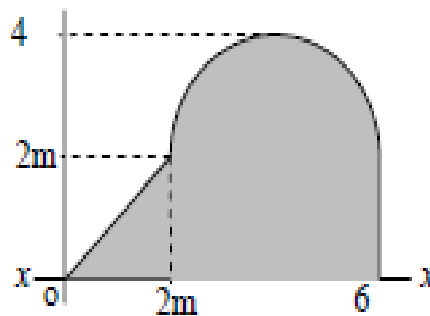# *VIDHYADEEP INSTITUTE OF ENGINEERING AND TECHNOLOGY*

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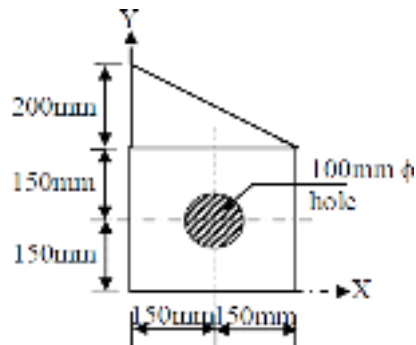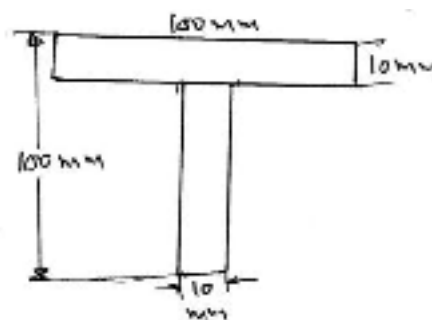
Q.7   Find center of gravity of a lamina shown in the fig.5.

Q.8   Find the moment of inertia of the area about x-x axis as shown in figure 8.

Q.9   Determine the M.I. of the section about both the centroid axis.

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Flexural stresses

Q.1 Write assumption in the theory of pure bending and derive the equation of bending stress distribution across the cross section in a beam subjected to general loading.

Q.2 Prove that the maximum shear stress in a circular section of a beam is 4/3 times of average shear stress.

Q.3 Draw qualitative sketches of shear stress distribution across the cross section indicating position of maximum shear stress in solid circular, triangular, I-section, Hollow square, H sections, T section of the beams and rhombus section.

Q.4 Draw bending stress distribution diagram across the cross section of a 'T' beam, having flange 150 x 20 mm and web 20 x 250 mm, carrying pure hogging

Q.5 A cast iron water pipe of 500 mm inside diameter and 20 mm thick, is supported over a span of 10 meters. Find the maximum bending stress in the pipe metal, when the pipe is running full. Take density of cast iron = 70.6 kN/m^3 and water = 9.8 kN/m^3.

Q.6 Write assumption in the theory of pure bending and derive the equation of bending stress distribution across the cross section in a beam subjected to general loading.

Torsion

Q.1 Write the assumptions for finding out shear stress in a circular shaft, subjected to torsion. Prove that $\tau/R = C\theta/L$ with usual notations for circular shaft.

Q.2 A solid steel circular shaft is required to transmit a torque of 6.5 kNm. Determine minimum diameter of the shaft, if shear stress is limited to 40 N/mm2 and angle of twist should not exceed 0.5º per meter. Take Modulus of rigidity C = 85 GPa.

Q.3 A solid steel shaft has to transmit 350 kW at 900 r.p.m. Find the diameter of the shaft if the shear stress is to be limited to 125 N/mm2. Calculate the diameter of the shaft if hollow shaft is provided of internal diameter equals 0.75 times external diameter

Q.4 A solid steel shaft has to transmit 350 kW at 900 r.p.m. Find the diameter of the shaft if the shear stress is to be limited to 125 N/mm2. Calculate the diameter of the shaft.

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Subject Name: Fundamentals of Machine Design (3141907)   Sem: 4th

Practical-3

Design and drawing of Joints and levers.

1   A double riveted double cover butt joint in plates 30 mm thick is made with 35 mm diameter rivets at 100 mm pitch. The permissible stresses are .σt =120Mpa, τ = 100 Mpa and σc =150 Mpa.Find the efficiency of joint, taking the strength of the rivet in double shear as twice than that of single shear.

2   What are the advantages and disadvantages of welded joints over riveted joints?

3   Draw neat sketch of Double riveted zigzag lap joint with all terminology
4   Design a double riveted zigzag lap joint for 13 mm thick plates. The allowable stresses are: σt = 80 MPa, τ = 60 MPa and σc = 120 MPa. State how the joint will fail and find efficiency of joint.
5   Deduce the equation for strength of transverse fillet weld.
6   Draw neat sketch of Double riveted zig-zag butt joint with all terminology.
7   Two steel plates, 120 mm wide and 12.5 mm thick, are joined together by means of double transverse fillet welds. The maximum tensile stress for plates and welding materials should not exceed 110 N/mm2. Find required length of weld, if strength of weld is equal to strength of plates.
8   Explain with neat sketch three basic types of lever stating their practical examples.
9   A bell crank lever is to be designed to raise a load of 6 kN at short arm end. The arm lengths are 160 mm and 550 mm. The permissible stresses for lever and pin materials in shear and tension are 60 MPa and 90 MPa respectively. The bearing pressure on pin is to be limited to 13 MPa. Assume lever cross section as t×4t and fulcrum pin length as 1.25 times pin diameter.
10   Design a right angled bell crank lever to raise a load of 6 kN at short

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arm. The lengths of short and long arms of a lever are 90 mm and 540 mm respectively. The lever and the pins are made of steel. The permissible stresses of steel are 80 N/mm2 in tension, 40 N/mm2 in shear and 10 N/mm2 in bearing. Assume the cross section of the lever as rectangular with depth as three times the thickness.

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Practical-4

Design and drawing of screw jacks (Bottle neck and Toggle).

1   What are the different types of screws threads used for power screw? Draw different form of threads used in power screws

2   Draw Terminology of power screw with neat sketch

3   What is self-locking and overhauling of power screw? Explain the condition for self-locking.

4   Derive the expression for torque and efficiency of a power screw.

5   A square threaded, triple start power screw, used in a screw-jack, has a nominal diameter of 50mm and a pitch of 8mm. the screw jack is used to lift a load of 7.5kN. The co-efficient of thread friction is 0.12 and collar friction is negligible. If the length of nut is 48mm, calculate 1. The principal shear stress in the body 2. The transverse shear stress in screw and nut and 3. The bearing pressure. State whether the screw is self-locking.

6   A power screw having double start square threads of 25 mm nominal diameter and 5 mm pitch is acted upon by an axial load of 10 kN. The outer and inner diameters of screw collar are 50 mm and 20 mm respectively. The coefficient of thread friction and collar friction may be assumed as 0.2 and 0.15 respectively. The screw rotates at 12 rpm. Assuming uniform wear condition at the collar and allowable thread bearing pressure of 5.8 N/mm2, find: (i) the torque required to rotate the screw; (ii) the stress in the screw; and (iii) the number of threads of nut in engagement with screw.

7   A double threaded power screw with ISO metric trapezoidal threads with 15° semi-angle of thread is used to raise a load of 300 kN. The nominal diameter is 100 mm and pitch is 12 mm. the coefficient of

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friction at screw threads is 0.15. Neglecting collar friction, calculate; (i) torque required to raise the load, (ii) torque required to lower the load and (iii) efficiency of the screw.

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Subject Name: Fundamentals of Machine Design (3141907)   *Sem: 4th*

Practical-5

Design of machine components under fluctuates loading.

1   Define factor of safety. List the factors affecting its value.
2   What is the difference between Drawing, Drafting and Design?
3   Name the different theories of failures of mechanical components made of ductile material. Explain the maximum shear stress theory giving conservative zone.
4   What is stress concentration? Explain any two methods of reducing of it with
     Neat sketches.
5   Explain maximum shear stress theory.
6   Calculate the diameter of a piston rod for a cylinder of 1.5 m diameter in
     which the greatest difference of steam pressure on two sides of piston may be
     assumed to be 0.2 N/mm2. The rod is made of mild steel and is secured to
     piston by a tapered rod and nut and to the crosshead by a cotter. Assume
     modulus of elasticity as 200 kN/mm2 and factor of safety as 8. The length of
     rod may be assumed as 3 m.
7   A bolt is subjected to a direct load of 25 kN and shear load of 15 kN. Considering
     (i) maximum normal stress (ii) maximum shear stress and (iii) von-Mises

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theories of failure, determine a suitable size of the bolt, if the material of the bolt
is C15 having 200 N/mm2 yield strength. Take Factor of safety = 2.

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Practical-6

Case study for design of mechanical components.

DESIGN AND ANALYSIS OF A CRANK SHAFT.

DESIGN AND ANALYSIS OF PISTON BY USING FINITE ELEMENT ANALYSIS.

DESIGN OF TOGGLE JACK.

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Practical-7

2D drawing of machine components using computer software.

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