# Lab Manual

## FUNDAMENTAL OF MACHINE DESIGN

## 3141907

**Department of Mechanical Engineering**

# LUKHDHIRJI ENGINEERING COLLEGE-MORBI

## Vision of the Institute

To provide quality engineering education and transforming students into professionally competent and socially responsible human beings.

## Mission of the Institute

- To provide a platform for basic and advanced engineering knowledge to meet global challenges
- To impart state-of-art know- how with managerial and technical skills
- To create a sustainable society through ethical and accountable engineering practices

## MECHANICAL ENGINEERING DEPARTMENT

## Vision of the Department

To deliver quality engineering education for Mechanical Engineers with Professional competency, Human values and Acceptability in the society.

## Mission of the Department

- To nurture engineers with basic and advance mechanical engineering concepts
- To impart Techno-Managerial skill in students to meet global engineering challenges
- To create ethical engineers who can contribute for sustainable development of society

## Program Educational Objectives (PEOs)

Program Educational Objectives of the Department are,

1. Apply their knowledge of basic science and engineering to analyze and solve problems related to mechanical engineering.
2. Able to design and develop the new system/process using advanced technologies and tools.
3. Enhance professional practice to meet global challenges with their ethical and social responsibility.

## Program Specific Outcomes (PSOs)

1. Students will be able to apply the knowledge of computer aided tools for design and development of products based on engineering principles.
2. Students will be able to manage production of components/systems using conventional and advanced manufacturing methods.

**VISION**

To deliver quality engineering education for Mechanical Engineers with Professional competency, Human values and Acceptability in the society.

# L.E.COLLEGE MORBI

## CERTIFICATE

*This is to certify that Mr./Ms.*_____

*Enrollment No.*_____ *Branch*_____

***Semester 4th*** *has satisfactory completed the course work in the subject*

***Fundamental of Machine Design in*** *this institute.*

Date of Submission: -___/___/ _____

Staff in Charge Head of Department

**Mission**

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- To create ethical engineers who can contribute for sustainable development of society

# L.E.COLLEGE MORBI

Department of Mechanical Engineering

B.E. Semester – IV

## Fundamental of Machine Design (3141907)

List of Experiments

| Sr. No. | Title | Date of completion | Initial of Teacher |
|---|---|---|---|
| 1 | Detail and assembly of mechanism/machine. | | |
| 2 | Problems related to fundamentals of design (chapter no. 1 to 4). | | |
| 3 | Design and drawing of different Joints and problems of eccentric loading. | | |
| 4 | Design and drawing of different levers. | | |
| 5 | Design related to beams and columns. | | |
| 6 | Design and drawing of screw jacks. | | |
| 7 | Design of machine components under fluctuates loading. | | |
| 8 | Case study for design of mechanical components. | | |
| 9 | 3D drawing of machine components using computer software. | | |
| 10 | Analysis of machine components using computer software. | | |

**MAPPING OF CO/PO/PSO:**

| Sr. No. | Title | COs | POs | PSOs | Marks |
|---|---|---|---|---|---|
| 1 | Detail and assembly of mechanism/machine. | CO1 | PO1,PO2 | | 2 |
| 2 | Problems related to fundamentals of design (chapter no. 1 to 4). | CO1 | PO1,PO2,PO3, | | 2 |
| 3 | Design and drawing of different Joints and problems of eccentric loading. | CO2/CO3 | PO1,PO2 PO3,PO4,PO5 | | 2 |
| 4 | Design and drawing of different levers. | CO2/CO3 | PO1,PO2 PO3,PO4,PO5 | | 2 |
| 5 | Design related to beams and columns. | CO2/CO3 | PO1,PO2 PO3,PO4,PO5 | | 2 |
| 6 | Design and drawing of screw jacks. | CO2/CO3 | PO1,PO2 PO3,PO4,PO5 | | 2 |
| 7 | Design of machine components under fluctuates loading. | CO4 | PO1,PO2 PO3,PO4,PO5 | | 2 |
| 8 | Case study for design of mechanical components. | CO3,CO4 | PO1,PO2 PO3,PO4,PO5 | | 2 |
| 9 | 3D drawing of machine components using computer software. | CO3,CO4 | PO3,PO4,PO5 | PSO1 | 2 |
| 10 | Analysis of machine components using computer software. | CO3,CO4 | PO3,PO4,PO5 | PSO1 | 2 |

## Experiment No – 01

Aim: Detail and assembly of mechanism/machine

**DATA---**

Prepare the Assembly and Detail drawing to the scale and show limit, fits & Surface finish symbols according to the following.

| Mechanical | | |
|---|---|---|
| **Sr. No.** | **Batch No.** | **Name of the Drawing Sheet** |
| **1** | **4M A1** | **Screw Jack** |
| **2** | **4M A2** | **Steam Stop Valve** |
| **3** | **4M B1** | **Spring loaded safety valve** |
| **4** | **4M B2** | **Petrol engine piston and connecting rod** |

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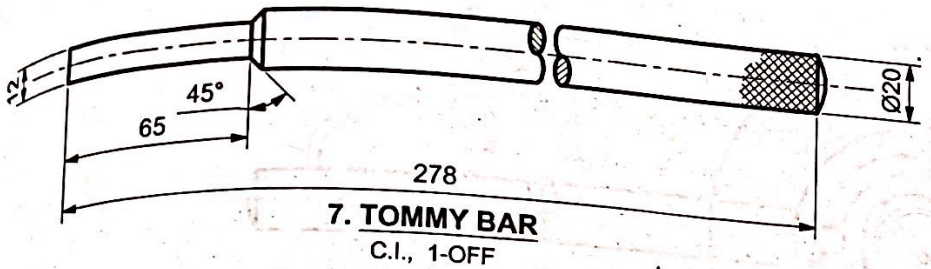
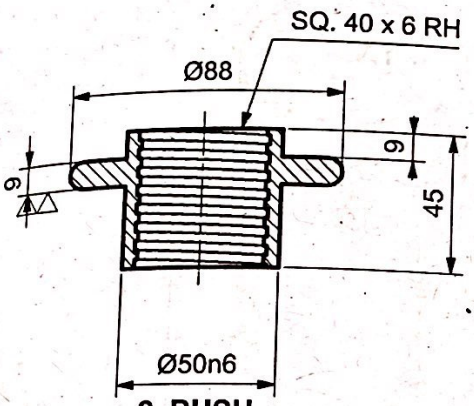
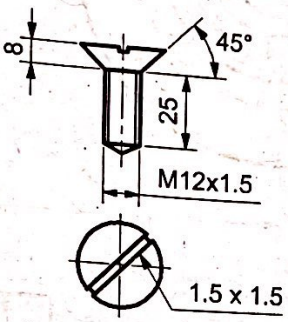


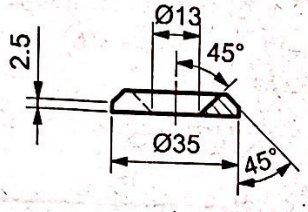

**7. TOMMY BAR**
C.I., 1-OFF



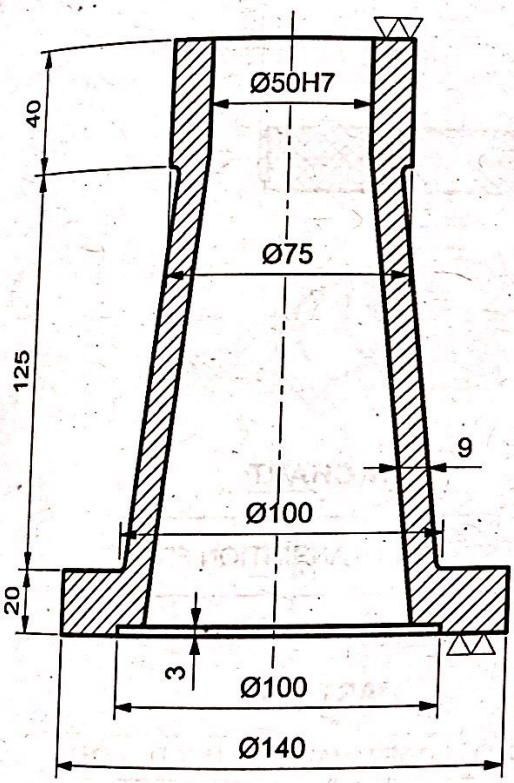

**2. BUSH**
C.I., 1-OFF

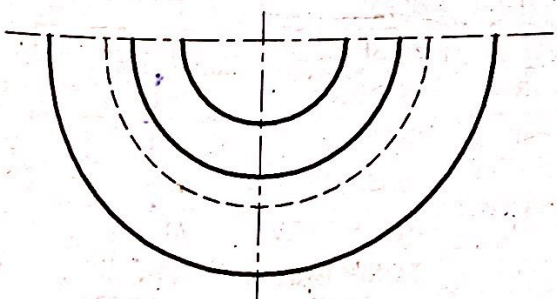



**6. SET SCREW**
C.I., 1-OFF

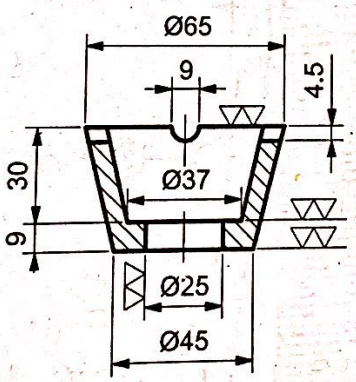


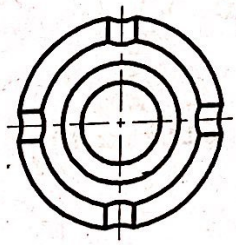

**5. WASHER**
C.I., 1-OFF



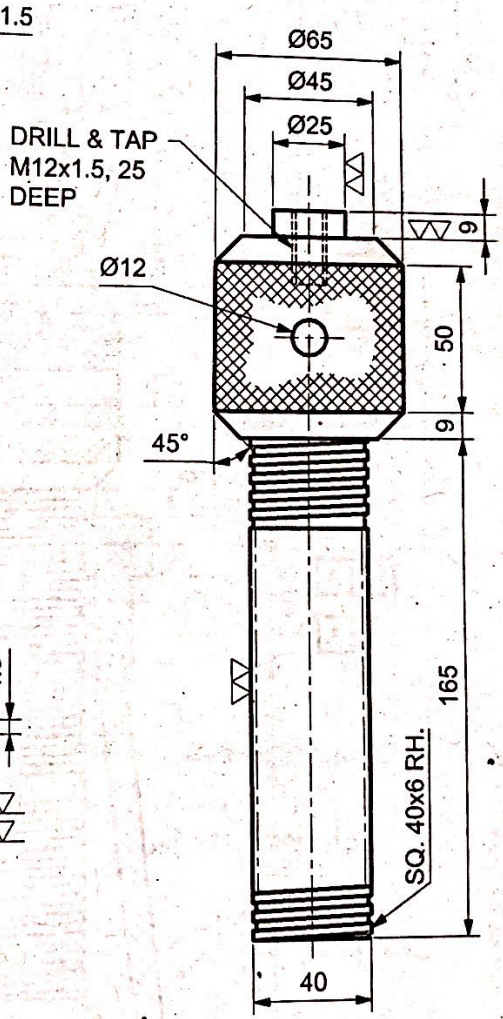



**1. BODY**
C.I., 1-OFF



**4. CUP**
C.I., 1-OFF

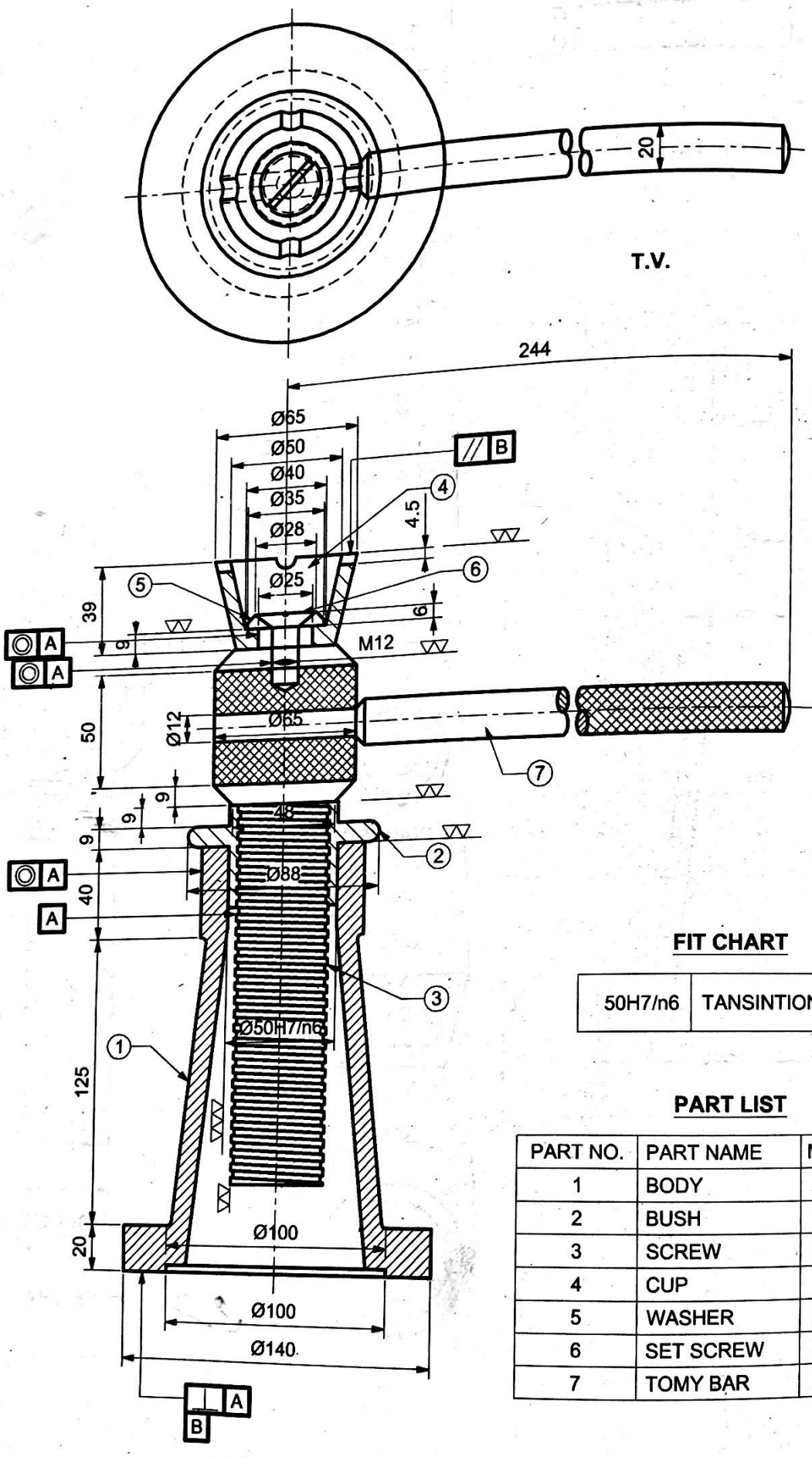



**3. SCREW**
C.I., 1-OFF

**TOLERANCE CHART**

| | |
|---|---|
| 50H7 = $^{+0.030}_{+0.000}$ | 50n6 = $^{+0.039}_{+0.020}$ |

**Fig. 7.18 : Screw jack coupling details**




**FIT CHART**

| | |
|---|---|
| 50H7/n6 | TANSINTION FIT |

**PART LIST**

| PART NO. | PART NAME | MATL. | QTY. |
|---|---|---|---|
| 1 | BODY | C.I. | 1 |
| 2 | BUSH | M.S. | 1 |
| 3 | SCREW | M.S. | 1 |
| 4 | CUP | C.I. | 1 |
| 5 | WASHER | M.S. | 1 |
| 6 | SET SCREW | M.S. | 1 |
| 7 | TOMY BAR | M.S. | 1 |

**Fig. 7.19 : Assembly of Screw jack coupling**

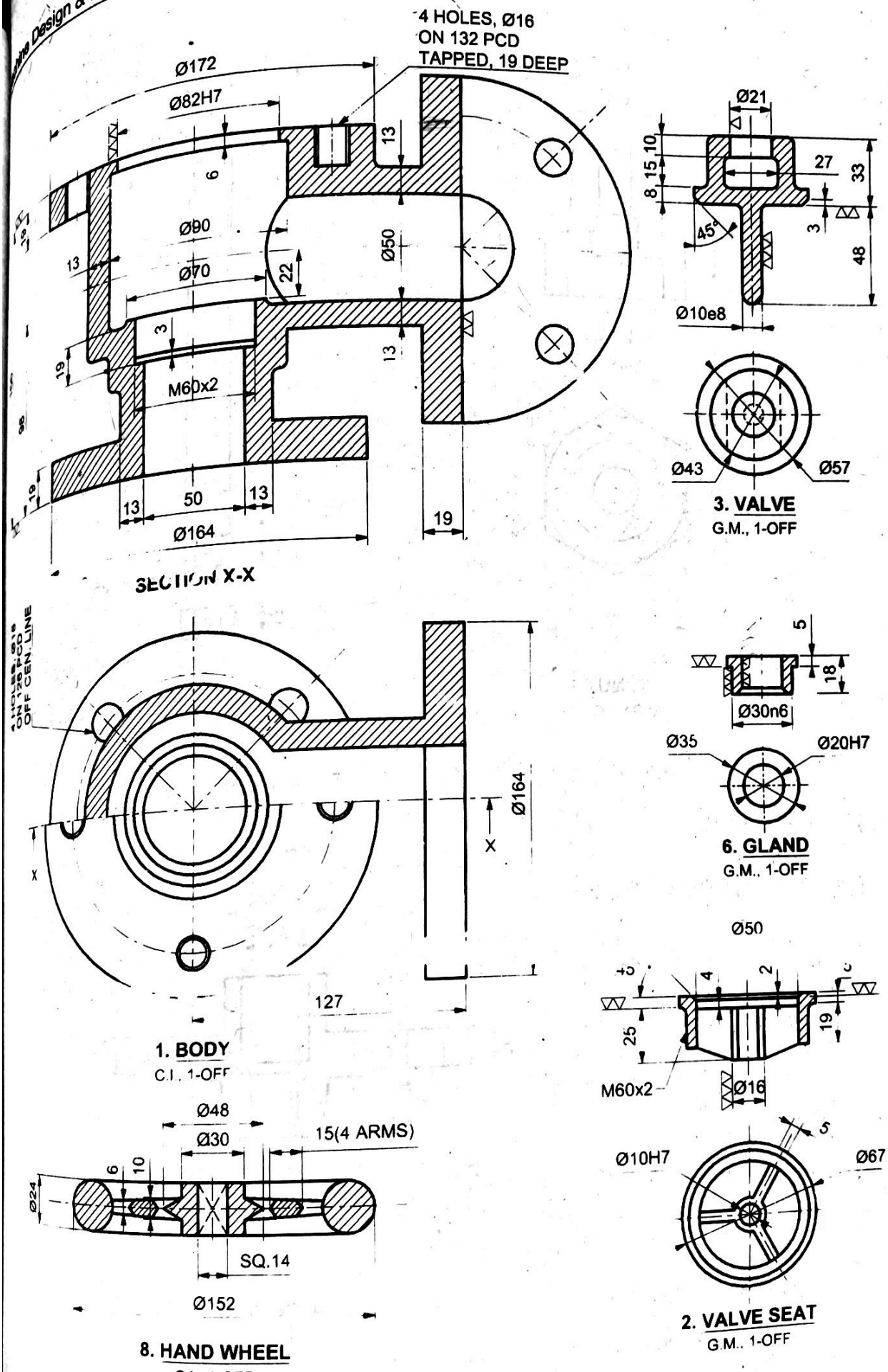
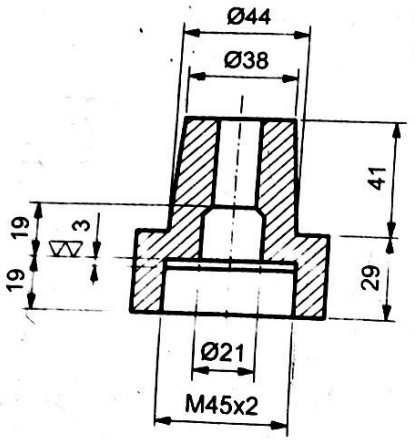
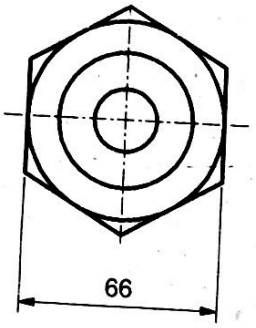
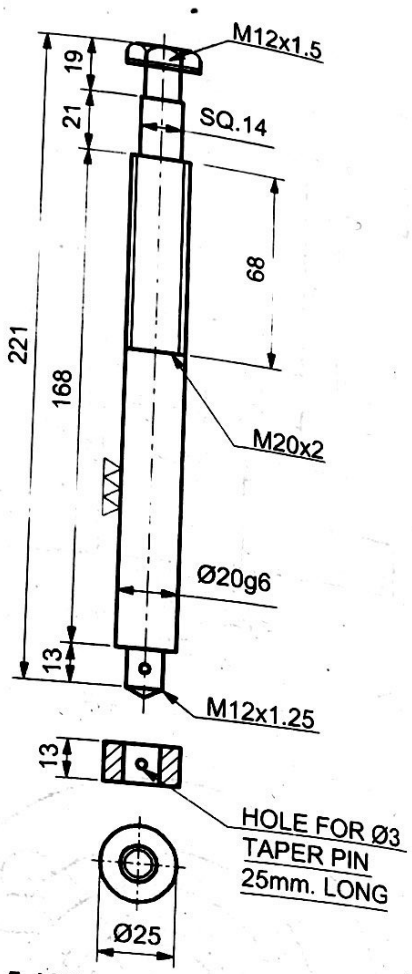



**Fig. 7.35 : Steam stop valve details**

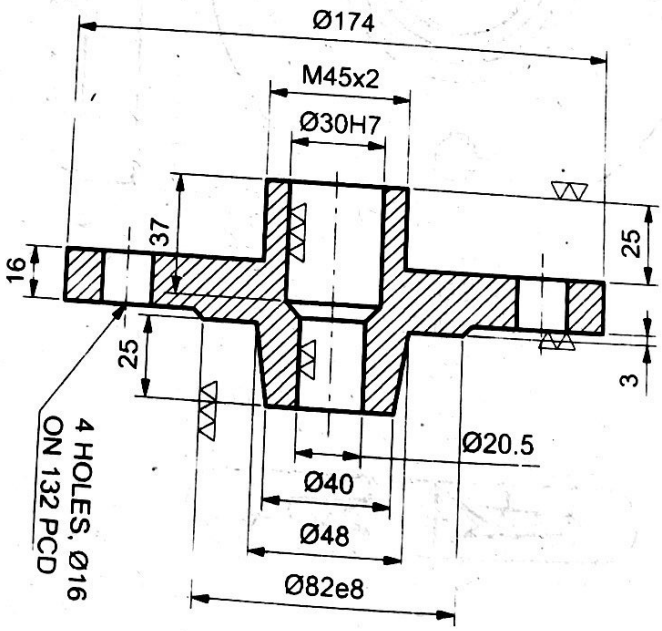



**7. NUT**
M.S., 1-OFF




**5. VALVE SPINDLE**
M.S.




**4. COVER**
C.I., 1-OFF

**Fig. 7.36 : Steam stop valve details**

**TOLERANCE CHART**

| | | | |
|---|---|---|---|
| 10H7 = | +0.018 +0.000 | 30H7 = | +0.011 +0.000 |
| 10e8 = | -0.032 -0.059 | 30e6 = | +0.033 +0.017 |
| 82H7 = | +0.035 +0.000 | 82e8 = | -0.072 -0.126 |
| 20H7 = | +0.021 +0.000 | 20g6 = | -0.007 -0.020 |

**FIT CHART**

| |
|---|
| 10H7/e8 = CLEARANCE FIT |
| 82H7/e8 = CLEARANCE FIT |
| 30H7/n6 = TRANSITION FIT |
| 20H7/g6 = CLEARANCE FIT |

**PART LIST**

| PART NO. | PART NAME | METL. | QTY. |
|---|---|---|---|
| 1 | BODY | C.I | 1 |
| 2 | VALVE SEAT | G.M. | 1 |
| 3 | VALVE | G.M | 1 |
| 4 | COVER | C.I. | 1 |
| 5 | SPINDLE | M.S. | 1 |
| 6 | GLAND | G.M | 1 |
| 5 | NUT | M.S. | 1 |
| 6 | HAND WHEEL | C.I. | 1 |

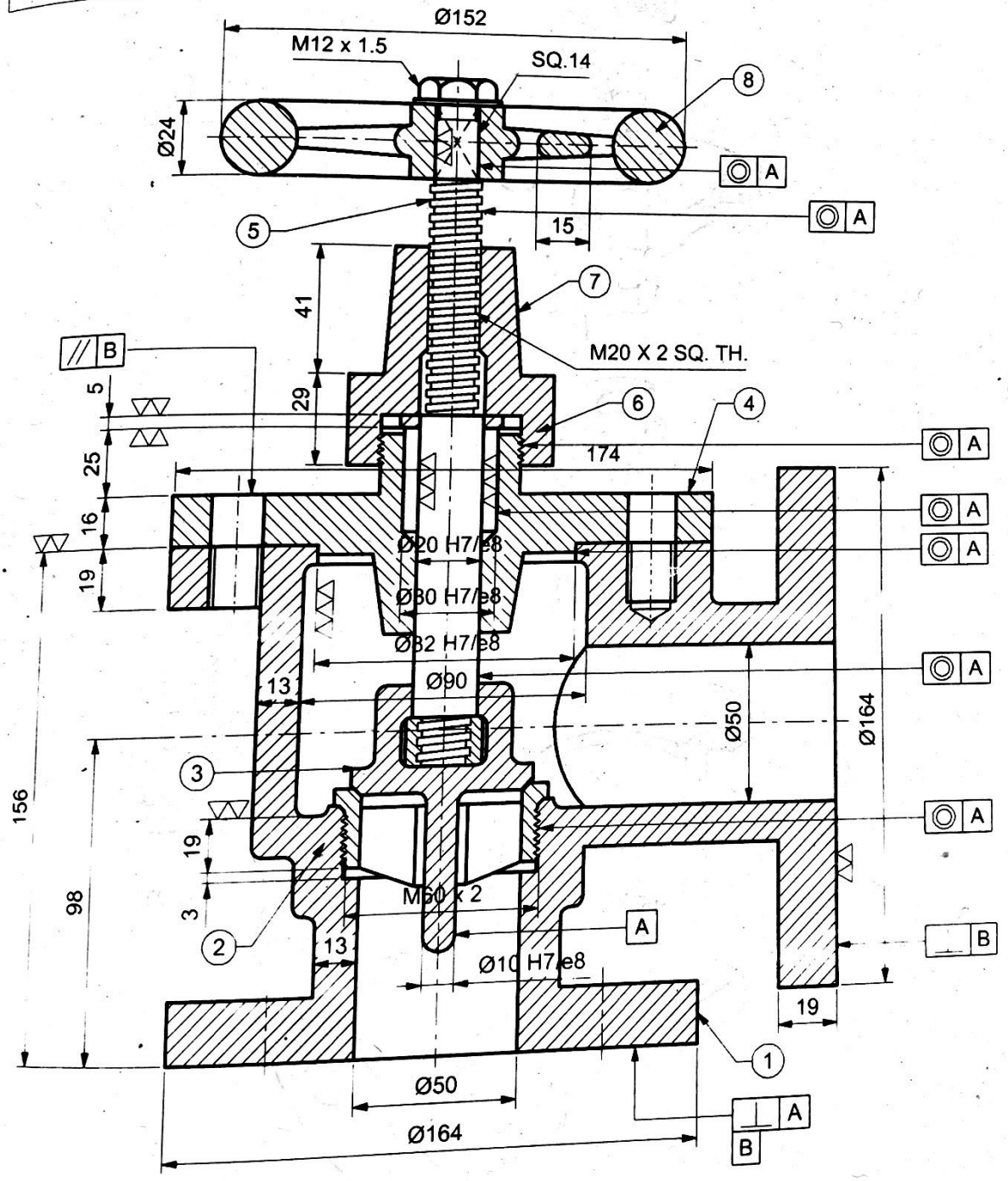



**Fig. 7.37 : Assembly of steam stop valve**

## 7.4.2 Spring Loaded Safety Valves :

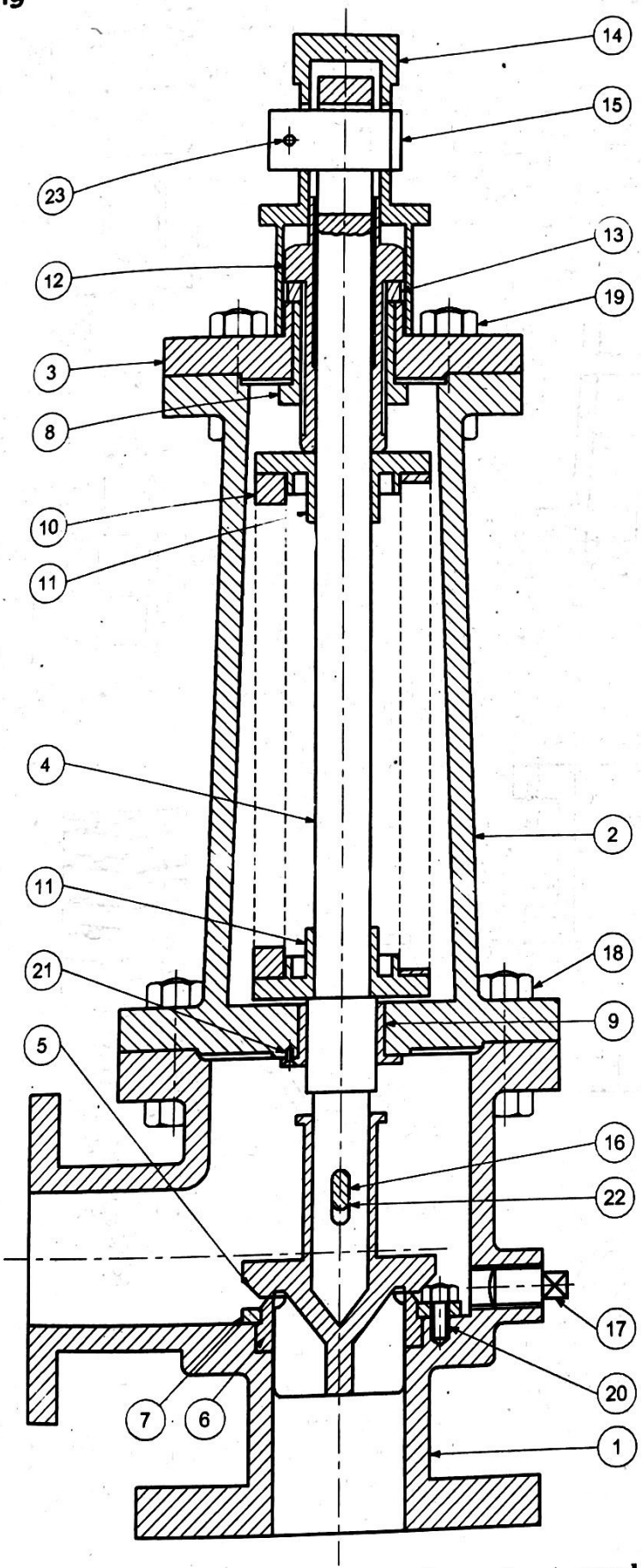



**Fig. 7.39 : Spring loaded safety valve (assembly)**

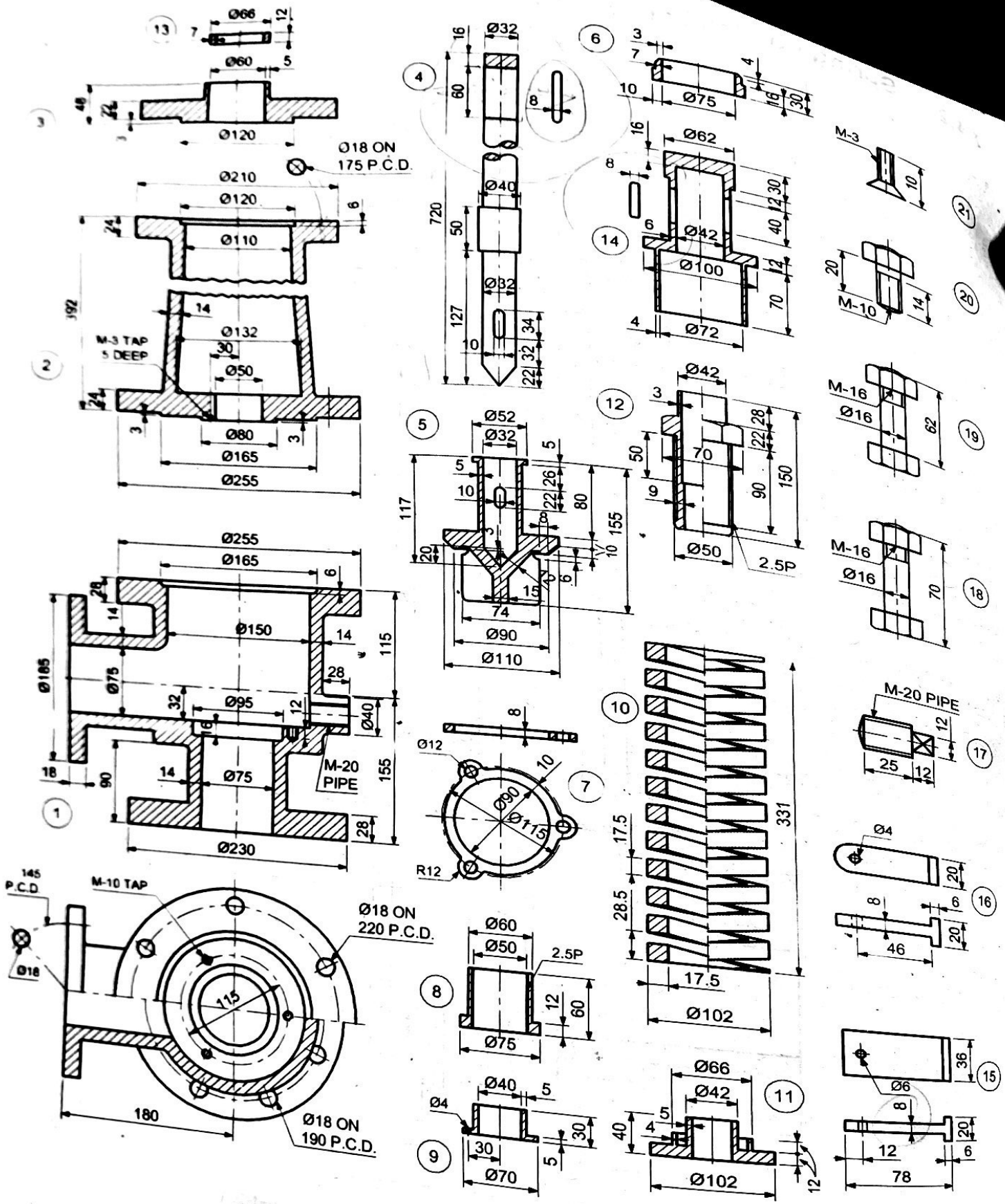
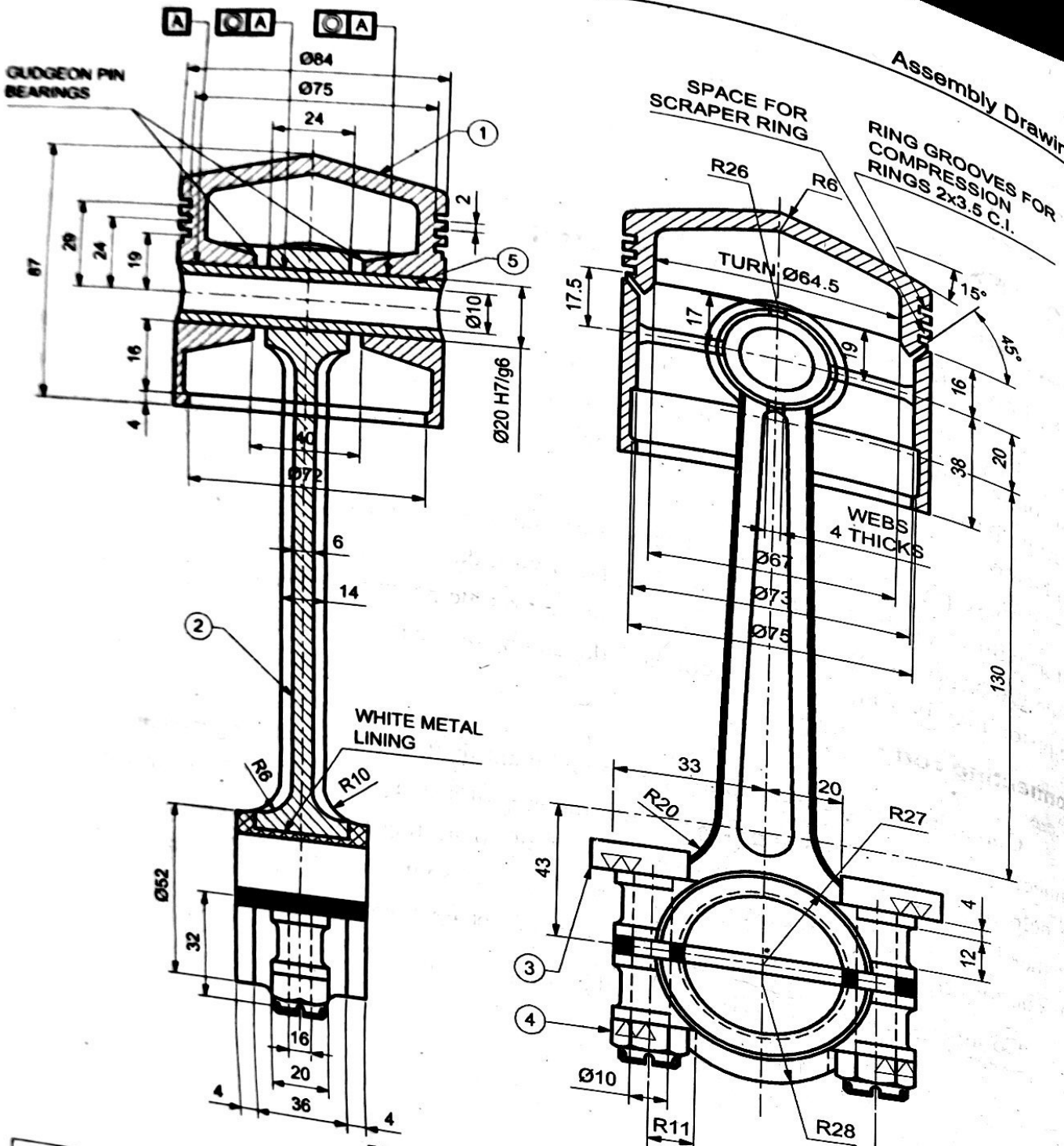



**Fig. 7.40 : Spring-loaded safety valve (details)**




**PART LIST**

| PART NO. | PART NAME | MATL. | QTY. |
|---|---|---|---|
| 1 | PISTON | ALLOY ALLOY | 1 |
| 2 | CONNECTING ROD | ALLOY STEEL | 1 |
| 3 | BIG-END BOLT | M.S. | 1 |
| 4 | CASTLE NUT | M.S. | 2 |
| 5 | GUDGEON PIN | HARDENED STEEL | 2 |

**FIT CHART**

| | |
|---|---|
| 20H7/g6 | CLEARANCE FIT |

**Fig. 7.1 : Assembly of petrol engine piston and connecting rod**

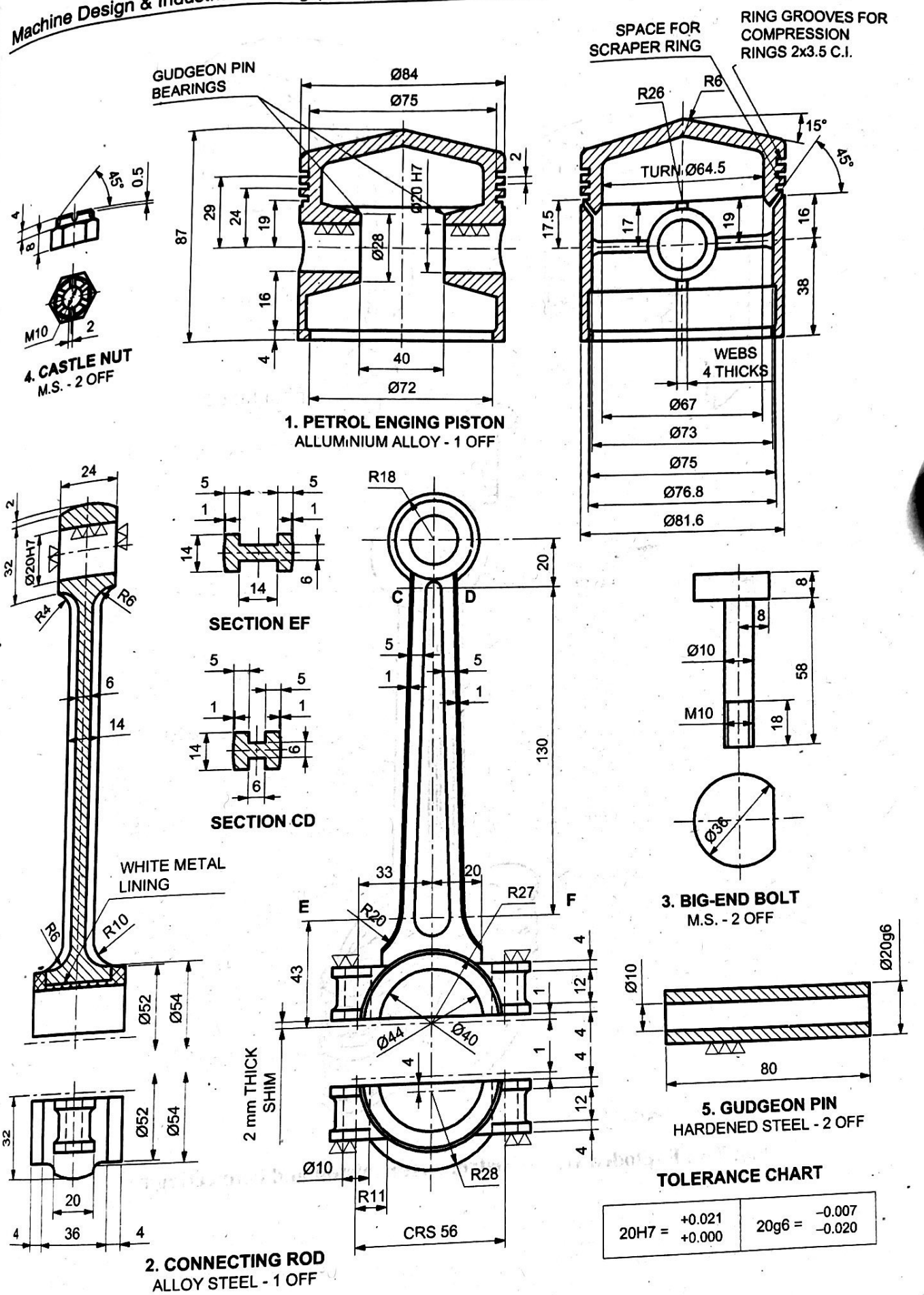



**Fig. 7.2 : Details of petrol engine piston and connecting rod**

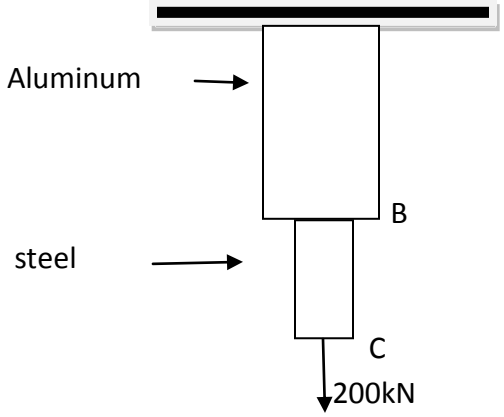
## Experiment No – 02

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

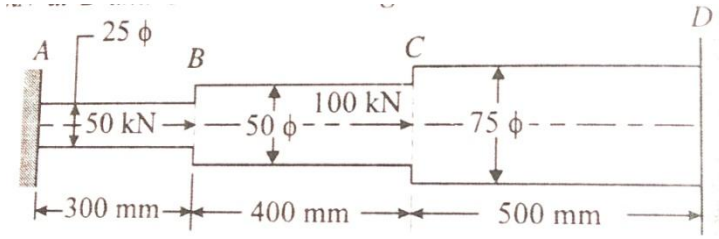
1 A hollow steel tube 305m long has external diameter of 120mm. In order to determine the internal diameter, the tube was subjected to a tensile of load of 400 kN and extension was measured to be 2 mm. If the modulus of elasticity for the material is 200 GPa, determine the internal diameter of the tube.

2 Two wires, one of steel and the other of copper, are of the same length and are subjected to the same tension. If the diameter of the copper wire is 2 mm, find the diameter of the steel wire, if they are elongated by the same amount. Take E for steel as 200GPa and for copper as 100GPa.

3 A compound bar ABC 1.5m long is made up of two parts of aluminum and steel and that cross sectional area of aluminum bar is twice that of steel bar. The rod is subjected to an axial tensile load of 200 kN. If the elongations of aluminum and steel parts are equal, find the length of the two parts of compound bar. Take E for steel as 200 GPa and for aluminum as one third of Steel.




4 A circular steel bar ABCD, fixed at A and D is subjected to axial loads of 50kN and 100kN at B and C as shown in fig. Find the load shared by each part of the bar and displacement of point B and C. Take E for steel 200GPa.




5 A steel rod ABC is firmly held between two rigid support as shown in fig. Find the stresses developed in the two portions of the rod, when it is heated through 15 K. Take $\alpha = 12 \times 10^{-6}$ /K and E= 200GPa

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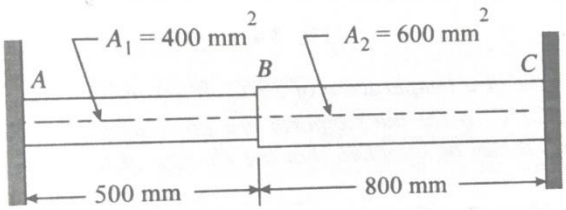
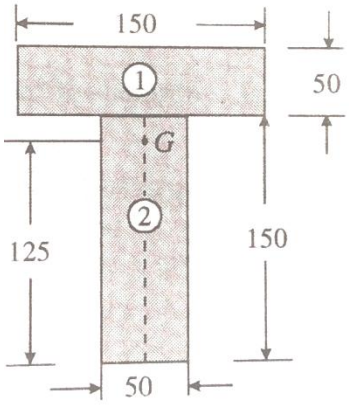
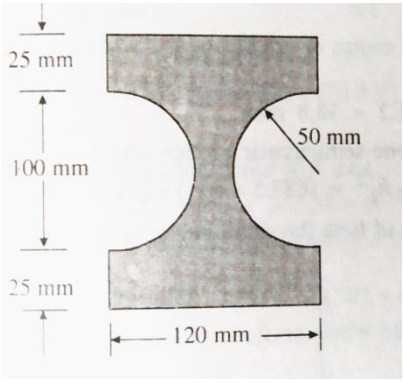



6 Find the moment of inertia of a T section shown in fig about X-X and Y-Y axes through the centre of gravity of the section.




7 Figure shows the cross section of cast iron beam. Determine the moments of inertia of the section about horizontal and vertical axes passing through the centroid of the section.




8 Two beams are simply supported over the same span and have the same flexural strength. Compare the weights of these two beams, if one of them is solid and the other is hollow with internal diameter half of the external diameter.

9 Three beams have the same length, the Same allowable stress and the same bending moment. The cross section of the beams are a square, a rectangle with depth twice the width and a circle as shown in fig,

10 A rectangular beam 60 mm wide and 150 mm deep is simply supported over a span of 6 m. if the beam is subjected to central point load of 12 kN, find the maximum bending stress induced

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in the beam.

11 A hollow steel tube having external and internal diameter of 100 mm and 75 mm respectively is simply supported over a span of 5m. The tube carries a concentrated load of W at a distance of 2 m from one of the supports. What is the value of W, if maximum bending stress is not to exceed 100 MPa.

12 A hollow shaft is to transmit 200kW at 80 rpm if the shear stress is not to exceed 60MPa and internal diameter is 0.6 of the external diameter. Find the diameters of the shaft.

13 A solid shaft is subjected to a torque of 1.6kN-m. find the necessary diameter of the shaft, if the allowable shear stress is 60MPa. The allowable twist is $1^{o}$ for every 20 diameter length of the shaft. Take C= 80GPa

14 A solid shaft of 60mm diameter is to be replaced by a hollow steel shaft of the same material with internal diameter equal to half of the external diameter. Find the diameter of hollow shaft and saving material, if the maximum allowable shear stress is same for both shafts.

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**Experiment No – 03**

## Aim: Design and drawing of different Joints and problems of eccentric loading.

1 A short column of external diameter 40 cm and internal diameter 20 cm as shown in Fig-2, carries an eccentric load of 80 KN. Find the greatest eccentricity which the load can have without producing tension on the cross-section

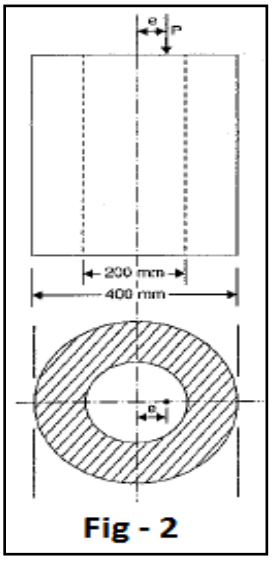

Fig - 2

2 Two rods, made of plain carbon steel 40C8 (Ultimate stress=380 N/mm$^2$) are to be connected by means of a cotter joint as shown in Fig - 4. The diameter of each rod is 50 mm and the cotter is made from a steel plate of 15 mm thickness. Calculate the dimensions if factor of safety is 6, the yield strength in compression is twice the tensile yield strength and the yield strength in shear is 50 % of the tensile yield strength

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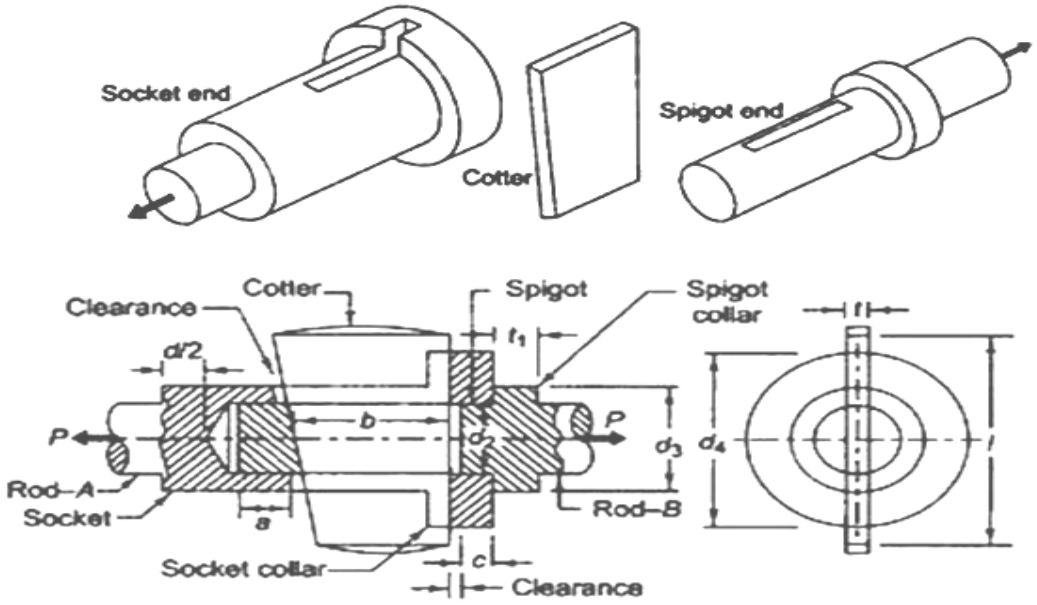


Fig - 4 Cotter Joint

3 Two rods are connected by means of a knuckle joint as shown in Fig – 5. The axial force P acting on the rods is 25 KN. The rods and the pin are made of plain carbon steel 45C8 (Ultimate stress = 380 N/mm$^2$) and the factor of safety is 2.5. The yield strength in shear is 57.7 % of the yield strength in tension. Design the joint.

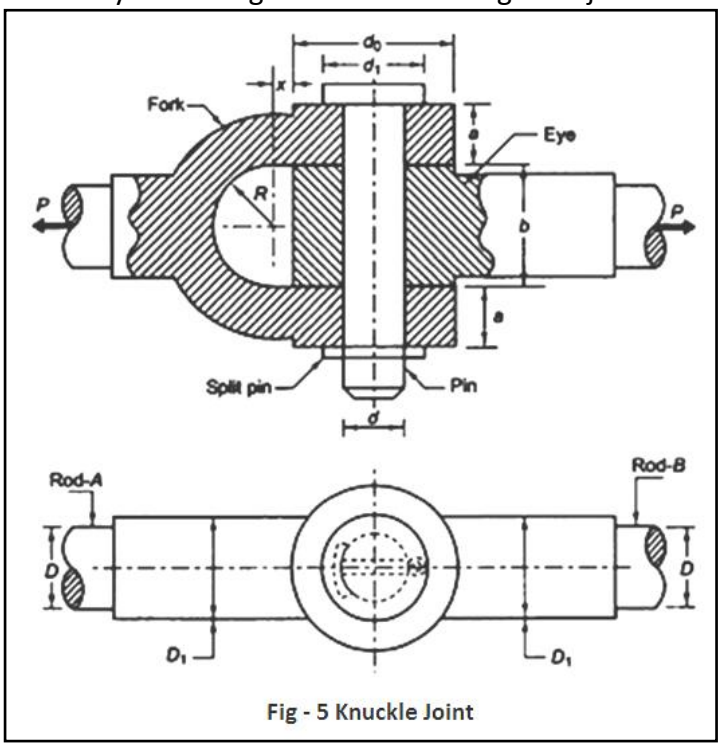


Fig - 5 Knuckle Joint

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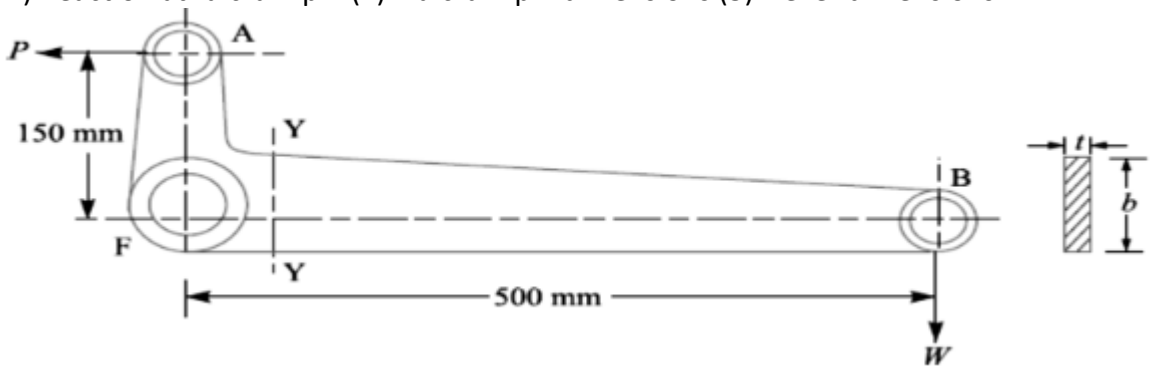
# Experiment No – 04

## Aim: Design and drawing of different levers.

**1** A right angle bell crank lever is shown in Fig. The load W = 4.5KN. The lever consists of forged steel material and a pin at the fulcrum. Take the following permissible stress for the pin and lever material. Safe stress in tension = 75MPa,Safe stress in shear = 60MPa, Safe bearing pressure on pin = 10N/mm2. The length of fulcrum pin is 1.25 times the diameter of fulcrum pin. Calculate the following:
(1.) Reaction at fulcrum pin (2). Fulcrum pin dimensions (3). Lever dimensions




**2** Design a rocker arm lever having equal arms of 160 mm length inclined at $135^{o}$ for an exhaust valve of a gas engine subjected to a maximum force 2500 N at roller end. Consider – I cross section 6t x 2.5t x t size (where t = thickness of web and flange) for lever. The permissible stresses for the lever material are 80MPa in tension and design bearing pressure is pin 6 MPa for pin.

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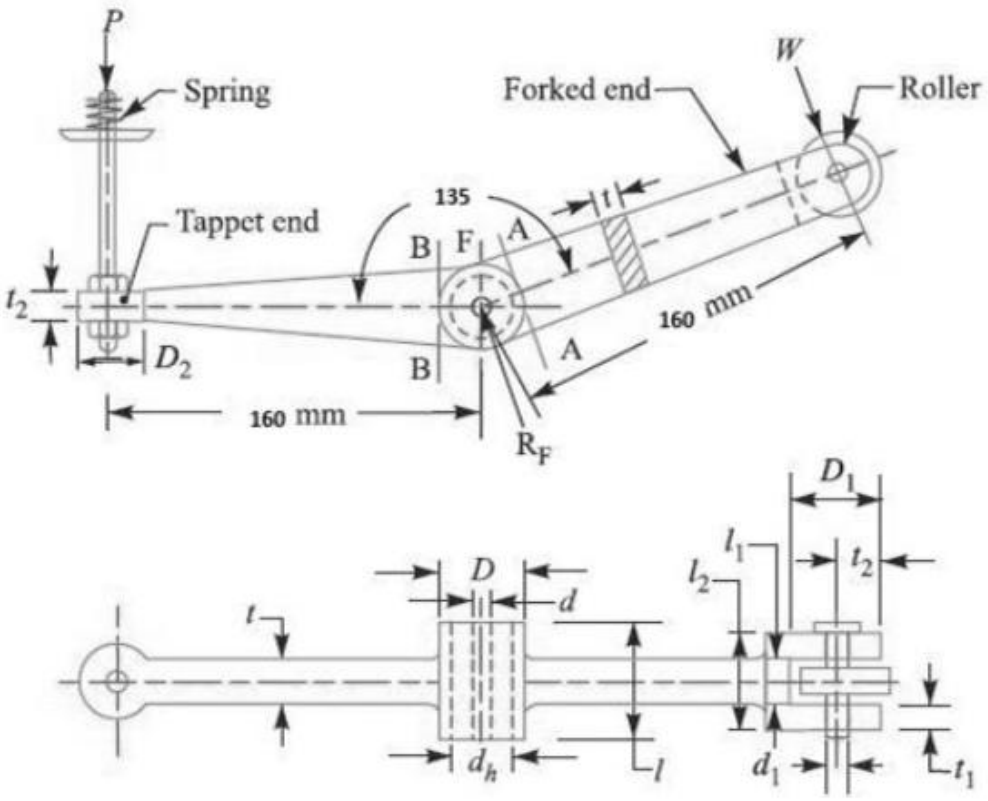


**3** Design a foot lever (brake lever) from following data:
Length of lever from the center of the shaft to point of application of load= 1 m and Max. Load on the foot plate = 800 N and Allowable tensile stress = 75 MPa and Allowable shear stress = 72 MPa.

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- To impart Techno-Managerial skill in students to meet global engineering challenges
- To create ethical engineers who can contribute for sustainable development of society

# Experiment No – 05

## Aim: Design related to beams and columns.

1 A column of timber section 15 cm X 20 cm is 6 meter length as shown in Fig-1 with both ends being fixed. If the Young's modulus for timber is 17.5 KN/mm$^2$, determine (a) Crippling load (b) Safe load for the column if factor of safety is 3

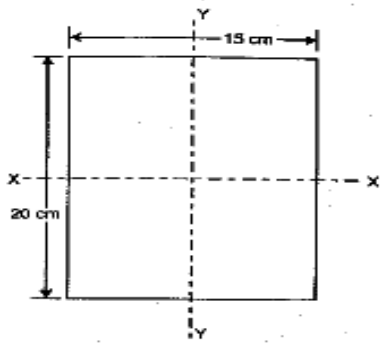


**Fig - 1**

2 A simply supported beam of length 4 meter is subjected to a uniformly distributed load of 30 KN/m over the whole span and deflects 15 mm at the centre. Determine the crippling loads when this beam is used as a column with the following conditions, assuming (a) One end fixed and other end hinged (b) Both ends pin jointed

3 Determine the ratio of bucking strengths of two columns one hollow and the other solid made of the same material, same length, same cross sectional area and same end conditions. The internal diameter of hollow column is 2/3$^{rd}$ of its external diameter.

4 A hollow mild steel tube of 5 m long, 4 cm internal diameter and 5 mm thick is used as a strut with both ends hinged. Find the crippling load and safe load taking factor of safety as 3. Take modulus of elasticity = 2 X 10 5 (N/mm2)

5 Calculate the safe compressive load on a hollow cast iron column (one end rigidly fixed and other hinged) of 10 cm external diameter, 7 cm internal diameter and 8 m in length. Use Euler's formula with factor of safety 4 and modulus of elasticity = 95 KN/mm2

6 The external and internal diameter of a hollow cast iron column is 5 cm and 3 cm respectively. If the length of this column is 4 m and both of its ends are fixed, determine the crippling load using Rankine's formula. Take the value of ultimate stress = 550 N/mm$^2$ and Rankine's constant as 1/1600

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# Experiment No – 06

## Aim: Design and drawing of screw jacks.

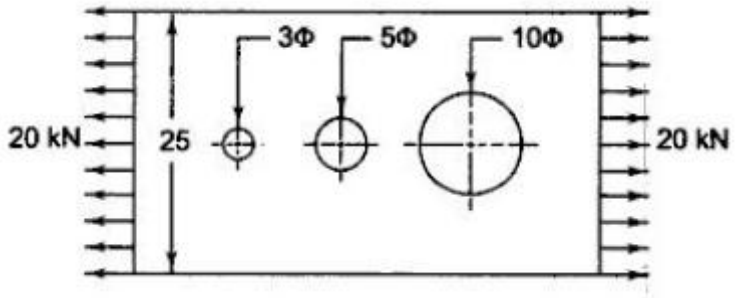
1 Write down the step by step design procedure of the screw jack.

2 Design a screw jack to lift load of 300 KN and having a maximum lift of 300 mm. select proper material and draw a proportional sketch.

# Experiment No – 07

## Aim: Design of machine components under fluctuates loading

**1** A rectangular plate, 15 mm thick, made of a brittle material is shown below. Calculate the stress at each of three holes of 3, 5 and 10 mm diameter.




**2** A forged steel bar, 50 mm in diameter, is subjected to reverse bending stress of 250 MPa. The bar is made of steel 40C8 (Ultimate tensile stress = 600 N/mm$^2$). Calculate the life of the bar for a reliability factor of 90 %

**3** The work cycle of a mechanical component subjected to completely reversed bending stresses consists of the following three elements: (a) ± 350 MPa for 85% of time (b) ± 400 MPa for 12% of time (c) ± 500 MPa for 3% of time. The material for the component is 50C4 (Ultimate tensile stress = 660 MPa) and corrected endurance limit of the component is 280 N/mm2. Determine the life of the component.

**4** A transmission shaft of cold drawn steel of 27Mn2 (Ultimate tensile stress = 500 MPa and Yield stress = 300 MPa) is subjected to a fluctuating torque which varies from ( - 100 Nm) to (+ 400 Nm). The factor of safety is 2 and the expected reliability is 90%. Neglecting the effect of stress concentration, determine the diameter of the shaft. Take distortion energy theory of failure

**5** A transmission shaft carries a pulley midway between the two bearings. The bending moment at the pulley varies from 200 Nm to 600 Nm, as the torsional moment in the shaft varies from 70 Nm to 200 Nm. The frequencies of variation of bending and torsion moments are equal to the shaft speed. The shaft is made of steel FeE 400 (Ultimate stess = 540 MPa, Yield stress = 400 MPa). The corrected endurance limit of the shaft is 200 N/mm2. Determine the diameter of shaft using factor of safety of 2.

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# Experiment No – 08

## Aim: Case study for design of mechanical components

**Students in a group of three will take case study for design of mechanical component from real world and make a report and explain in Laboratory session.**

# Experiment No – 09

**Aim: 3D drawing of machine components using computer software**

**As per given excise, draw 3D drawing in CREO software and attach output**

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# Experiment No – 10

## Aim: Analysis of machine components using computer software

- **Students will solve the problems which is given in experiment 2 to 6 (any five ) in ANSYS software and evaluate the answer with manual calculation.**
- **Attach the output file of solution.**