INSTITUTE OF AERONAUTICAL ENGINEERING
(AUTONOMOUS)

(Permanently affiliated to JNTUH and Approved by AICTE, Accredited by NBA)
Dundigal-Hyderabad-500 043

DEPARTMENT OF MECHANICAL ENGINEERING

PRODUCTION DRAWING PRACTICE& INSTRUMENTATION

LAB MANUAL

JNTUH – R15

COURSE CODE – A70391

Prepared By

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MECHANICAL ENGINEERING

Program Outcomes	
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, Engineering in the field of Mechanical Engineering.
PO2	**Problem analysis**: An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics , science and Engineering
PO3	**Design/development of solutions**: Competance to design a system, component or process to meet socital need within realistic constraints.
PO4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as analyze and implement data using research methodologies.
PO5	**Modern tool usage**: An ability to formulate solve complex engineering problems using modern engineering and information technology tools.
PO6	**The engineer and society**: To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural, and society issues.
PO7	**Environment and sustainability**: To Understand the impact of the engineering solutionsin societal contexts, and demonstrate the knowledge for sustainable development.
PO8	**Ethics**: An understanding and implementation of professional and Ethical responsibilties
PO9	**Individual and team work**:To Function as an effectively individual, and as an member or leader in Multi-disciplinary environment and adopt in diverse teams.
PO10	**Communication**: An ability to assimilate, communicate, give and receive instructions to present effectively with engineering community and society.
PO11	**Project management and finance**:An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.
PO12	**Life-long learning**: Recognize the need and an ability to engage in lifelong to keep broadest with technological changes.
Program Specific Outcomes	
PSO1	Professional Skills:To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.
PSO2	Problem-solving Skills: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.
PSO3	To build the nation, by imparting technological input and managerial skills to become technocrats.

PRODUCTION DRAWING PRACTICE AND INSTRUMENTATION LAB SYLLABUS

(A) PRODUCTION DRAWING PRACTICE

UNIT – I
CONVENTIONAL REPRESENTATION OF MATERIALS: conventional representation of parts – screw joints, welded joints, springs, gears, electrical, hydraulic and pneumatic circuits – methods of indicating notes on drawings.
Limits, Fits and Tolerances: types of fits, exercises involving selection/interpretation of fits and estimation of limits from tables.

UNIT – II
FORM AND POSITIONAL TOLERANCES: introduction and indication of form and position tolerances on drawings, types of runout, total runout and their indication.

UNIT – III
SURFACE ROUGHNESS AND ITS INDICAIONS: definition, types of surface roughness indication – surface roughness obtainable from various manufacturing processes, recommended surface roughness on mechanical components. Heat treatment and surface treatment symbols used on drawings.

UNIT – IV
DETAILED AND PART DRAWINGS: drawing of parts from assembly drawings with indications of size, tolerances, roughness, tolerances, form and position errors etc.

UNIT-V
PRODUCTION DRAWING PRACTICE: part drawings using Computer aided drafting by CAD software.

TEXT BOOKS:
1. Production and drawing/ K.L. Narayana & P. Kannaiah/ New Age.
2. Machine Drawing with Auto CAD/ Pohit and Ghosh, PE.

REFERENCES:
1. Geometric dimensioning and tolerancing/ James D. Meadows/ B.S Publications.
2. Engineering Metrology/ R.K. Jain/ Khanna Publications.

(B) INSTRUMENTATION LAB
1. Calibration of Pressure Gauges.
2. Calibration of Transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge for temperature measurement.
5. Calibration of thermocouple for temperature measurement.
6. Calibration of capacitive transducer for angular measurement.
7. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
8. Calibration of resistance temperature detector for temperature measurement.
9. Study and calibration of a rotameter for flow measurement.

10. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
11. Study and calibration of Mcleod gauge for low pressure.

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp. No.	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
PART I: PRODUCTION DRAWING PRACTICE			
1	CONVENTIONAL REPRESENTATION OF MATERIALS: conventional representation of parts – screw joints, welded joints, springs, gears, electrical, hydraulic and pneumatic circuits – methods of indicating notes on drawings.Limits, Fits and Tolerances: types of fits, exercises involving selection/interpretation of fits and estimation of limits from tables.	PO1, PO2, PO3, PO5	PSO1, PSO2
2	FORM AND POSITIONAL TOLERANCES: introduction and indication of form and position tolerances on drawings, types of runout, total runout and their indication.	PO1, PO2, PO3, PO5	PSO1, PSO2
3	SURFACE ROUGHNESS AND ITS INDICAIONS: definition, types of surface roughness indication – surface roughness obtainable from various manufacturing processes, recommended surface roughness on mechanical components. Heat treatment and surface treatment symbols used on drawings.	PO1, PO2, PO3, PO5	PSO1, PSO2
4	DETAILED AND PART DRAWINGS: drawing of parts from assembly drawings with indications of size, tolerances, roughness, tolerances, form and position errors etc.	PO1, PO2, PO3, PO5	PSO1, PSO2
5	PRODUCTION DRAWING PRACTICE: part drawings using Computer aided drafting by CAD software.	PO1, PO2, PO3, PO5	PSO1, PSO2
PART II: INSTRUMENTATION LAB			
1	Calibration of Pressure Gauges.	PO1, PO2, PO3, PO5	PSO1, PSO2
2	Calibration of Transducer for temperature measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2
3	Study and calibration of LVDT transducer for displacement measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2
4	Calibration of strain gauge for temperature measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2
5	Calibration of thermocouple for temperature measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2

6	Calibration of capacitive transducer for angular measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2
7	Study and calibration of photo and magnetic speed pickups for the measurement of speed.	PO1, PO2, PO3, PO5	PSO1, PSO2
8	Calibration of resistance temperature detector for temperature measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2
9	Study and calibration of a rotameter for flow measurement.	PO1, PO2, PO3, PO5	PSO1, PSO2
10	Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.	PO1, PO2, PO3, PO5	PSO1, PSO2
11	Study and calibration of Mcleod gauge for low pressure.	PO1, PO2, PO3, PO5	PSO1, PSO2

PRODUCTION DRAWING PRACTICE & INSTRUMENTATIONLAB

OBJECTIVE:

PDP LAB

PDP (Production Drawing Practice) provides a convenient means to create designs for almost every engineering discipline. Computer Aided Design software can be used for the component drawings and explaining clearly the tolerances, surface roughness's etc.

INSTRUMENTATION LAB

The Present course concentrates on developing basic understanding about various instruments that are involved in measuring. This course enables the student to understand the working of various measuring instruments. The course focuses on all principles, working, advantages, disadvantages and applications of various measuring instruments. In this course; students also will gain a broad understanding of the control systems. Student can learn in detail about how to measure displacement, temperature, pressure, level, flow, acceleration, vibration, strain, humidity, force, torque and power and their appropriate application. A general understanding of measuring characteristics is also included in the beginning of this course. An understanding of the control systems, servomechanisms is also be given to the students at the end of this course.

OUTCOMES:

Upon the completion of Production Drawing Practice and Instrumentation practical course, the student will be able to:

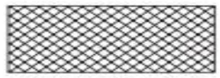
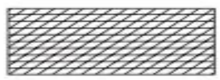
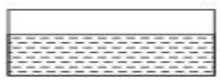
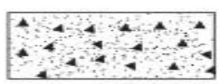
1. **Draw** the conventional representation of different materials used in engineering practice like wood, glass, metal etc., and the limits and tolerances.
2. **Understand**and indication of form and position tolerances on drawings, types of runout, total runout and their indication.
3. **Improve** visualization ability of surface roughness and its indications with respect to the material surface.

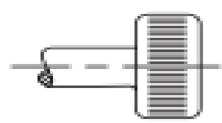
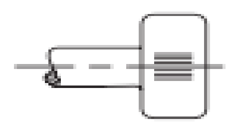
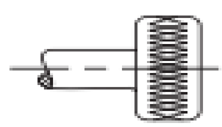
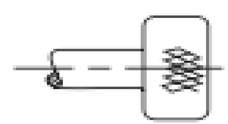
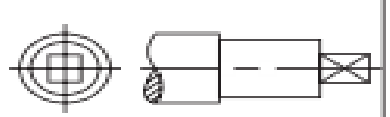
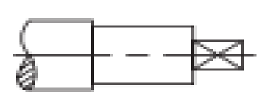
4. **Apply**the drawing techniques to draw various part drawings and assembly, indicate tolerances, roughness etc.
5. **Understand** the basic principles and performance characteristics of measurement.
6. **Apply** the working principles and identify the measurands for displacement.
7. **Understand** the temperature and importance of maintaining in various applications.
8. **Visualize** the areas affected with pressure in equipment and calibrate the pressure measuring devices.
9. **Comprehend** the level of liquid in any container and the various applications of measurement of flow.
10. **Evaluate** the measurement of speed in engineering applications and importance of speed measurement in instrumentation.

PRODUCTION DRAWING PRACTICE

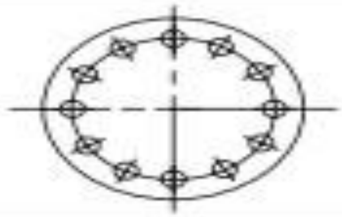
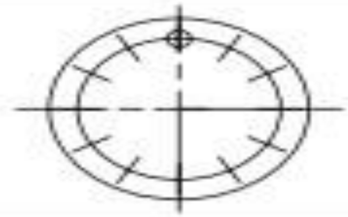
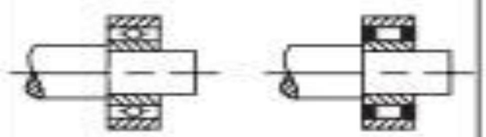
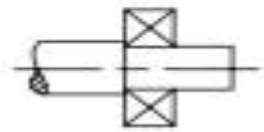
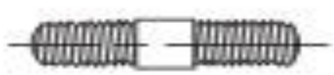
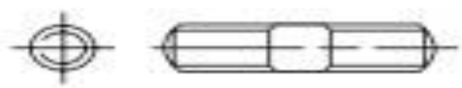
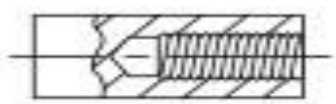
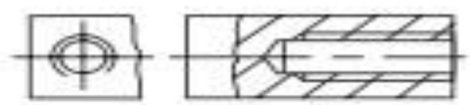
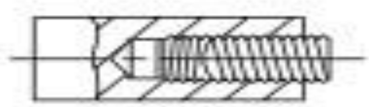
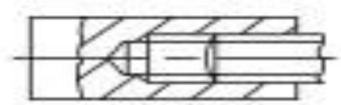
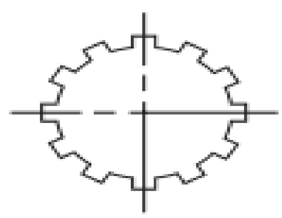
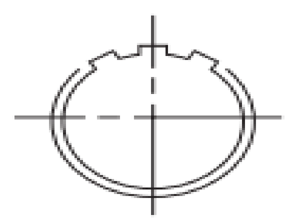
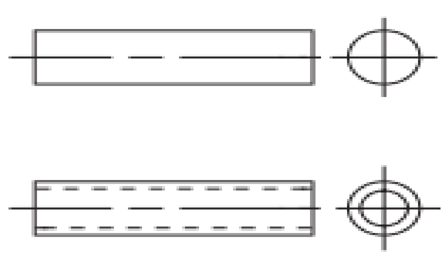
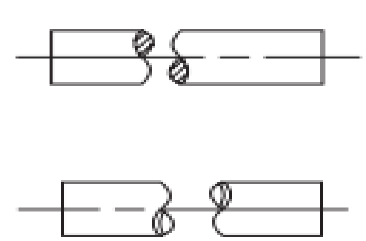
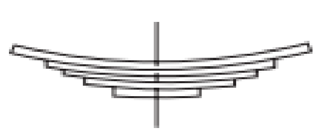
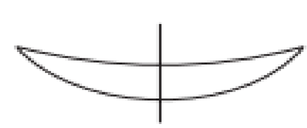
EXPERIMENT – I

Representation Materials & Machine Components

Type	Convention	Material
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its Alloys, etc.
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating material		Porcelain, Stoneware, Marble, Slate, etc.
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, Insulating and Filling materials, etc.
Liquids		Water, Oil, Petrol, Kerosene, etc.
Wood		Wood, Plywood, etc.
Concrete		A mixture of Cement, Sand and Gravel

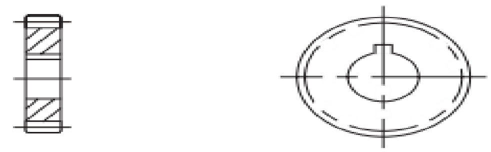
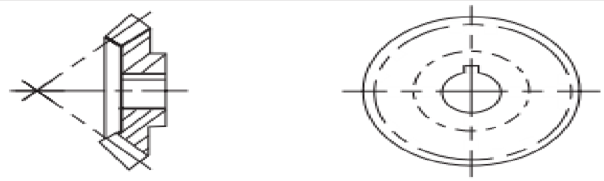
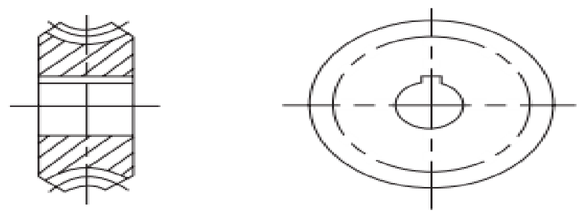
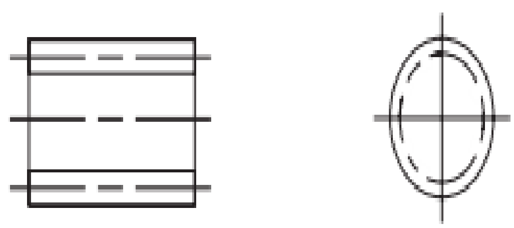
Title	Subject	Convention
Straight knurling		
Diamond knurling		
Square on shaft		

EXPERIMENT – II

Holes on circular pitch		
Bearings		
External screw threads (Detail)		
Internal screw threads (Detail)		
Screw threads (Assembly)		
Splined shafts		
Interrupted views		
Semi-elliptic leaf spring		

Semi-elliptic leaf spring with eyes			
	Subject	Convention	Diagrammatic Representation
Cylindrical compression spring			
Cylindrical tension spring			

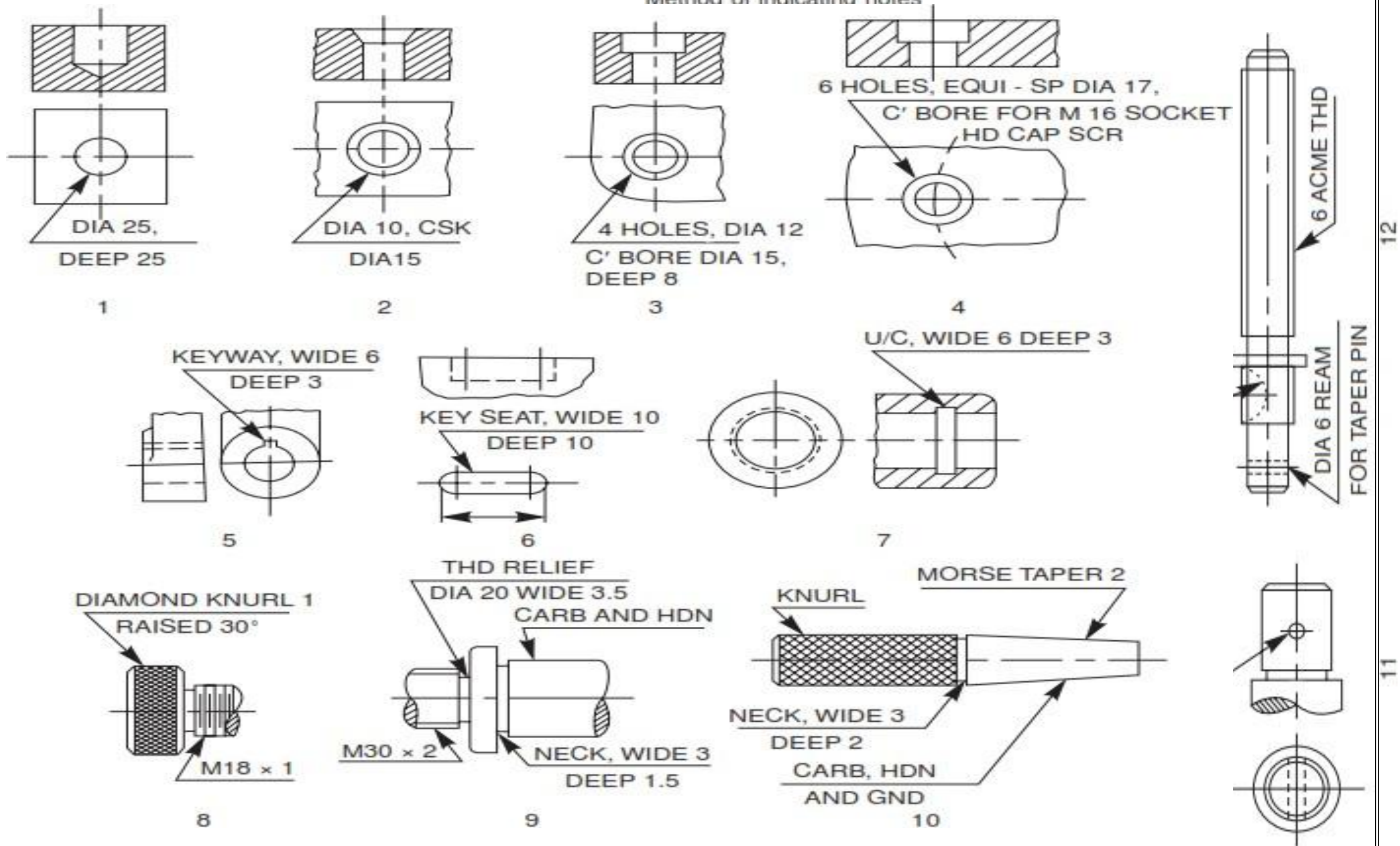
Conventional representation of machine components

Title	Convention
Spur gear	
Bevel gear	
Worm wheel	
Worm	

Conventional representation of machine components

EXPERIMENT - III

Method of indicating notes



S.No.	Note	Meaning / Instruction
1.	DIA 25 DEEP 25	Drill a hole of diameter 25 mm, to a depth of 25 mm.
2.	DIA 10 CSK DIA 15	Drill a through hole of diameter 10 mm and countersink to get 15 mm on top.
3.	4 HOLES, DIA 12 C BORE DIA 15 DEEP 8	Dirll through hole of ⌀ 12 mm, counterbore to a depth of 8 mm, with a ⌀ 15 mm, the number of such holes being four.
4.	6 HOLES, EQUI–SP DIA 17 C BORE FOR M 16 SOCKET HD CAP SCR	Drill a through hole of ⌀ 17 and counterbore to insert a socket headed cap screw of M 16. Six holes are to be made equi-spaced on the circle.
5.	KEYWAY, WIDE 6 DEEP 3	Cut a key way of 6 mm wide and 3 mm depth.
6.	KEY SEAT, WIDE 10 DEEP 10	Cut a key seat of 10 mm wide and 10 mm deep to the length shown.
7.	U/C, WIDE 6 DEEP 3	Machine an undercut of width 6 mm and dpeth 3 mm.
8.	(a) DIAMOND KNURL 1 RAISED 30°	Make a diamond knurl with 1 mm pitch and end chamfer of 30°.
	(b) M 18 × 1	Cut a metric thread of nominal diameter 18 mm and pitch 1 mm.
9.	(a) THD RELIEF, DIA 20 WIDE 3.5	Cut a relief for thread with a diameter of 20.8 mm and width 3.5 mm.
	(b) NECK, WIDE 3 DEEP 1.5	Turn an undercut of 3 mm width and 1.5 mm depth
	(c) CARB AND HDN	Carburise and harden.
10.	(a) CARB, HDN AND GND	Carburise, harden and grind.
	(b) MORSE TAPER 2	Morse taper No. 1 to be obtained.
11.	DIA 6 REAM FOR TAPER PIN	Drill and ream with taper reamer for a diameter of 6 mm to suit the pin specified.
12.	6 ACME THD	Cut an ACME thread of pitch 6 mm.

LIMIT SYSTEM

Following are some of the terms used in the limit system,

Tolerance: The permissible variation of a size is called tolerance. It is the difference between the maximum and minimum permissible limits of the given size.

Limits: The two extreme permissible sizes between which the actual size is contained are called limits. The maximum size is called the upper limit and the minimum size is called the lower limit.

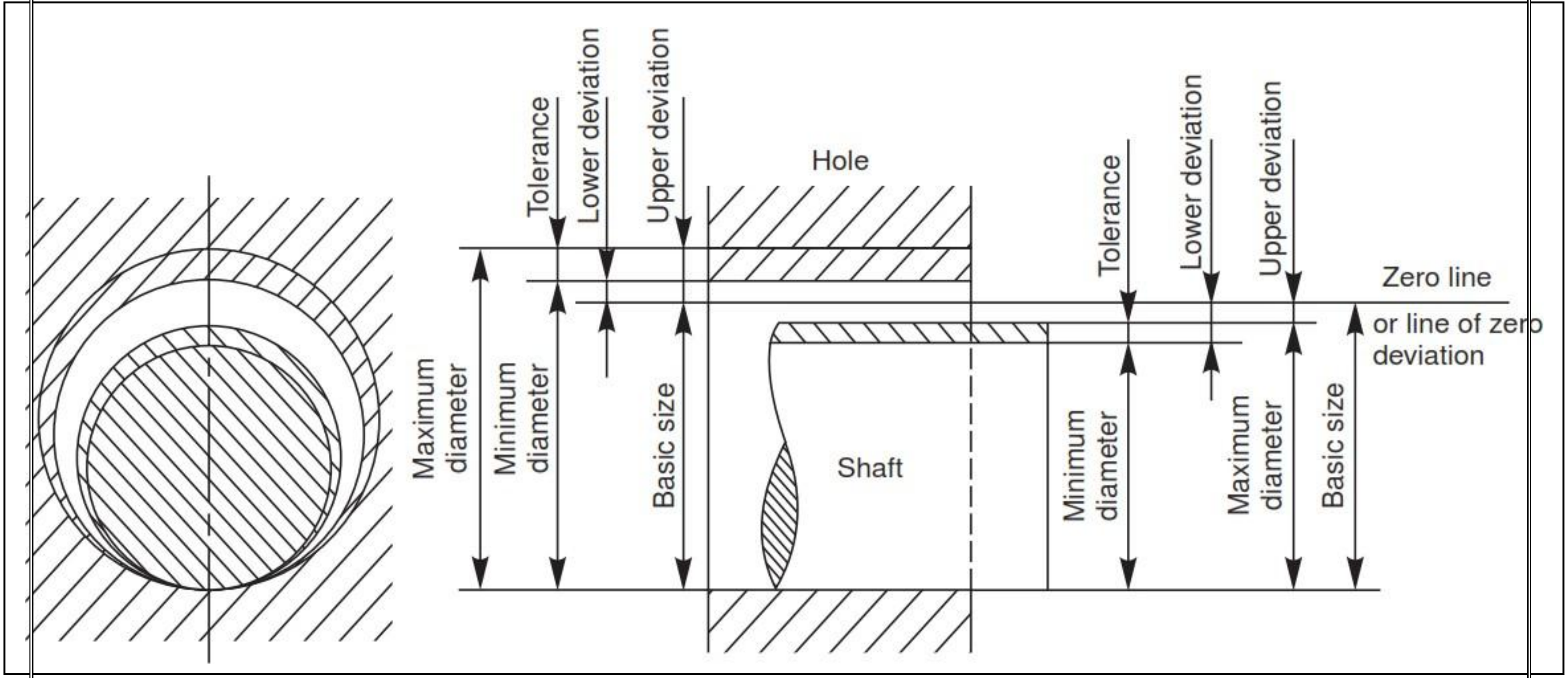
Deviation: It is the algebraic difference between a size (actual, maximum, etc.) and the corresponding basic size.

Actual Deviation: It is the algebraic difference between the actual size and the corresponding basic size.

Upper Deviation: It is the algebraic difference between the maximum limit of the size and the corresponding basicsize.

Lower Deviation: It is the algebraic difference between the minimum limit of the size and the corresponding basicsize.

Allowance: It is the dimensional difference between the maximum material limits of the mating parts, intentionally provided to obtain the desired class of fit. If the allowance is positive, it will result in minimum clearance between the mating parts and if the allowance is negative, it will result in maximum interference.



EXPERIMENT – V

The relation between two mating parts is known as a fit. Depending upon the actual limits of the hole or shaft sizes, fits may

FITS

be classified as clearance fit, transition fit and interference fit.

Clearance Fit: It is a fit that gives a clearance between the two mating parts.

Transition Fit: This fit may result in either an interference or a clearance, depending upon the actual values of the tolerance of individual parts.

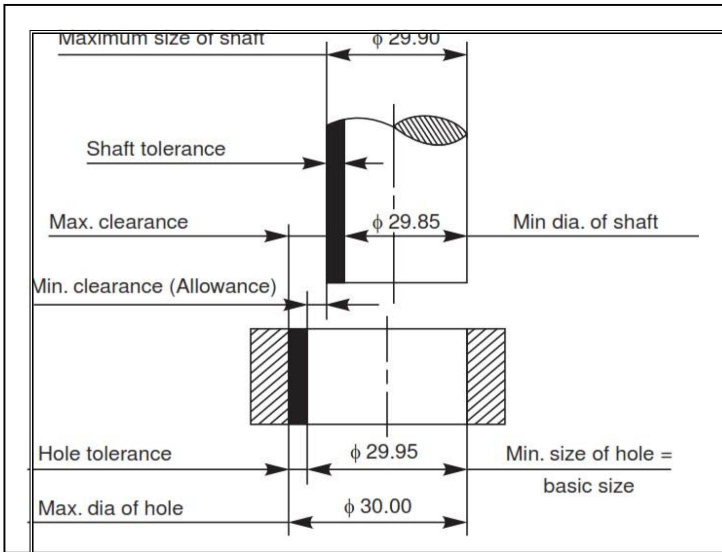
Interference Fit: If the difference between the hole and shaft sizes is negative before assembly; an interference fit is obtained.

HOLE BASIS SYSTEM, SHAFT BASIS SYSTEM

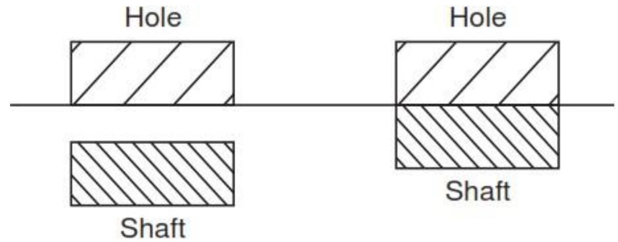
In working out limit dimensions for the three classes of fits; two systems are in use, *viz*., the hole basis system and shaft basis system

HOLE BASIS SYSTEM: In this system, the size of the shaft is obtained by subtracting the allowance from the basic size of the hole. In this system, the lower deviation of the hole is zero. The letter symbol for this situation is '*H*'.

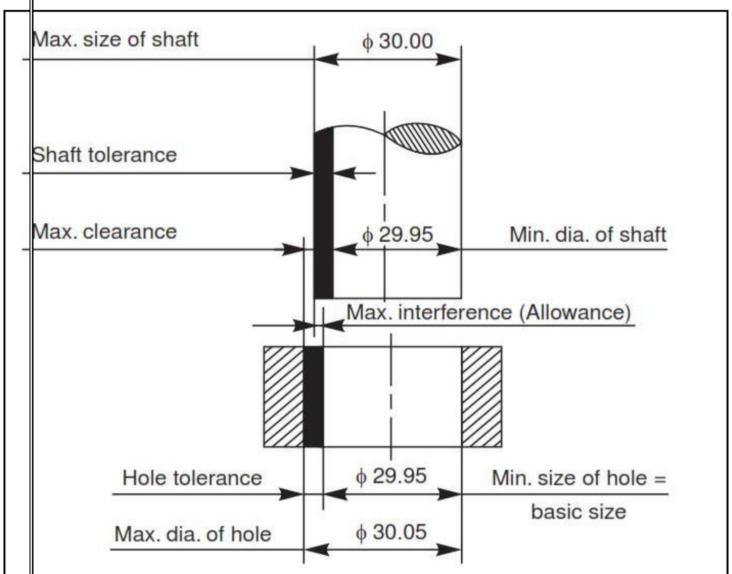
SHAFTBASISSYSTEM:Inthissystem,thesizeoftheholeisobtainedbyaddingtheallowancetothebasicsizeoftheShaft. plied to eachToleran ces part. In this system, the upper deviation of the shaft is zero. The letter symbol for this situation is'*h*'.



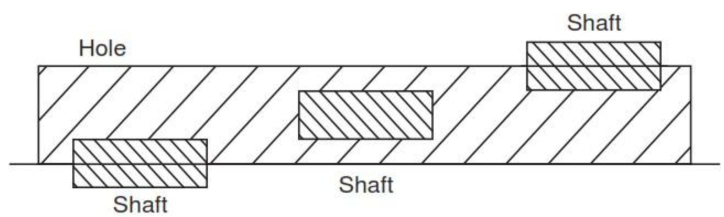
Clearance fit



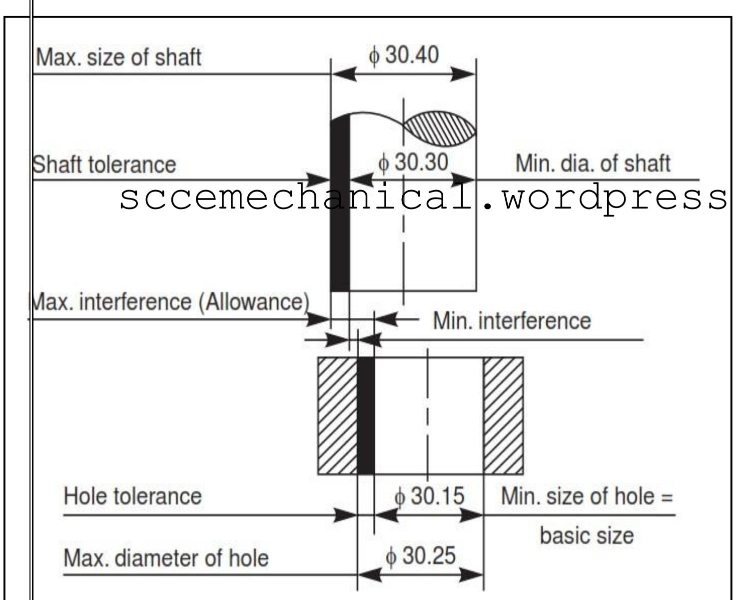
Clearance fit



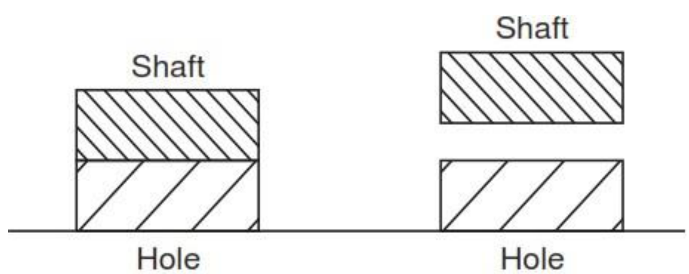
Transition fit



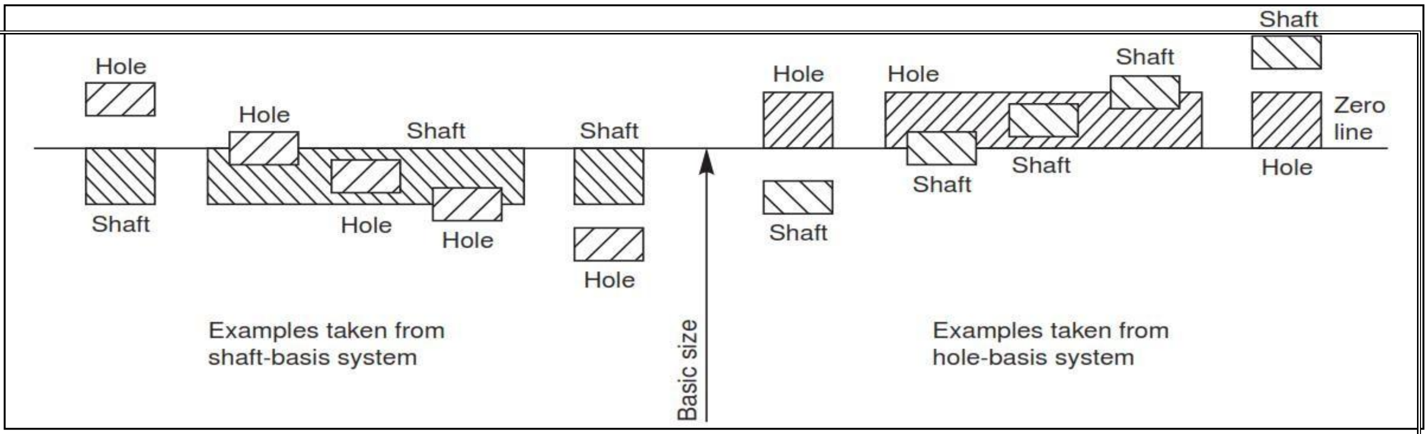
Transition fit



Interference fit



Interference fit

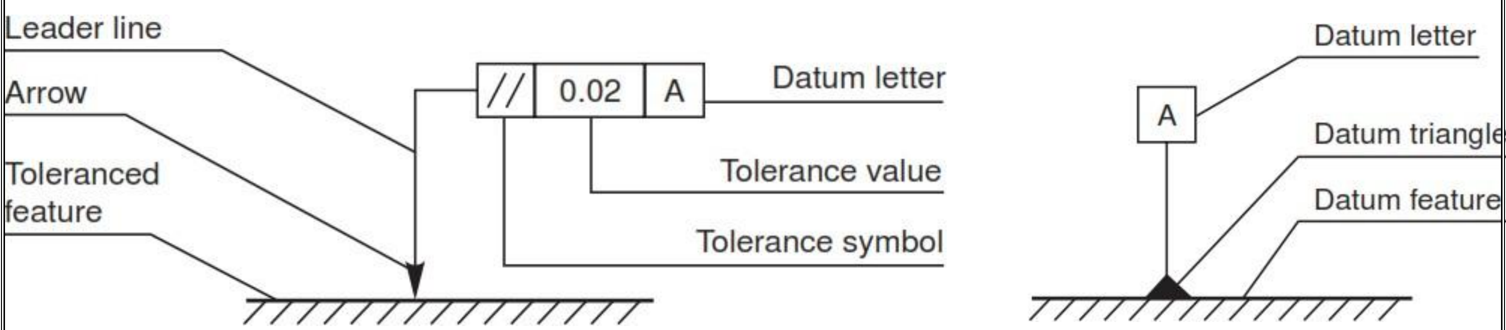

Hole
Shaft
Hole
Shaft
Hole
Hole
Shaft
Hole
Examples taken from
shaft-basis system
Basic size
Hole
Shaft
Hole
Shaft
Shaft
Shaft
Shaft
Zero
line
Hole
Examples taken from
hole-basis system

EXPERIMENT – VI

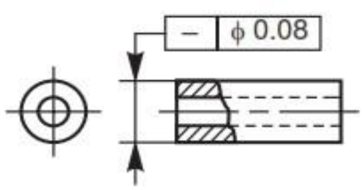
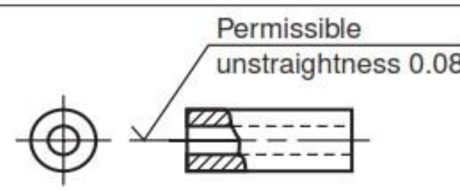
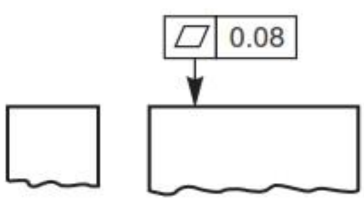
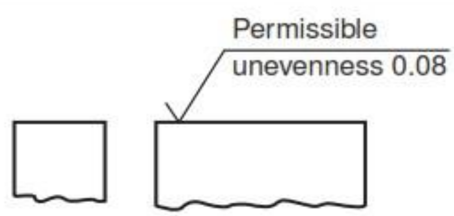
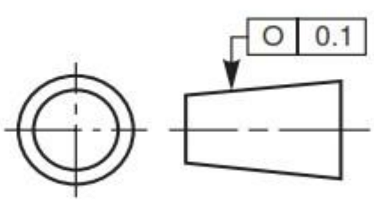
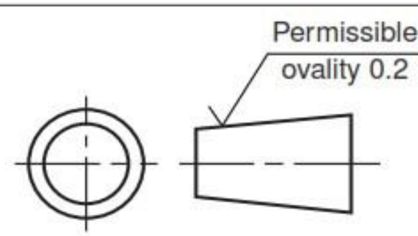
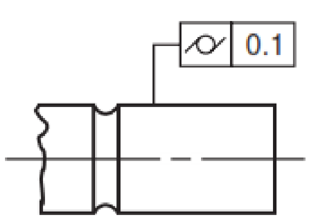
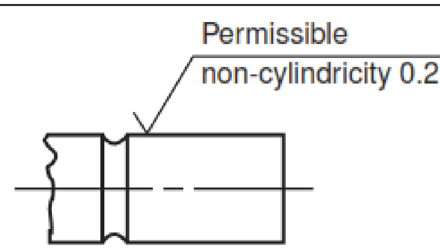
Characteristics to be toleranced		*Symbols*
Form of single features	Straightness	⏤
	Flatness	▱
	Circularity (roundness)	○
	Cylindricity	⌭
	Profile of any line	⌒
	Profile of any surface	⌓
Orientation of related features	Parallelism	//
	Perpendicularity (squareness)	⊥
	Angularity	∠
Position of related features	Position	⌖
	Concentricity and coaxiality	◎
	Symmetry	⌯
	Run-out	↗

Symbols Representing the Characteristics to be Toleranced.

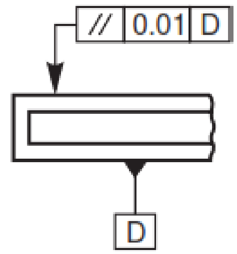
Datum feature: A datum feature is a feature of a part, such as an edge, surface, or a hole, which forms the basis for a datum or is used to establish its location

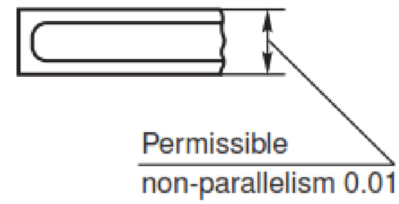


FORM AND POSITIONAL TOLERANCES

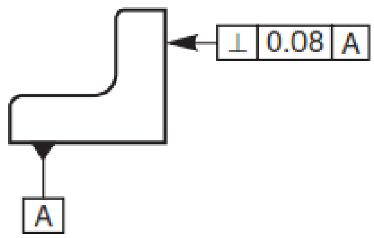
As per the standard	*As prevalent in industry*
1. Straightness tolerance	
	
2. Flatness tolerance	
	
3. Circularity tolerance	
	
4. Cylindricity tolerance	
	

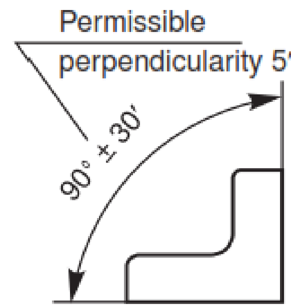
5. Parallelism tolerance



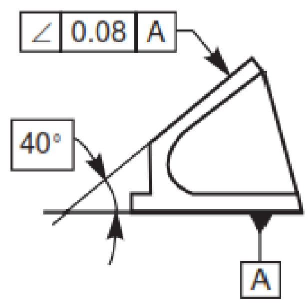


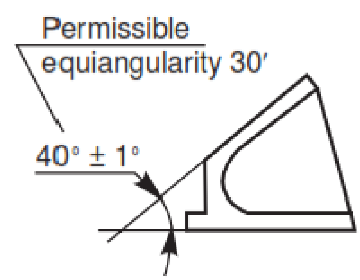
6. Perpendicularity tolerance



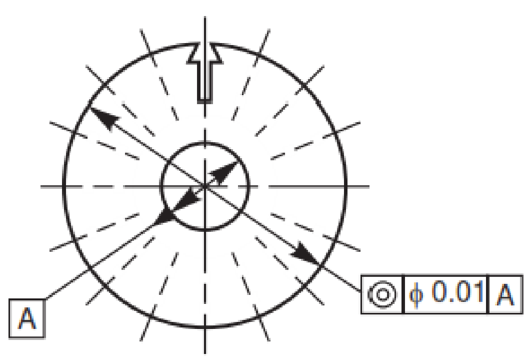


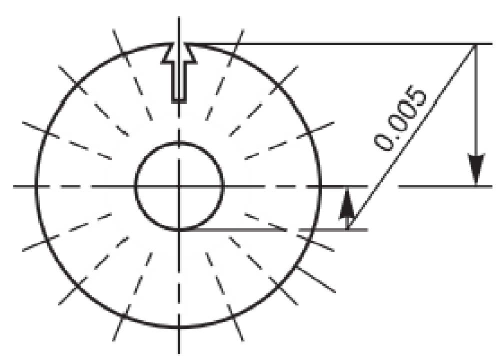
7. Angularity tolerance



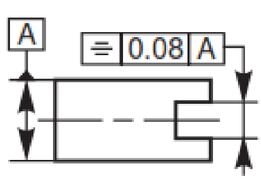


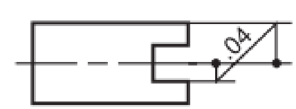
8. Concentricity and coaxiality tolerance



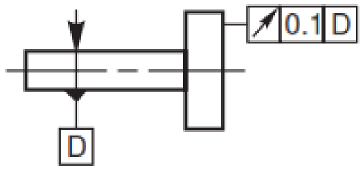


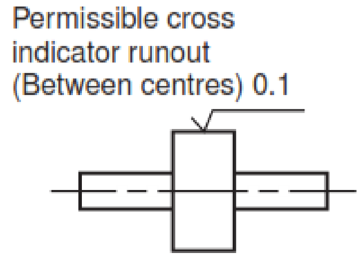
9. Symmetry tolerance



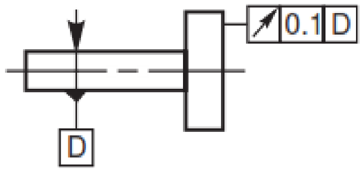


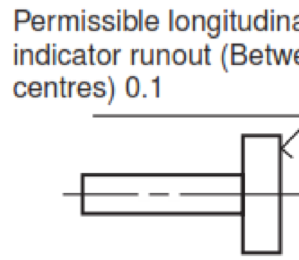
10. Radial run-out





11. Axial run-out





Systems of Indication of Tolerances of Form and of Position.

EXPERIMENT – VII

Surface Roughness and its Indication & Heat and Surface Treatment Symbols

Surface Roughness:

The properties and performance of machine components are affected by the degree of roughness of the various surfaces. The higher the smoothness of the surface, the better is the fatigue strength and corrosion resistance. Friction between mating parts is also reduced due to better surface finish.

Surface Roughness Number:

The surface toughness number represents the average departure of the surface from perfection over a prescribed sampling length and is expressed in microns.

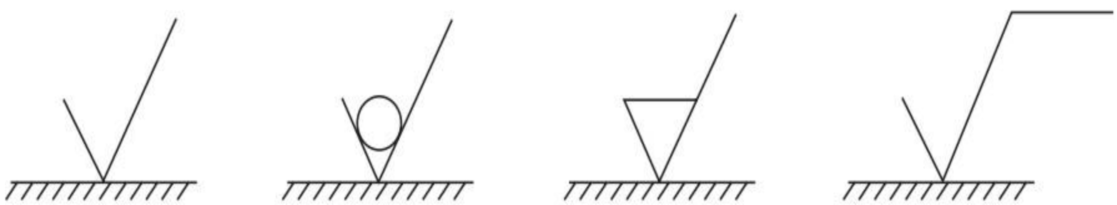
$$R_a = \frac{h_1 + h_2 + h_3 + \ldots + h_n}{n}$$

The surface roughness may be measured, using any one of thefollowing:

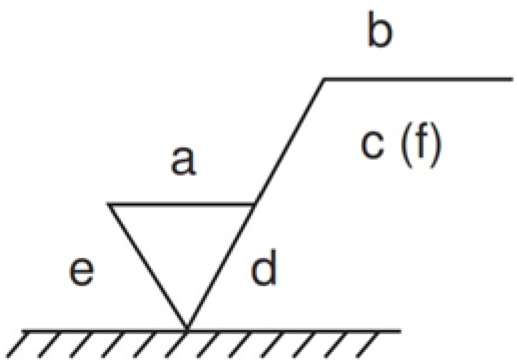
1. Straightedge 2.Surfacegauge 3.Opticalflat
2.

Machine Symbols:

The basic symbol consists of two legs of unequal length, inclined at approximately 60° to the line, representing the surface considered. This symbol may be used where it is necessary to indicate that the surface is machined, without indicating the grade of roughness or the process to be used.



(a) (b) (c) (d)

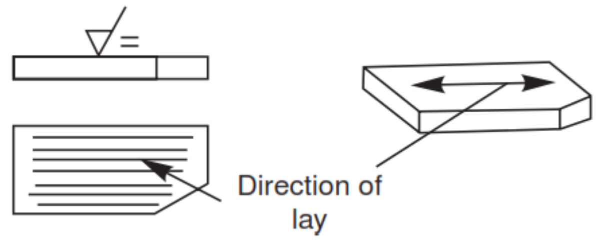
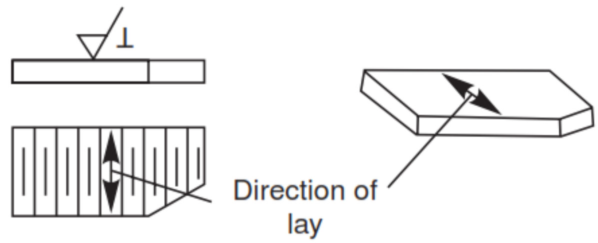
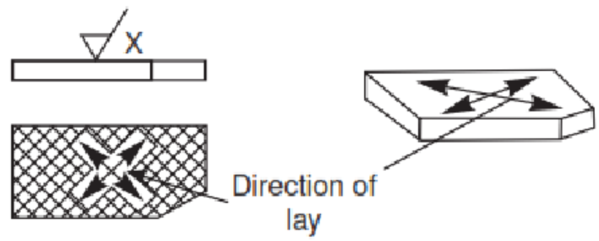
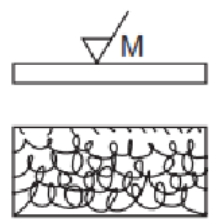
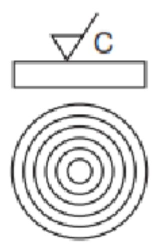
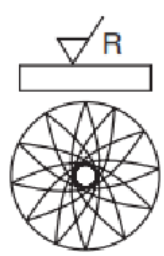


a. Roughness Number,
b. Type Of machiningProcess,
c. C(f): SamplingLength,
d. Direction OfLay,
e. MachiningAllowance

Indication of Machining Allowance.

Equivalent surface roughness symbols.

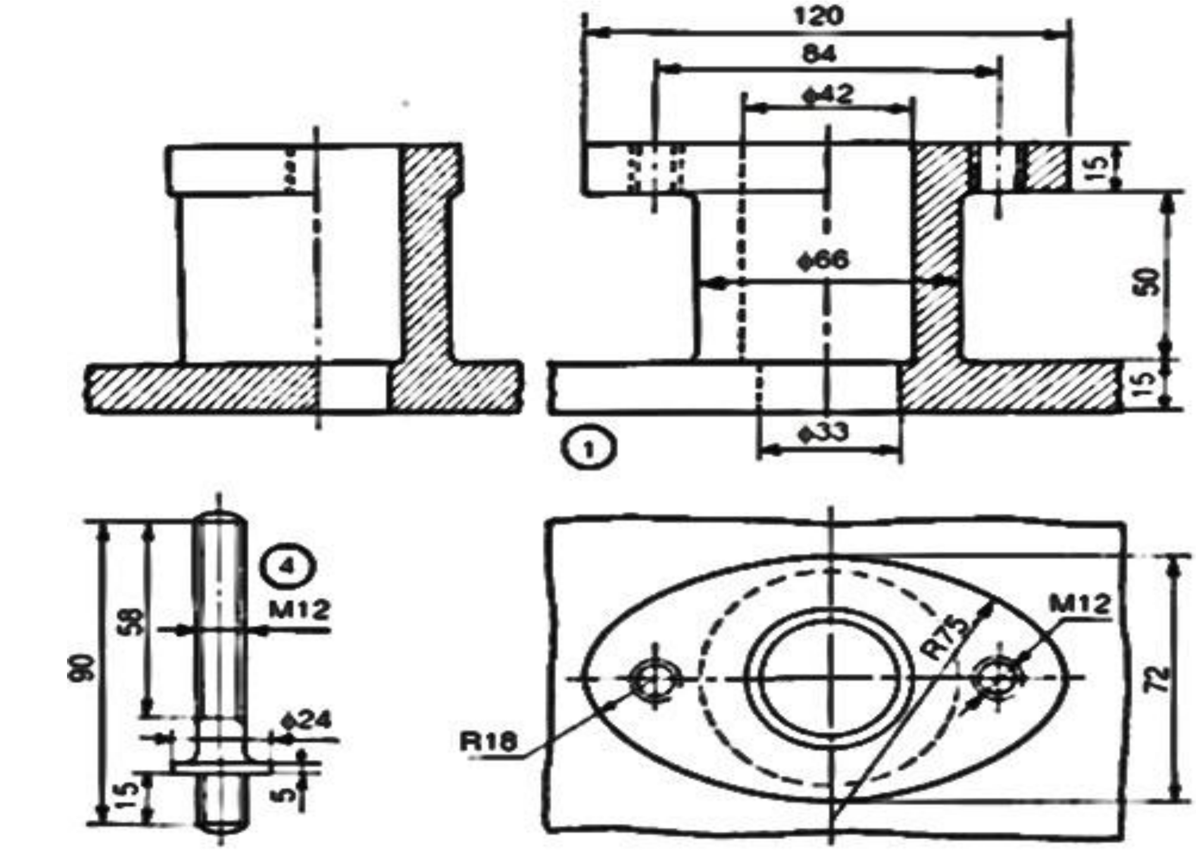
Roughness values R_a *µm*	*Roughness grade number*	*Roughness grade symbol*
50	N12	∼
25	N11	▽
12.5	N10	
6.3	N9	▽▽
3.2	N8	
1.6	N7	
0.8	N6	▽▽▽
0.4	N5	
0.2	N4	
0.1	N3	▽▽▽▽
0.05	N2	
0.025	N1	

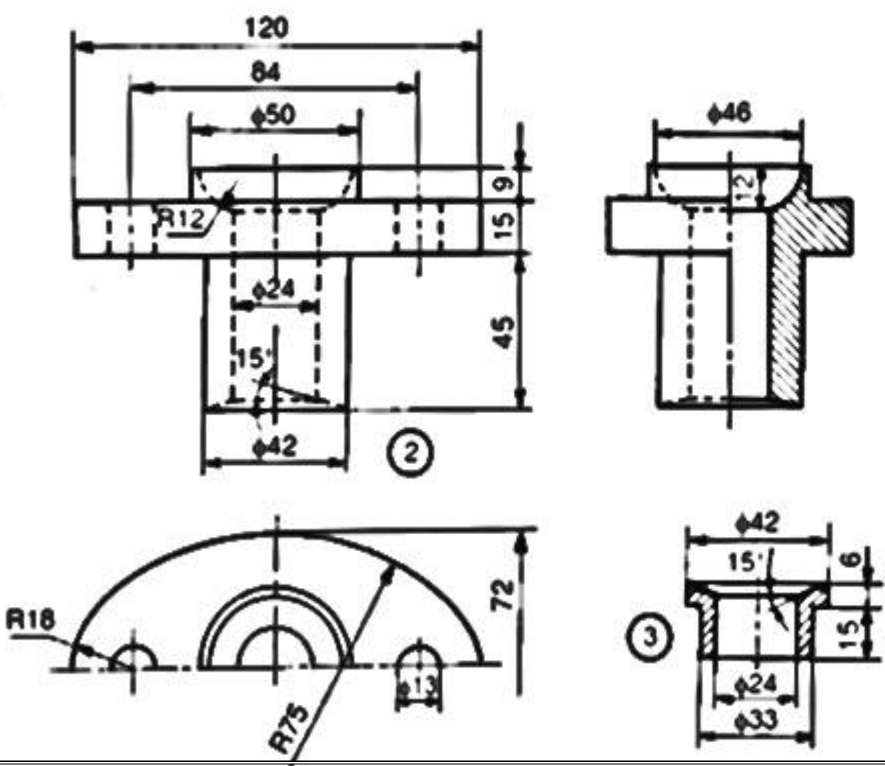
Symbol	Interpretation	
=	Parallel to the plane of projection of the view in which the symbol is used	
⊥	Perpendicular to the plane of projection of the view in which the symbol is used	
X	Crossed in two slant directions relative to the plane of projection of the view in which the symbol is used	
M	Multi-directional	
C	Approximately circular, relative to the centre of the surface to which the symbol is applied	
R	Approximately radial, relative to the centre of the surface to which the symbol is applied	

EXPERIMENT –VIII
DETAILED PART DRAWINGS

Stuffing Box

It is used to prevent loss of fluid such as steam, between sliding or turning parts of machine elements. In a steam engine, when the piston rod reciprocates through the cylinder cover; stuffing box provided in the cylinder cover, prevents leakage of steam from the cylinder.





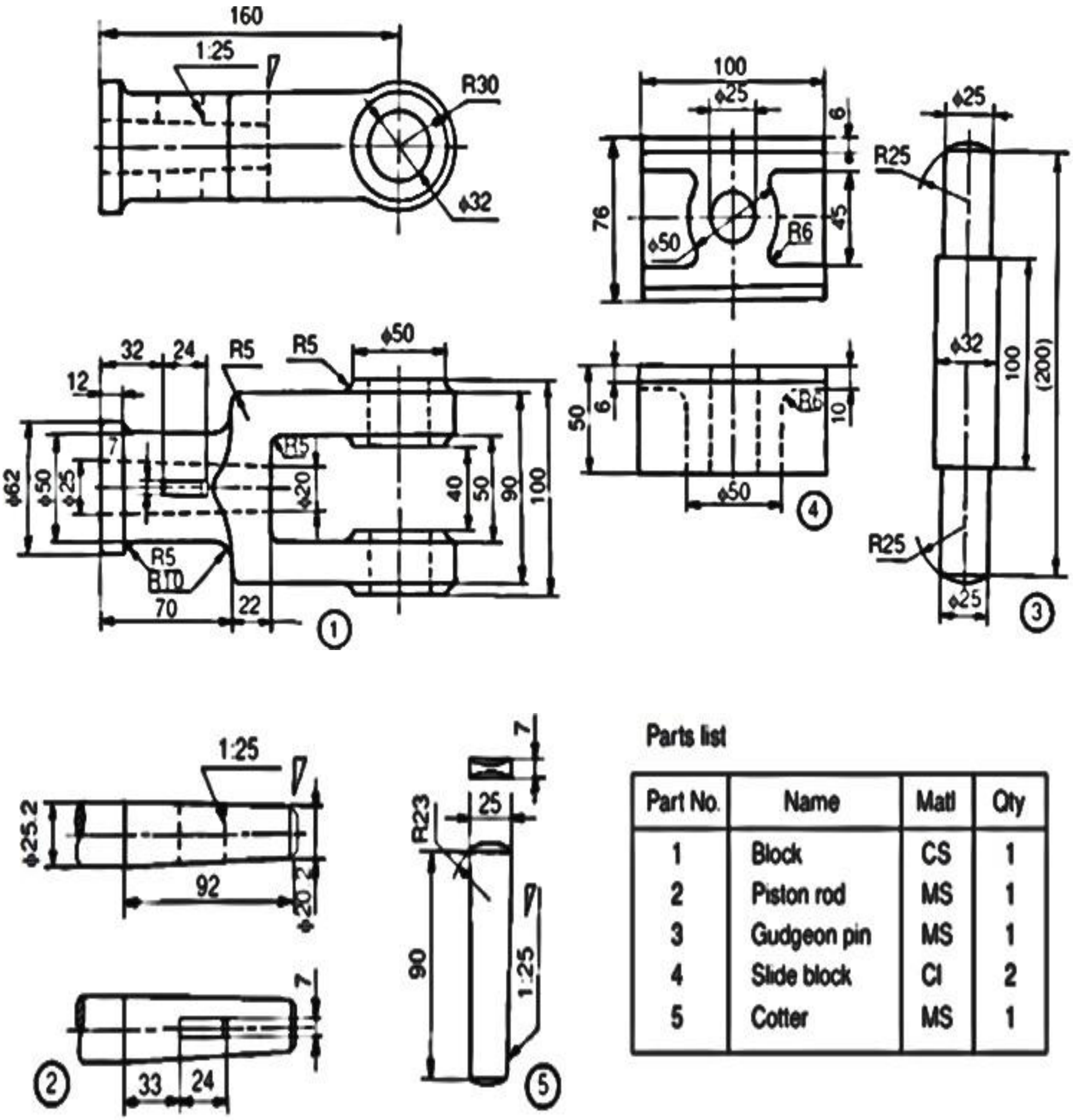
Stuffing box

Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Gland	Brass	1
3	Bush	Brass	1
4	Stud	MS	2
5	Nut, M12	MS	2

Crosshead

It is used in horizontal steam engines for connecting the piston rod and connecting rod. The crosshead, with the help of slide block 4, reciprocates between two guides provided in the engine frame. The gudgeon pin 3, connects the slide blocks with the crosshead block 1. This acts as a pin joint for the connecting rod. The piston rod 2 is secured to the **crosshead** block by means of the cotter 5. The assembly ensures reciprocating motion along a straight line for the piston rod and reciprocating cum oscillatory motion for the connecting rod.



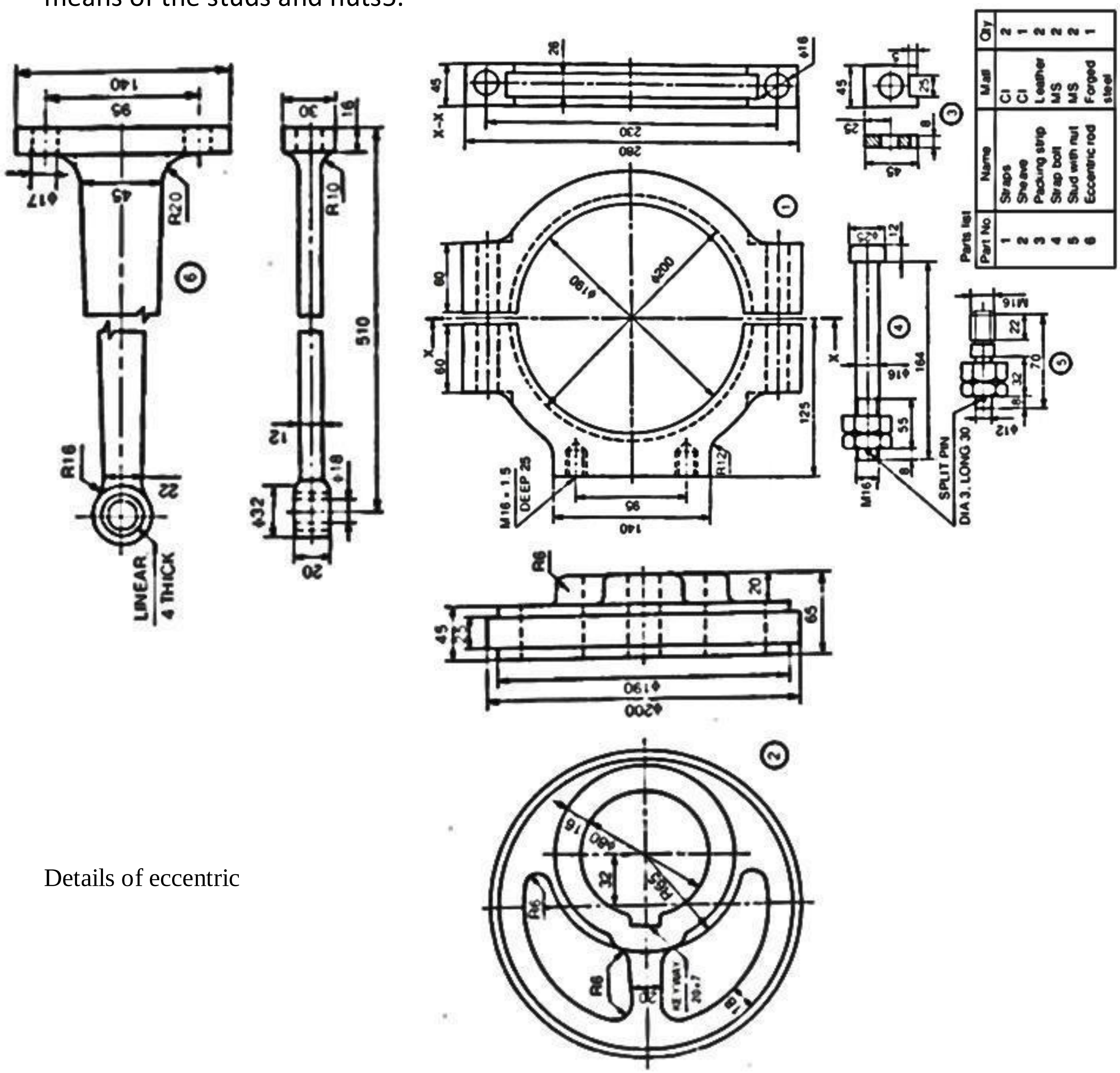
Parts list

Part No.	Name	Matl	Qty
1	Block	CS	1
2	Piston rod	MS	1
3	Gudgeon pin	MS	1
4	Slide block	CI	2
5	Cotter	MS	1

Steam engine crosshead

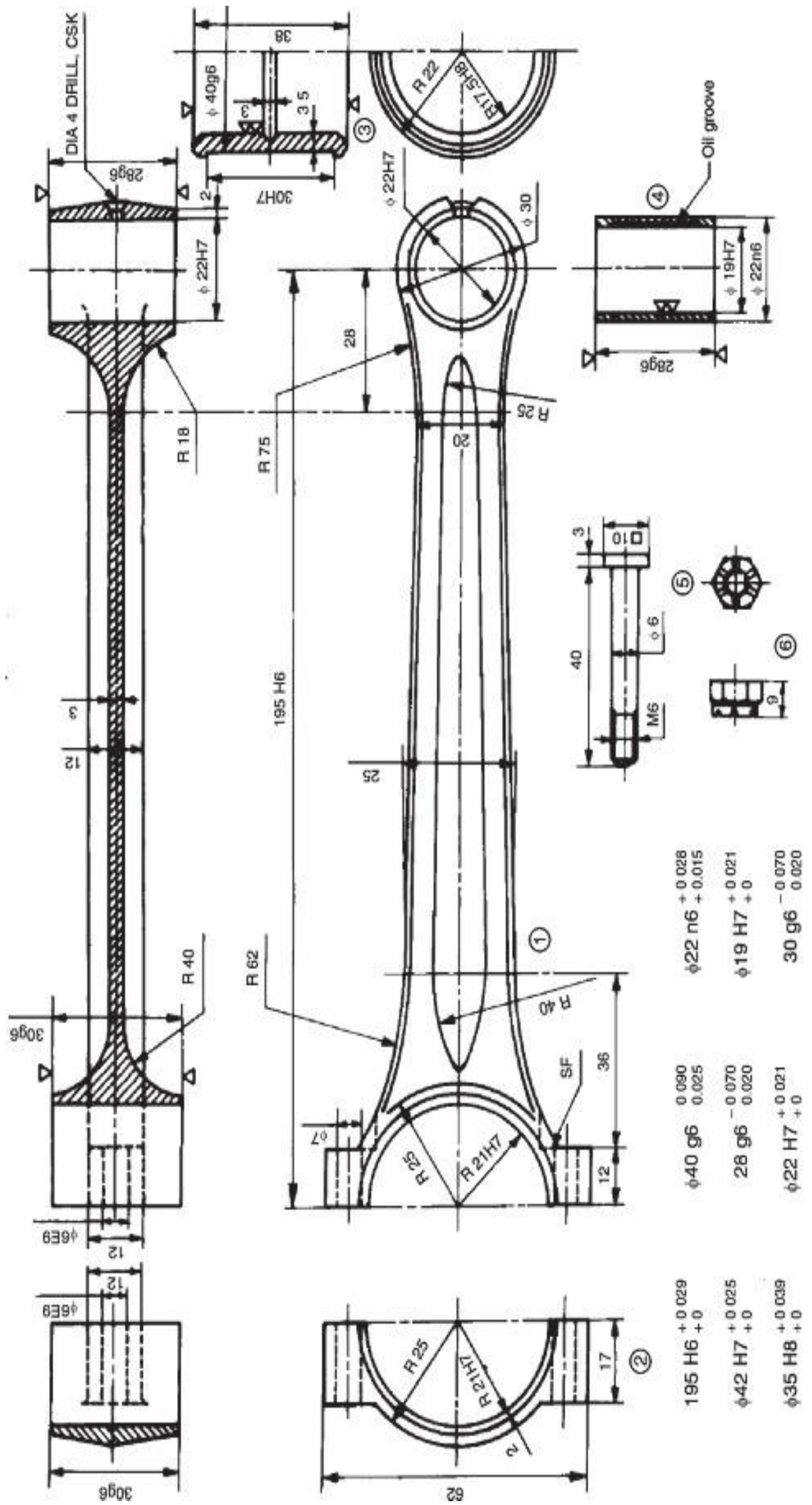
EXPERIMENT – IX

Eccentric is used to provide a short reciprocating motion, actuated by the rotation of a shaft. **Eccentrics** are used for operating steam valves, small pump plungers, shaking screens, etc. Rotary motion can be converted into a reciprocating motion with an eccentric, but the reverse conversion is not possible due to excessive friction between the sheave and the strap. The sheave 2 which is in the form of a circular disc with a stepped rim is keyed on the shaft. When the shaft rotates, the sheave rotates eccentrically because of the eccentrically placed hole in it and imparts reciprocating motion to eccentric rod 6. The straps 1 are semi-circular elements with an annular recess to accommodate the steppedrimofthesheave.Theseareheldtogetherontheshe aveby meansofstrapbolts4,withpacking strips 3 placed between them. The eccentric rod is fixed to the eccentric strap by means of the studs and nuts5.



Details of eccentric

Connecting rod is used in center crank engines. The bearing bush 4 which is in one piece, is fittedat the small end of the connecting rod 1. The small end of the rod is connected to the piston. The main bearing bush, which is split into two halves, is placed at the big end of the connecting rod. The big end of the rod is connected to the crank pin of the center crank. First, the split bearing brasses 3 are placed on the crankpin,then the big end of the connecting rod and the cap2 are clamped on to these,by means of two bolts 5 and nuts6.



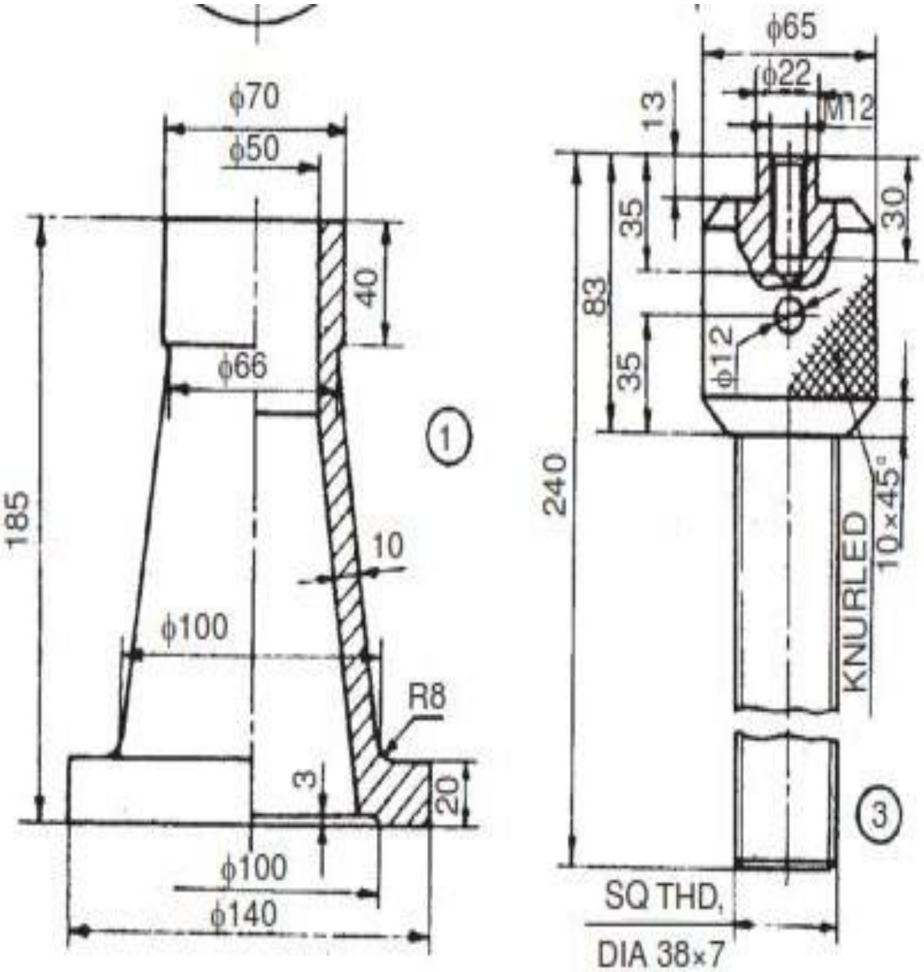
Parts list

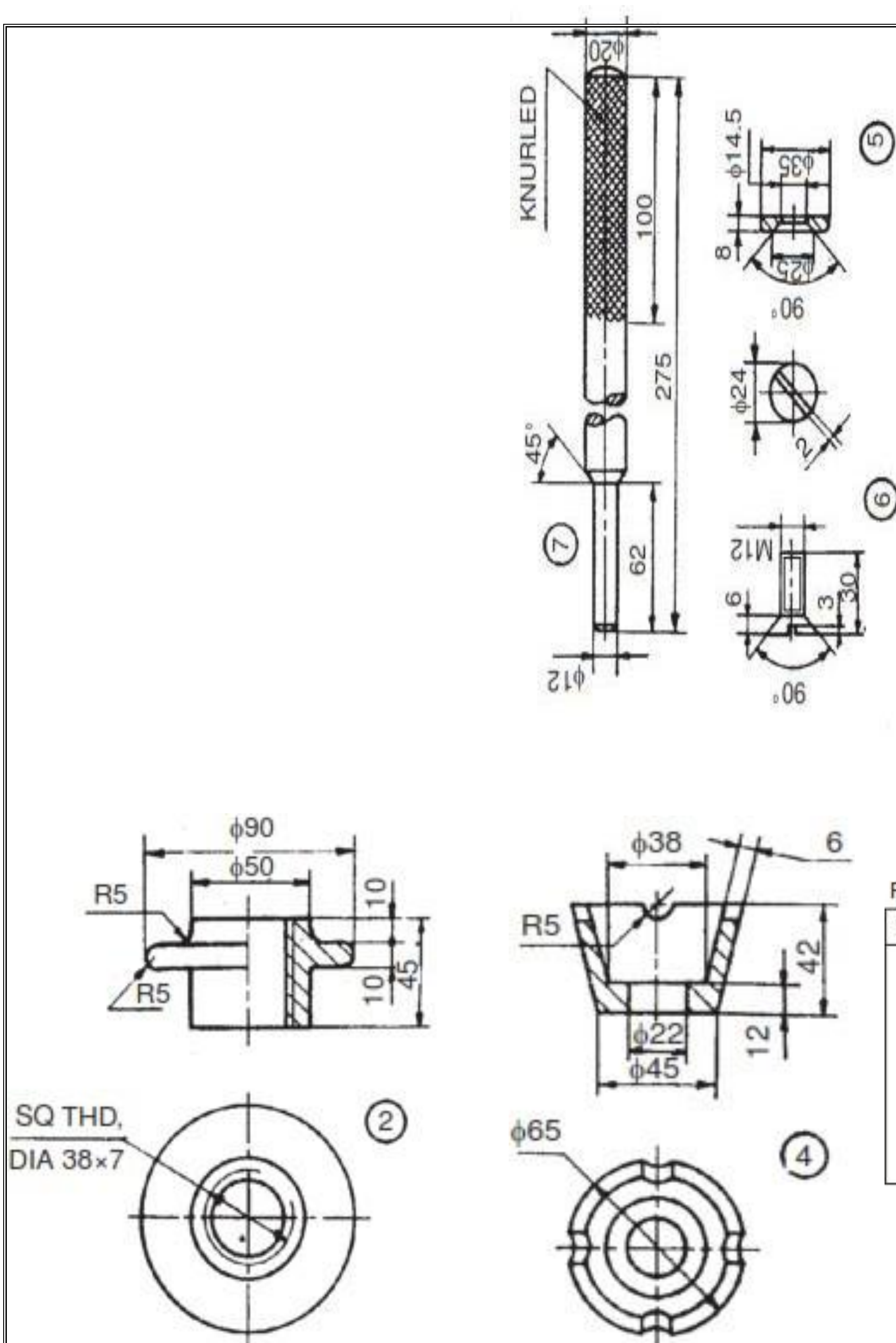
Part No	Name	Matl.	Qty
1	Rod	FS	1
2	Cap	FS	1
3	Bearing brass	GM	2
4	Bearing bush	P Bronze	1
5	Bolt	MCS	2
6	Nut	MCS	2

Details of Petrol Engine Connecting Rod.

Screw jack

It is used for raising heavy loads through very small heights. In this, the screw 3 works in the nut 2 which is press fitted into the main body 1. The tommy bar 7 is inserted into a hole through the enlarged head of the screw and when this is turned,the screw will move up or down, there by raising or lowering theload.





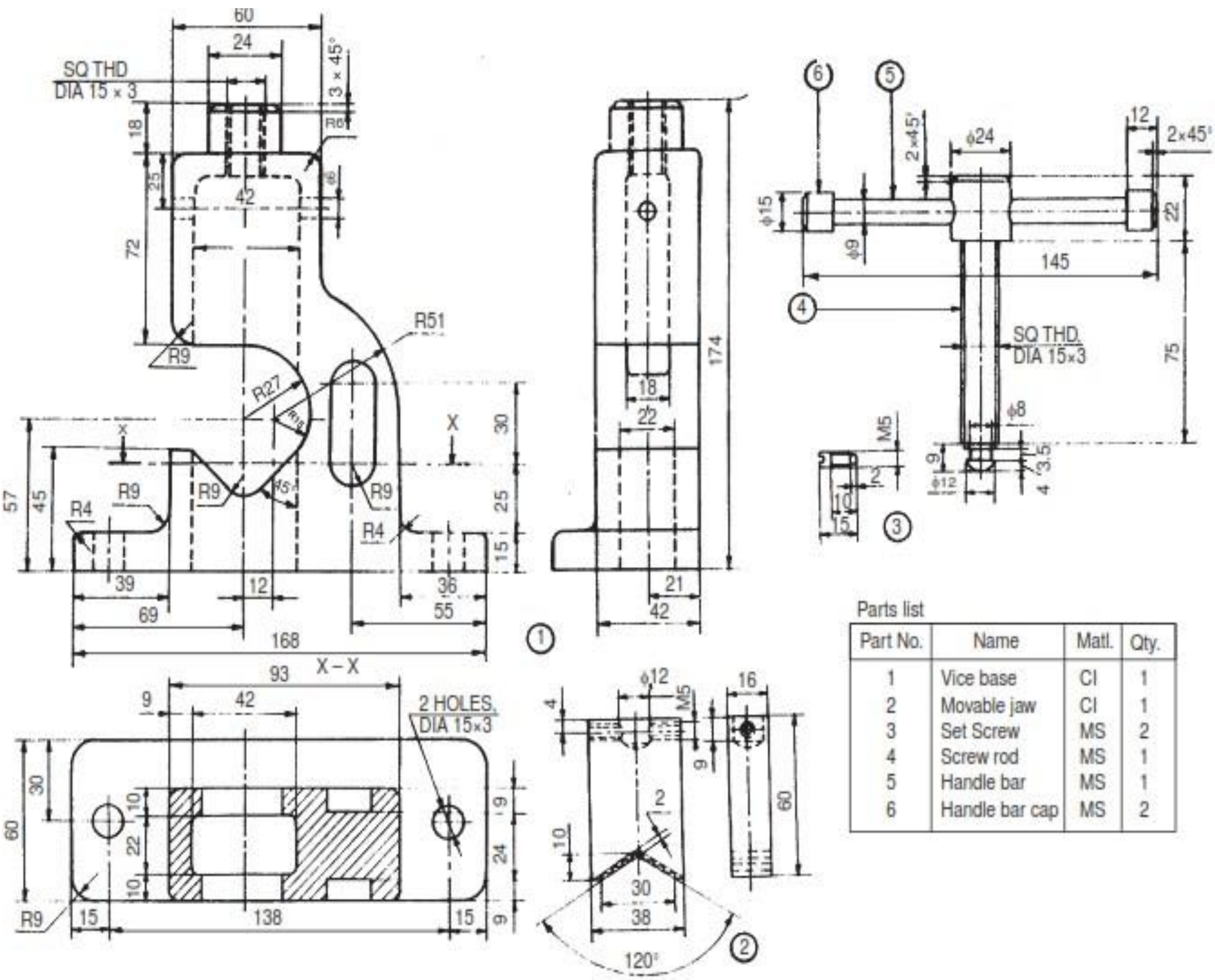
Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Nut	GM	1
3	Screw	MS	1
4	Cup	CS	1
5	Washer	MS	1
6	Screw	MS	1
7	Tommy bar	MS	1

Screw jack

Pipe vices

It is designed for holding pipes, to facilitate operations such as threading or cutting-off to required length. To assemble the vice, the screw rod 4 is screwed into the base 1 from above. When the circular groove at the end of the screw rod is in-line with the 6 mm diameter transverse hole in the housing, the movable jaw 2 is inserted from below. After alignment, two set screws 3 are inserted into the jaw. This arrangement allows the jaw to move vertically without rotation when the handle is operated and the screw is turning. The V-shaped base of the housing can accommodate pipes of different diameters. The serrations provided on the V-shaped end of the movable jaw provide effective grip on the pipe surface.



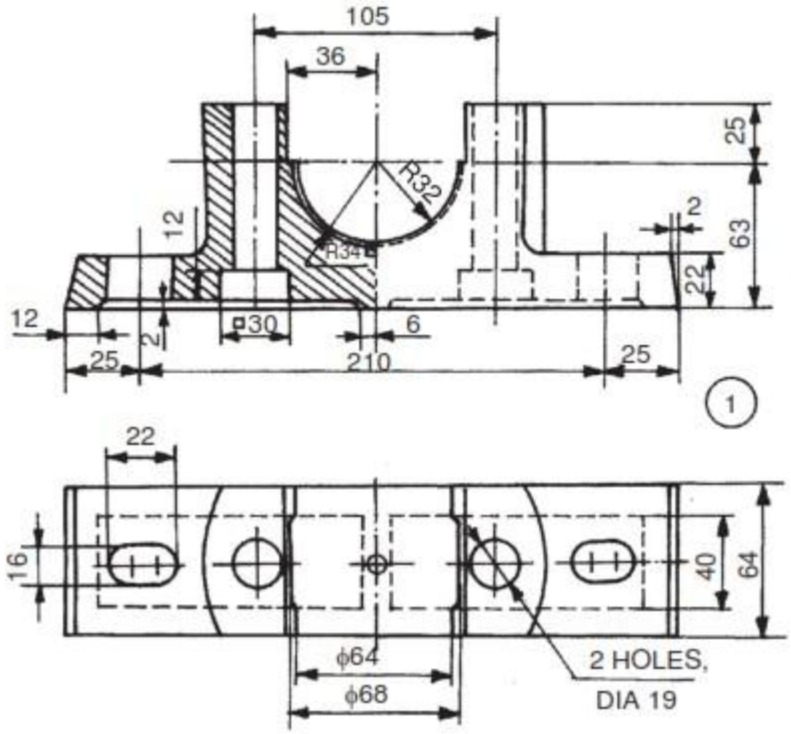
Parts list

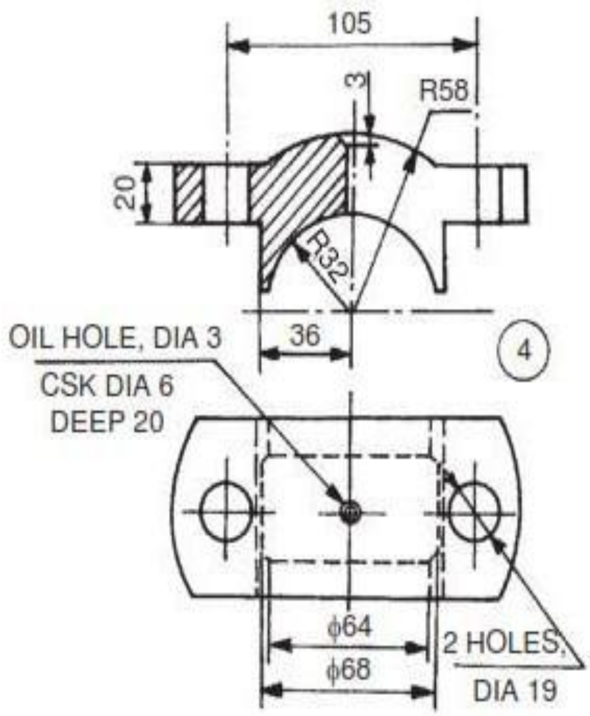
Part No.	Name	Matl.	Qty.
1	Vice base	CI	1
2	Movable jaw	CI	1
3	Set Screw	MS	2
4	Screw rod	MS	1
5	Handle bar	MS	1
6	Handle bar cap	MS	2

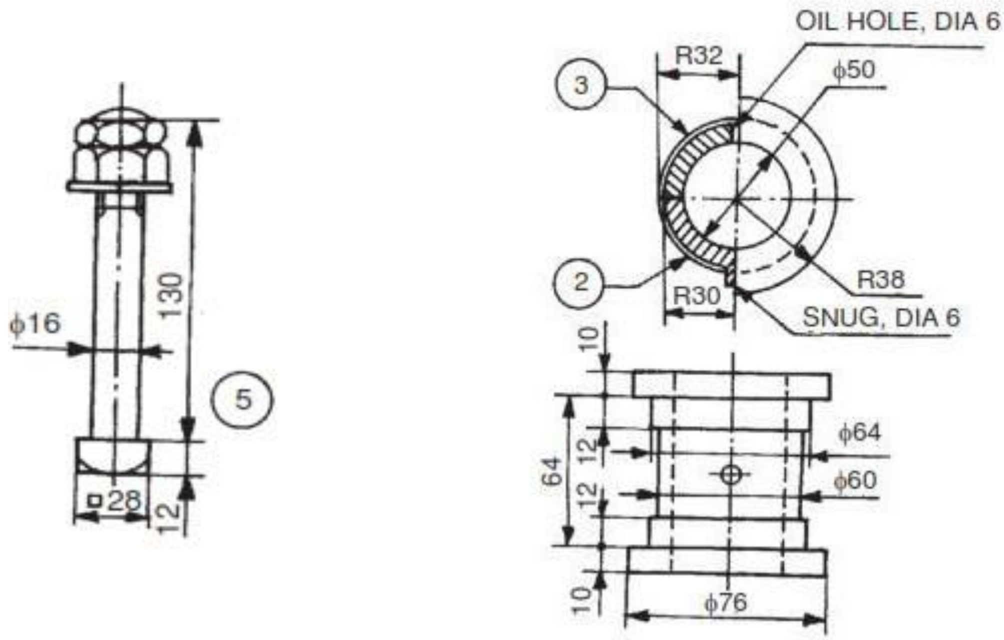
Pipe Vice

Plummer block

It is used for long shafts, requiring intermediate support, especially when the shaft cannot be introduced into the bearing, end-wise. The bottomhalf2 of the bearing brass is placed in the base 1 such that, the snug of the bearing enters into the corresponding recess in the base; preventing rotation of the brasses. After placing the journal (shaft) on the bottom half of the bearing brass, kept in the base; the upper half of the bearing brass3 is placed and the cap4 is then fixed to the base, by means of two bolts with nuts5.The bearing is made of two halves so that the support can be introduced at any location of the long shaft.







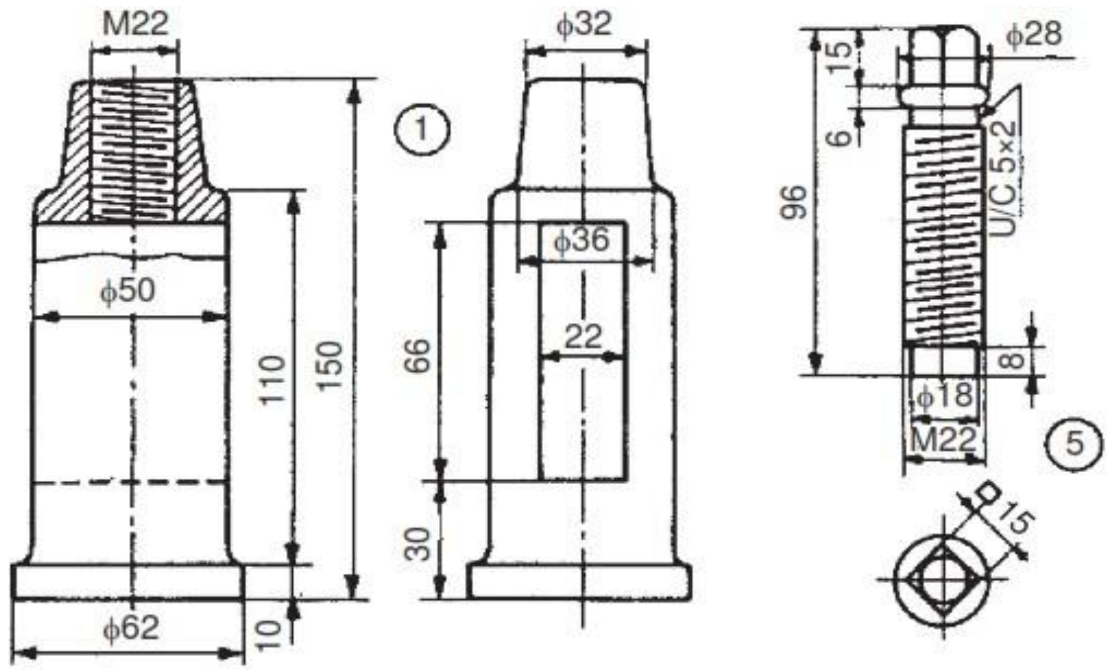
Parts list

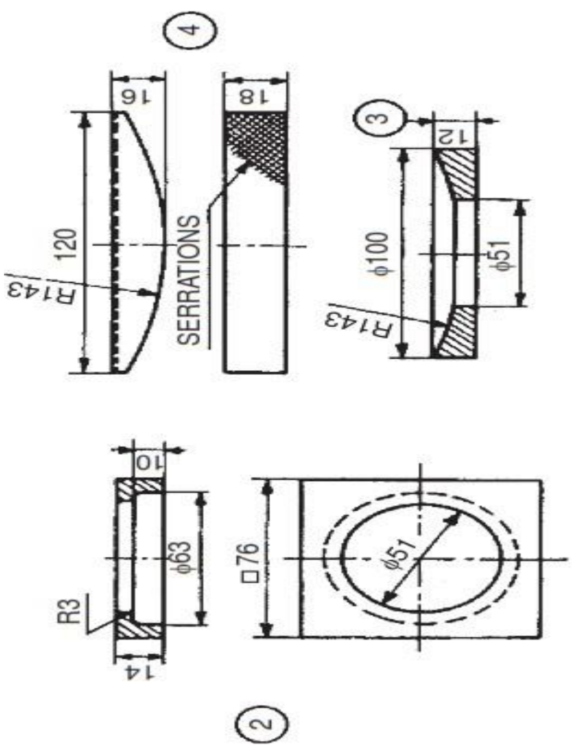
Sl. No.	Name	Matl.	Qty.
1	Base	CI	1
2	Bearing brass	Bronze	1
3	Bearing brass	Bronze	1
4	Cap	CI	1
5	Bolt with nuts	MS	2

Plumer block

Lathe tool post

It supports one cutting tool at a time and is used on small sized lathes. This unit is fixed on the compound rest of the lathe carriage. The tool post consists of a circular body1 with a collar at one end and a threaded hole at the other. A vertical slot is provided in the body to accommodate the tool/tool holder. The body is solid through the square block 5, which is finally located in the T-slot, provided in the compound rest. The design permits rotation of the body about the vertical axis. A circular ring 4 having spherical top surface is slid over the body and the wedge 3 is located in the vertical slot. The tool / tool holder is placed over the wedge. By sliding the wedge on the ring, the tool tip level can be adjusted. The tool is clamped in position by means of the square headed clamping screw 2, passing through the head of the body.



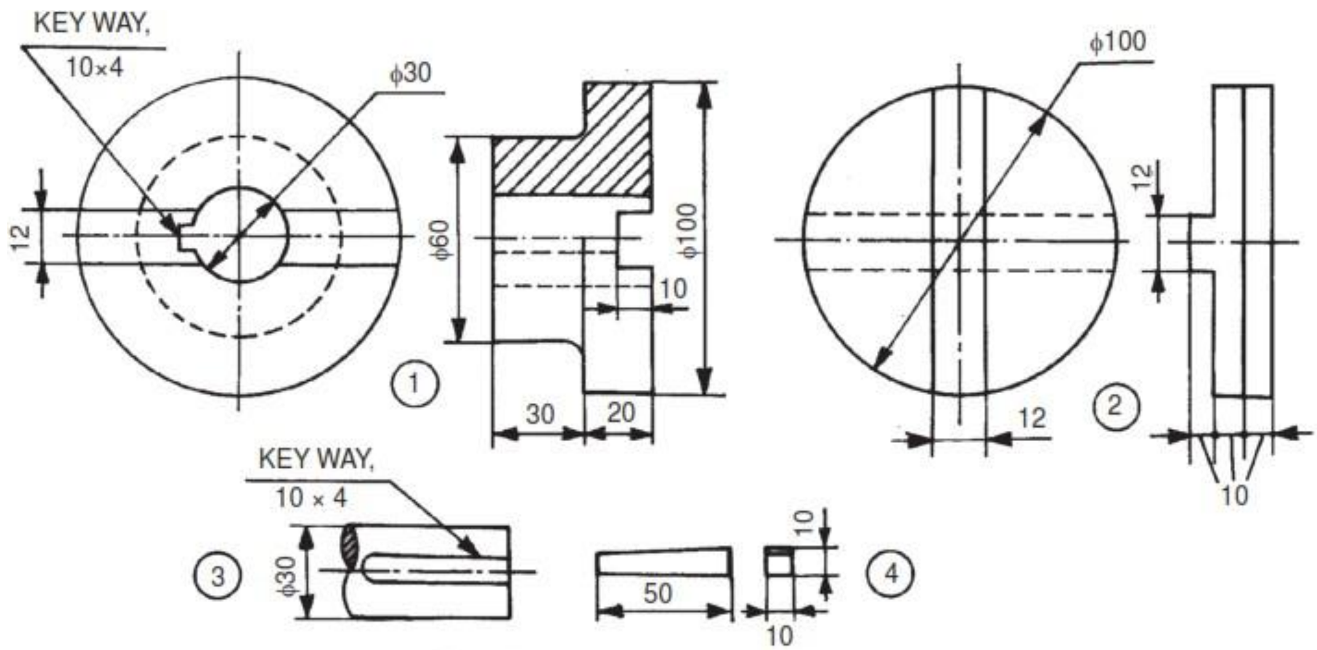


Parts list

No.	Name	Matl	Qty
1	Piller	MCS	1
2	Block	MCS	1
3	Ring	MS	1
4	Wedge	MCS	1
5	Screw	TS	1

Tool post

Oldham coupling is known as a non-aligned coupling and is used to connect two parallel shafts, whose axes are at a small distance apart. The two flanges 1 are mounted on the ends of shafts 3 by means of sunk keys 4. The flanges are having rectangular slots in them. These flanges are set such that, the slotsinthemareatrightangletoeach other.Thecirculardisc2isnowpositionedin-betweenthem so that the projections in the circular disc, enter into the corresponding slots of the flanges. During rotation of the shafts, the central disc slides in the slots of theflanges.



Parts list

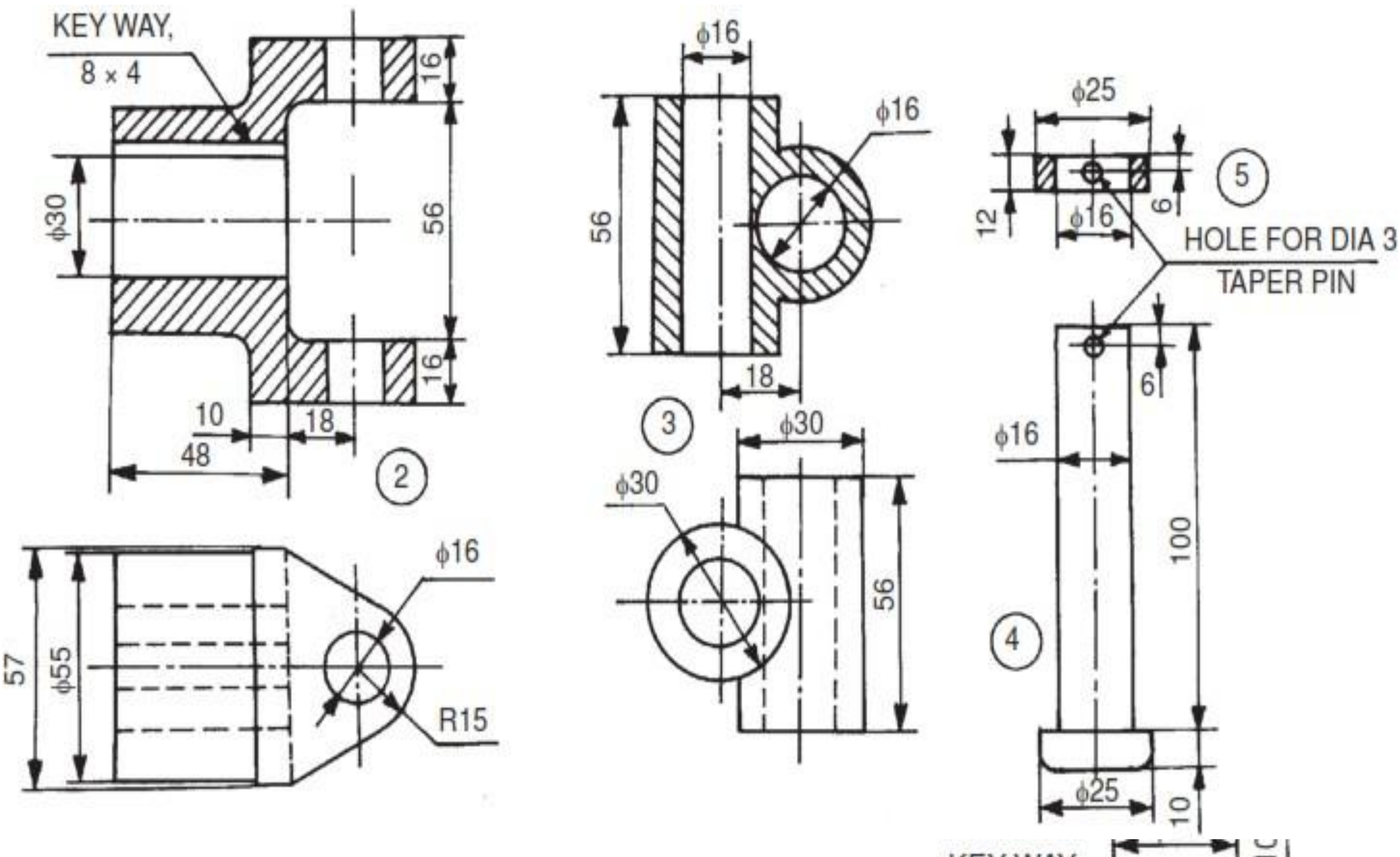
Sl. No.	Name	Matl.	Qty.
1	Flange	MS	2
2	Disc	MS	1
3	Shaft	MS	2
4	Key	MS	2

Oldham Coupling

EXPERIMENT – X

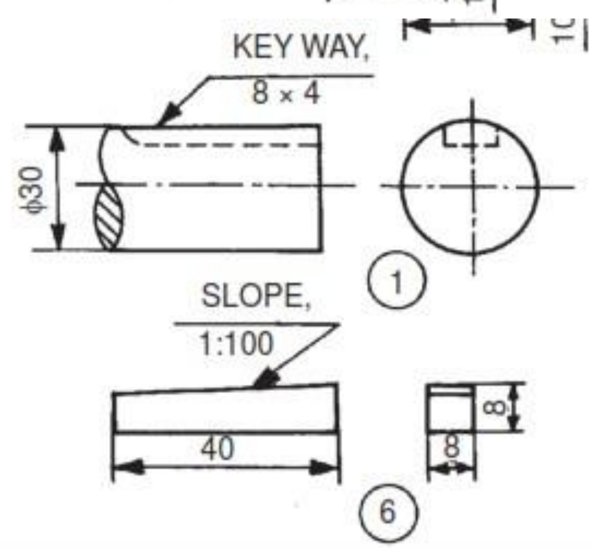
Universal coupling

It is a rigid coupling and is used to connect two shafts, whose axes intersect if extended. The forks 2 are mounted at the ends of two shafts 1, making use of sunk keys 6. The central block 3, having two arms at right angle to each other, is placed between the forks and connected to both of them by using pins4 and collars5. A taper pin is used to keep the pins4 in position. During rotation of shafts, the angle between them can be varied.



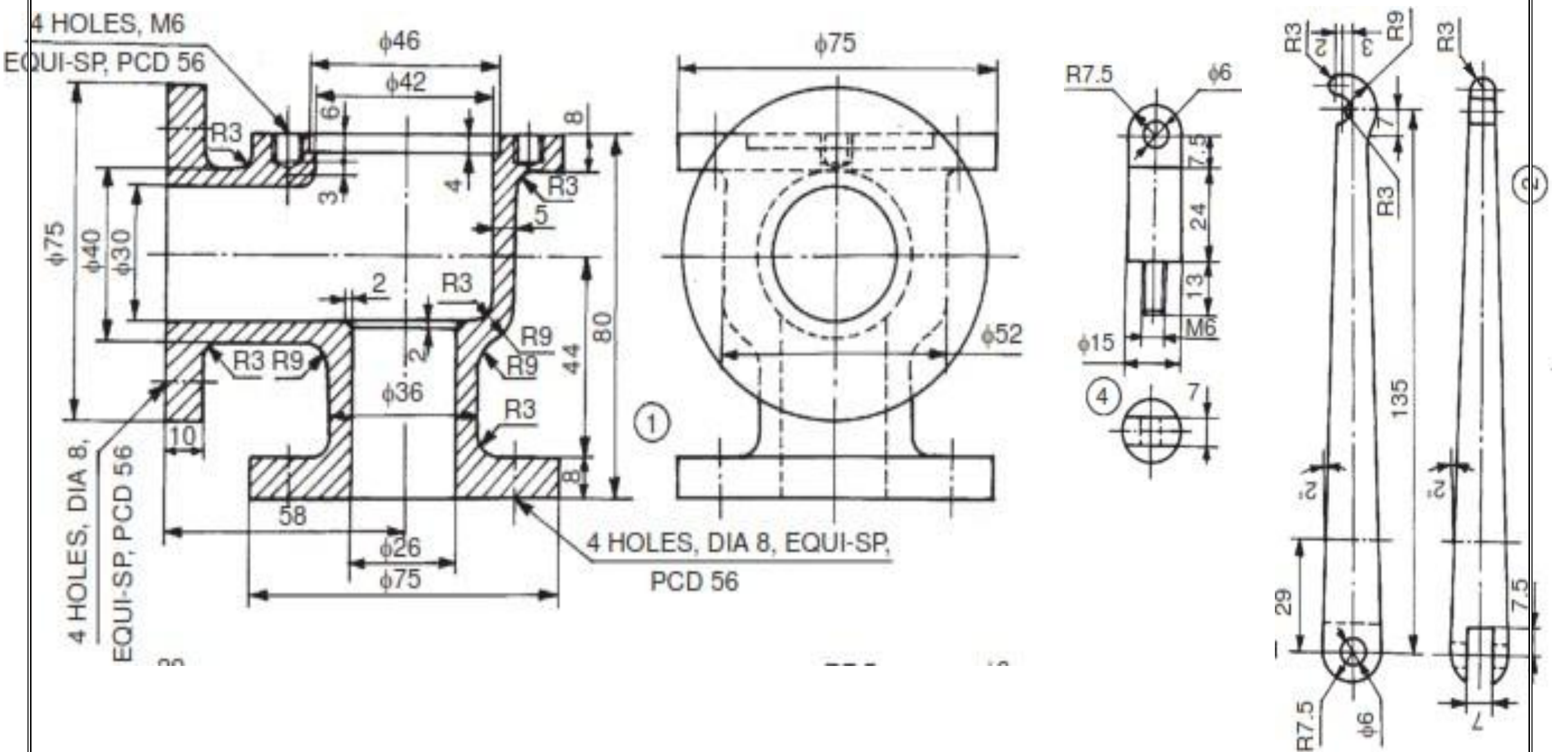
Parts list

Sl. No.	Name	Matl.	Qty.
1	Shaft	MS	2
2	Fork	FS	2
3	Central block	FS	1
4	Pin	MS	2
5	Collar	MS	2
6	Key	MS	2

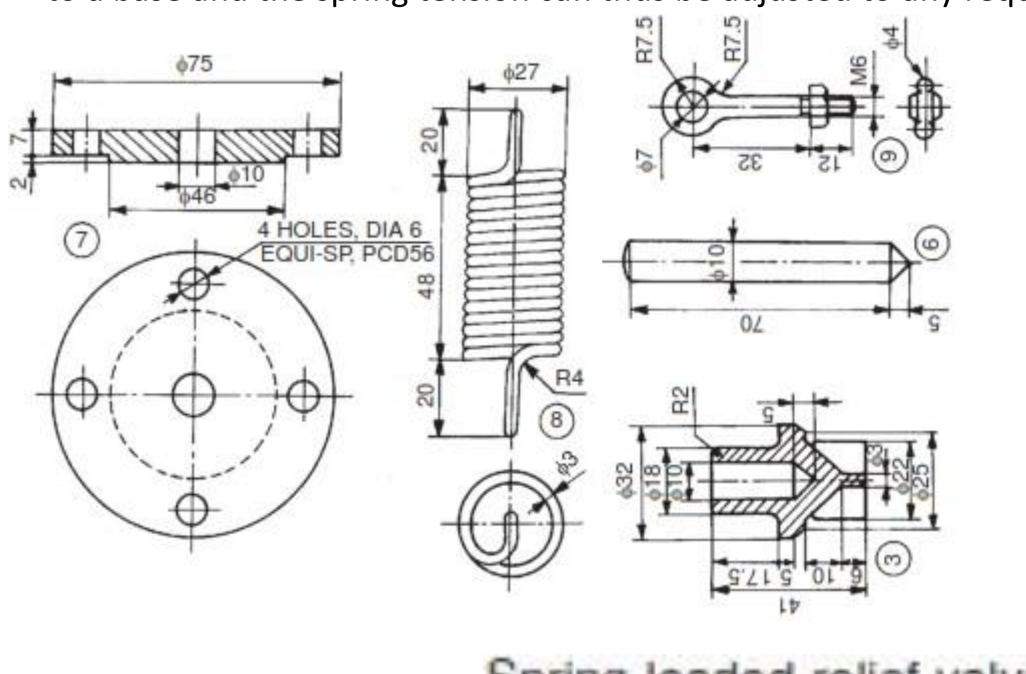


Universal coupling

Safety or relief valves are used as boiler mountings and they let off steam from inside the boiler whenever the pressure exceeds the set value. Thus, these valves safe guard the boilers. The pressure may be set by using a dead weight or a tension spring with tension

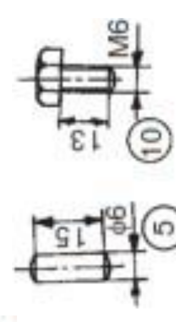


adjustment arrangement. Spring loaded relief valve in which a tension spring is used to set a pre-determined value for the steam pressure in the boiler. Valve 3 is placed vertically inside the valve body 1 and the valve seat is an integral part of the valve body, in the design considered. Stem 6 is located in the valve, with pointed end entering into the valve. Flange 7 is now placed over this assembly and fastened to the valve body by fulcrum bolt 4. Lever 2 is attached to the fulcrum bolt by using the fulcrum pin 5 such that, the lever rests on the stem6. One end of the tension spring 8 is attached to the lever and the other end to the tension adjusting bolt 9. The tension adjusting bolt is attached to a base and the spring tension can thus be adjusted to any required value.



Parts list

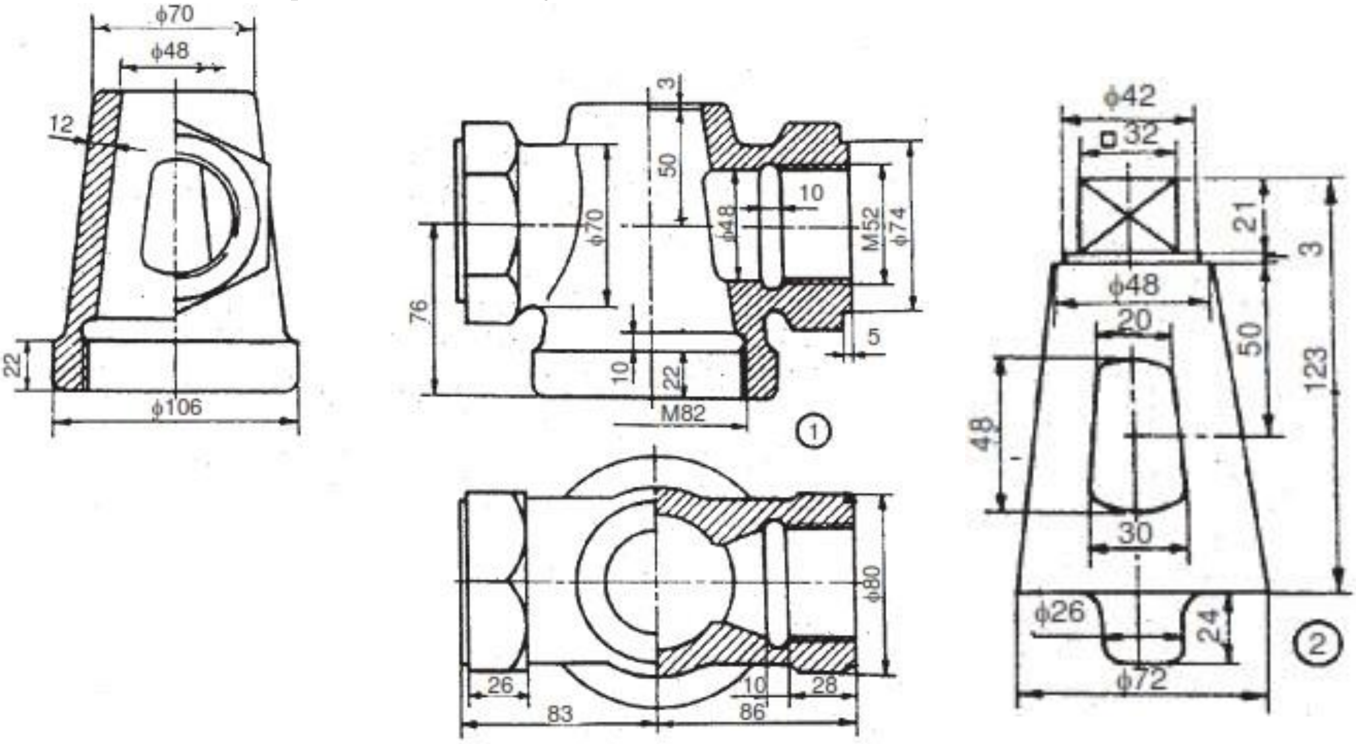
Sl. No.	Name	Matl.	Qty.
1	Valve body	CI	1
2	Lever	MS	1
3	Valve	GM	1
4	Fulcrum bolt	MS	1
5	Fulcrum pin	MS	1
6	Stem	MS	1
7	Flange	CI	1
8	Tension spring	HCS	1
9	Tension adjusting bolt with nut	MS	1
10	Screw	MS	3

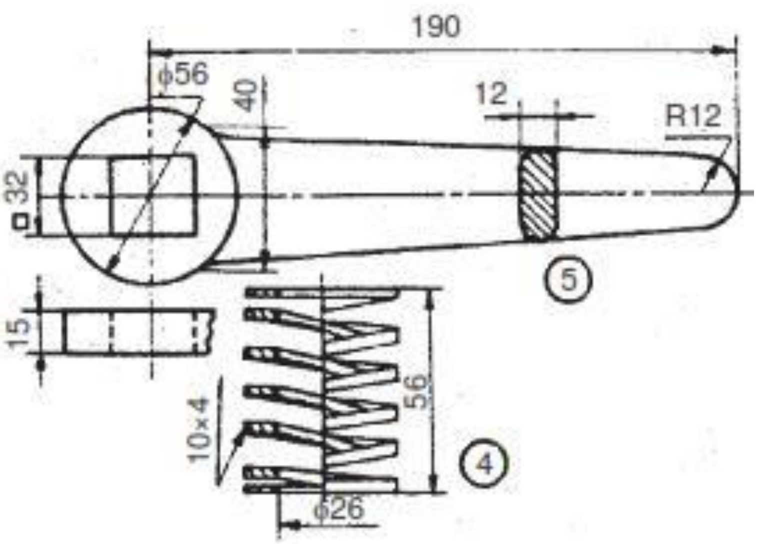


Spring loaded relief valve

Air cock

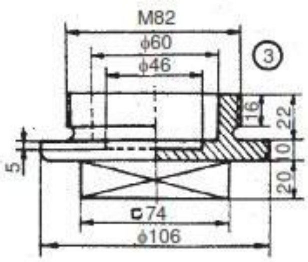
This valve is used to control air or gas supply. It consists of a plug 2 which is inserted into the body 1, from the bottom. The rectangular sectioned spring 4 is placed in position at the bottom of the plug and seated over the screw cap 3. The screw cap is operated to adjust the spring tension. Lever 5 with square hole is used to operate the cock. By a mere 90° turn, the cock is either opened or closed fully.





Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Plug	CI	1
3	Screw cap	MS	1
4	Spring	Spring S	1
5	Lever	FS	1



Air cock

INSTRUMENTATION AND CONTROL SYSTEMS

CONTENTS

S. No	Topic	Page No’s
1.	Calibration of capacitive transducer for angular displacement.	4 - 6
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3.	Calibration of resistance temperature detector for temperature measurement.	12 - 14
4.	Calibration of thermistor for temperature measurement.	15 – 18
5.	Calibration of thermocouple for temperature measurement.	19 – 22
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I N T R O D U C T I O N

Introduction to Transducers and Measurement systems:

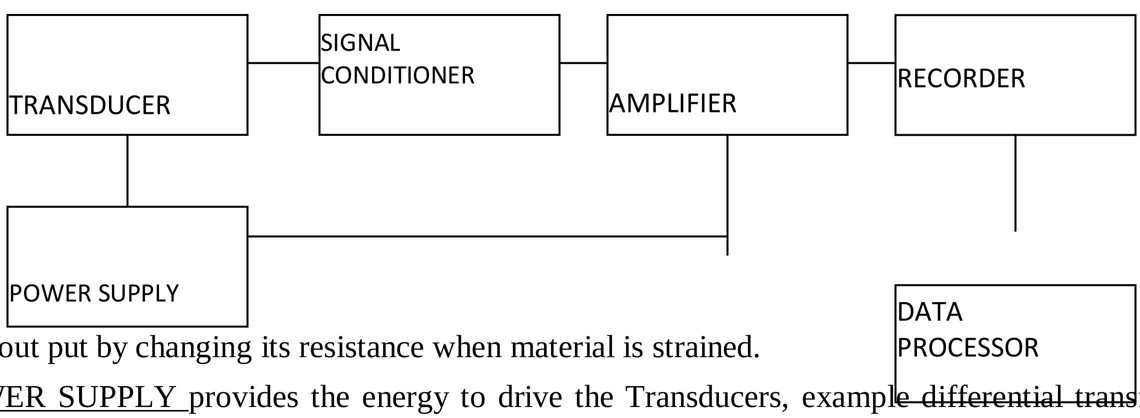
Transducer:
Transducer is a device which converts one form of energy into another form like Electrical to Mechanical, Mechanical to Electrical, Thermal to Electrical and etc.,

Emphasis in the instrumentation trainers will be directed toward electronic instrumentation systems rather than mechanical systems. In most cases electronic systems provide better data more accurately completely characterize the design or process being experimentally evaluated. Also the electronic system provides an electrical out put signal that can be used for automatic data reduction or for the control of the process. These advantage of the electronic measurement system over the mechanical measurement system have initiated and sustained trend instrumentation toward electronic methods.

An attempt is made through these "Instrumentation trainer kits" to make as easy as possible for the students to learn about the electronic instrumentation system and various transducers used for the measurement of mechanical component. The instrumentation tutor panels are design in such a way that block diagrams of the stages of electronic instrumentation system are clearly pictured on them. This makes the instrumentation tutor self explanatory and also the best teaching aid for engineering students.

Since the instrumentation tutors are not instrument as a whole the accuracy of the measurement cannot be claimed. It is very clear that the instrumentation tutors are only for demonstration purpose and cannot be used for any external measurement other than conducting experiments.

THE ELECTRONIC INSTRUMENTATION SYSTEM.
The complete electronic instrumentation system usually contains six sub systems or elements the TRANSDUCER is a device that convert a change in the mechanical or thermal quantity being measured into a change of an electrical quantity. Example strain gauges bonded in to an specimen, gives out



electrical out put by changing its resistance when material is strained.

The POWER SUPPLY provides the energy to drive the Transducers, example differential transformer, which is a transducer used to measure displacement required an AC voltage supply to excite the coil.

SIGNAL CONDITIONERS are electronic circuits the convert, compensate, or manipulate the out put from in to a more usable electronic quantity. Example the whetstone bridge used in the strain transducer converts the change in resistance. AR to a change in the resistance AE.

AMPLIFIERS are required in the system when the voltage out put from the transducer signal conditioner combination is small. Amplifiers with game of 10 to 1000 are used to increase their signals to levels they are compatible with the voltage – measuring devices.

RECORDERS are voltage measuring devices that are used to display the measurement in a form that can be read and interpreted Digital/Analog voltmeters are often used to measure static voltages.

DATA PROCESSORS are used to convert the out put signals from the instrument system into data that can be easily interpreted by the Engineer. Data processors are usually employed where large amount of data are being collected and manual reduction of these data would be too time consuming and costly.

EXPERIMENT NO.1

CALIBRATION OF CAPACITIVE TRANSDUCER FOR ANGULAR DISPLACEMENT.

Displacement measurement by Capacitive Transducer:

I N T R O D U C T I O N

Unique Capacitance trainer Module is the best trainer for which demonstrate the use of capacitance as a transducer. Two parallel plates (A1), one fixed to the base and the other moving over the fixed plate parallel with a small gap between the two. The over lapping of the plate will act as a capacitor with air as dielectric media. The parallel capacitor is used as a displacement sensor which measure the displacement.

The instrument is built around an NE556 integrated circuit. The NE556 is a dual 556 times IC. The first timer is connected as a stable multi vibrator while the second time is sued as a mono stable.

At each trigger, the mono stable output a pulse whose width is determined by the Resistance and the Capacitance of the parallel plate capacitor Cx connected across the measuring terminals. Specifically the mono stable duration is given by T=1.1 R range X Cx, where R range is the range resistance across the measurement terminals. From this is is seen that the width of the mono stable pulse is directly proportional to capacitance Cx (parallel plate capacitor).

Since the mono stable duration is itself is proportional to capacitance Cx (parallel plate capacitor) across the measurement terminals, it follows that the meter indicated is directly proportional to the capacitance. The mono stable output is average during averaging circuit and feed to amplified for Zero setting and calibration the instrument to read displacement.

Theory

Capacitive transducer is a device used to measure the displacement by the following equation

$$C = \varepsilon A/d$$

Where c- capacitance,
ε – Dielectric medium, A-
Area of overlapping,
d- Distance betweenplates

BY capacitive Transducer we have three combinations for measuring Linear and Angular Displacement:

1. Change in the Area ofoverlapping,
2. Change in the Distance betweenplates,
3. Change in the Dielectricmedium.

Here, in this experiment we are going to use Change in the Area of overlapping for finding the LIneasr displacement measaurement

Aim:

To perform an experiment on Displacement measurement using capacitive transducer

O P E R A T I N G P R O C E D U R E

- Check connection made to theinstrument
- Allow the instrument in On position for 10 minutes for initial warmup
- Pull the top plate to Zeroposition
- Adjust the ZERO potentiometer so that the display reads'000'
- Move the plate in step of 5 to 10 mm and note down the reading in the tabular column till50mm.

S P E C I F I C A T I O N S

Sensor	:	Parallel platecapacitor
SensorMateria.3	:	Aluminumplates
DielectricMedium	:	Air
Displacement	:	0 to 50 mm
Accuracy	:	5 to10%
Display	:	3.5 digit LED display to read
+/- 1999 countsfor		
Power	:	230V +/- 10% 50HZ

E X P E R I M E N T & T A B U L A R C O L U M N

Measurement of displacement using capacitance is a demo model to demonstrate the use of capacitance as displacement sensor. In measurement Repeatability, Linearity. Accuracy important factors. So the experiment to test the Parallel plate Capacitance for all thesefactors.

EXPERIMENT

Known displacement is given to the parallel plate and the displacement on the scale can be noted down along with the display readings. Graph of scale reading versus Display reading can be Plotted. Accuracy and the linearity of the Capacitance sensor can be calculated by the graphs, Repeatability can be calculated by repeating the experiment 3 to 4 times and tabulating the readings both for ascending and descending of displacement.

TABULAR COLUMN

A SL. NO.	B ACTUAL SCALE READINGS (MM)	C INDICATOR READINGS (MM)	D ERROR B-0	E % ERROR

Questions:

1. What is the principle of working of capacitivetransducer?
2. What iscalibration?
3. How capacitive transducer used for displacementmeasurement?
4. What are the advantages of capacitive transducer?
5. What is the replacement for displacement measurement if capacitive transducer is notthere?

EXPERIMENTNO.2

STUDY AND CALIBRATION OF LVDT TRANSDUCER FOR DISPLACEMENT MEASUREMENT

Displacement Measurement by LVDT

I N T R O D U C T I O N

The primary object of the INSTRUMENTATION TRAINER is to introduce and to educate electronic instrumentation systems in a manner sufficiently complete that the students will acquire proper knowledge and the idea about the transducers and their applications to measure mechanical and terminal quantities. The mechanical quantities include strain, force, pressure torque displacement, acceleration, frequency, etc. The terminal quantities include temperature and heat flux.

It is understood that the students will have a conceptual understand of these quantities through exposure of mechanics or physics courses, such as static's dynamics, strength of materials or thermodynamics. The students experience in actually measuring these quantities by conducting experiments, however, will usually be quit limited. It is an objective of this tutor to introduce methods commonly employed in such measurements and the usage of such electrical components such as capacitance, resistance, inductance, intensity, etc.

Emphasis in the instrumentation trainer will be directed toward electronic instrumentation systems rather than mechanical systems. In most cases electronic systems provide better data more accurately completely characterize the design or process being experimentally evaluated. Also the electronic system provides an electrical out put signal that can be used for automatic data reduction or for the control of the process. These advantage of the electronic measurement system over the mechanical measurement system have initiated and sustained trend instrumentation toward electronic methods.

An attempt is made through these "Instrumentation trainer" to make as easy as possible for the students to learn about the electronic instrumentation system and various transducers used for the measurement of mechanical component. The instrumentation tutor panels are design in such a way that block diagrams of the stages of electronic instrumentation system are clearly pictured on them. This makes the instrumentation tutor self explanatory and also the best teaching aid for Engineeringstudents.

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THEORY

MEASUREMENT OF DISPLACEMENT

Differential transformers on a variable inductance principle, are also used to measure displacement. The most popular variable inductance transducer for linear displacement measurement is the Linear Variable Differential Transformer (LVDT). The LVDT illustrated in the fig. consists of three symmetrically spaced coils would onto an insulated bobbin. A magnetic core moves through thee bobbin without contact, provides a path for magnetic flux linkage between coils. The position of the magnetic core controls the mutual between the center or primary coil and with the two outside of secondary coils.

When an AC carrier excitation is applied to the primary coil, voltages are induced in the two secondary coils that are wires in a series-opposing circuit. When the core is centered between the two secondary coils, the voltage induces between the secondary coils are equal but out of phase by 180^0. The voltage in the two coil cancels and the output voltage will be zero. When the core is moves from the center position,

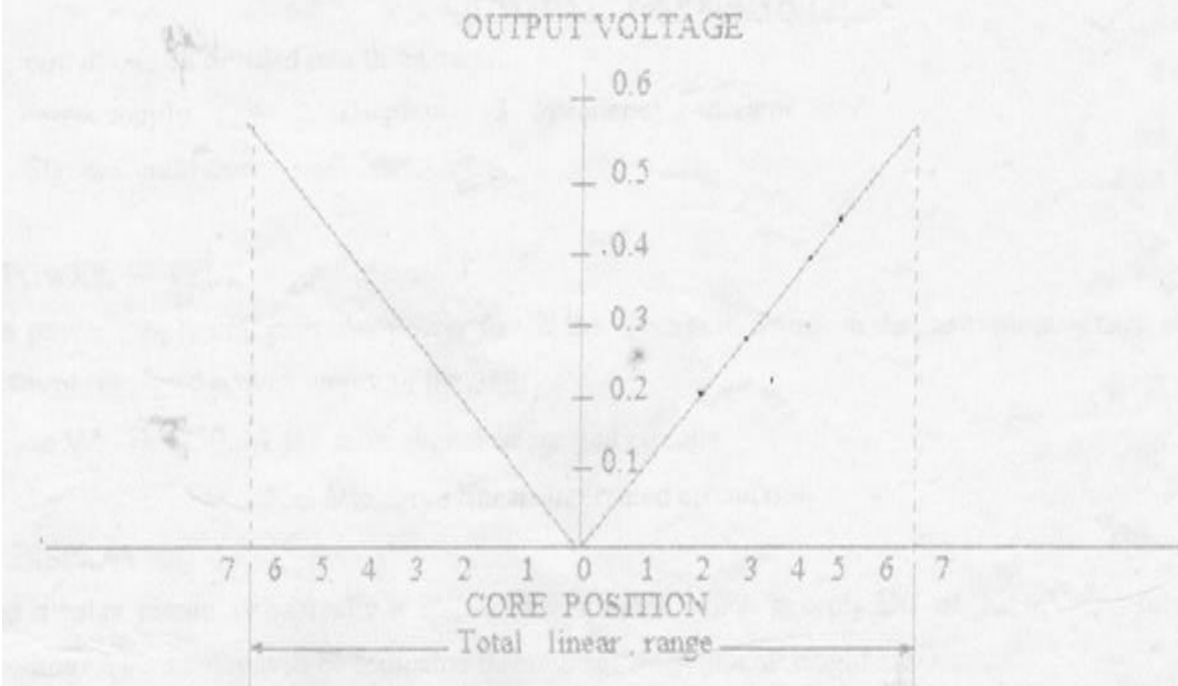


FIG. 1 Magnitude of the output Voltage as a function of LVDT core Position.

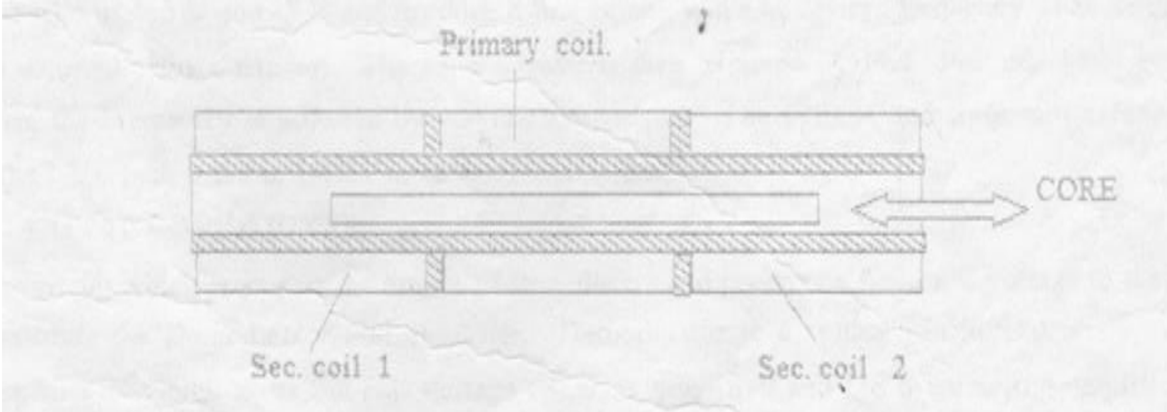


FIG. 2 Diagram to shows schematically the working of LVDT.

an imbalance in mutual inductance between the primary coil and the secondary coil occurs and an output voltage develops. The output voltage is a linear function of the core position as long as the motion of the core is within the operating range of theLVDT.

C I R C U I T E X P L A N A T I O N

The circuit can be divided into three parts.

1. Power supply 2. Display3. Frequency generator &
4. Signal Conditioner

1. POWER SUPPLY

The power supply unit provides power for all the electronic device in the instrument. There are two differential regulated power supply in the unit.

a) +5V, -5V 250mA too drive digital integratedcircuits.
b) +5V, -0 -5V, 250mA to drive linear integratedcircuits.

2. DISPLAY

The display circuit is basically a 3 ½ digit voltmeter which accepts DC of 200mV for full scale Reading. The display
will be indicated through seven segment bright LED's.

3. FREQUENCYGENERATOR

The circuit is an IC based (OP AMP) used to generate excitation voltage to the LVDT primary coil. The IC's use +5V and -5V and produce a fine square wave of desired frequency. The Voltage can be adjusted using a trim pot. The square wave is then trimmed by FET, PnP and NpN transistor. Then the Frequency is adjusted by varying the trim pot. The voltage and frequency is adjusted to 2khz 2 V which is fed to LVDT as an excitationvoltage.

4. SIGNALCONDITIONER

The circuit which processes the output of transducers and presents a fixed DC voltage to the display constitute the Demodulator and amplifier. Demodulator is a phase sensitive detector and AC amplifier, which gives out DC voltage which is amplified and fed to summing amplifiers. The output of the summing amplifier is fad to the display.

S P E C I F I C I A T I O N S

INDICATOR

* DISPLAY : 3 ½ digit seven segment red LED displayof
Rage 200mV for full scale deflection to read $^{+}/_{-}$ 1999 counts
* EXCITATIONVOLTAGE : 1000 Hz atIV
* OPERATINGTEMPERATURE: $+10^{0}$ c to 55^{0}C
* ZEROADJUSTMENT : Front panel throughPotentiometer
* SENSTIVITY : 0.1 mm
* SYSTEMINACCURACY : 1%

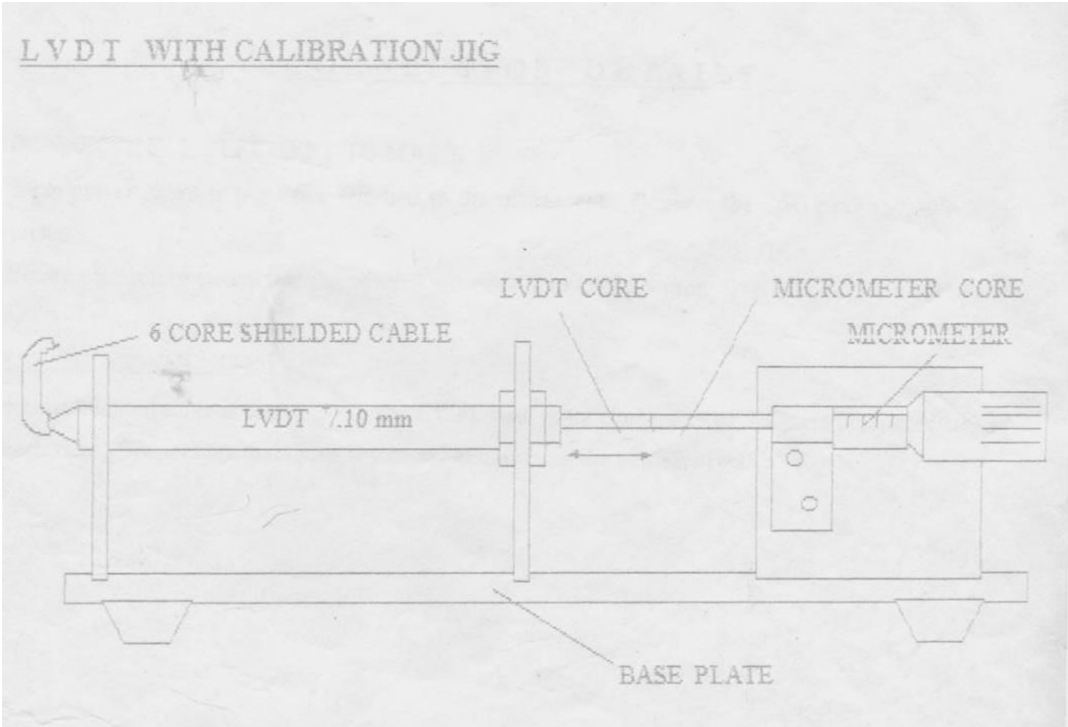
*	REPEATABILITY	:	1%
*	CONNECTION	:	Through 6 core shielded cable withDin connector.
*	FUSE	:	250mA fast glowtype.
*	POWER	:	230 V +/- 10%, 50Hz

SENSOR

*	RANGE	:	+/- 10.0mm
*	EXCITATIONVOLTAGE	:	1 to 4 kHz at 1 to4V
*	LINEARITY	:	1%
*	OPERATINGTEMPERATURE:	:	$+10^0$c to 55^0C
*	CONNECTION	:	Through 6 core shielded cableprovided along with the sensor of 2Mlength.
*	CALIBRATIONJIG	:	Micrometer to 0 to 25 mm length is mounted on the base.

PANEL DETAILS

DISPLAY : 3 ½ Digit LED display of 200mV FSD to read up to “+/- 1999” counts.
ZERO : Single turn potentiometer to adjust“000” when the sensor is connected
CAL : Single turn potentiometer to adjustthe calibrationpoint.
CIRCUITRY : Block diagram of the circuitfor displacement indicator. The diagram also shows LVDT block diagram also.



MOUNTING OF L V D T ON THE CALIBRATION JIG

L V D T has to be mounted perfectly on the calibration Jig. Micrometer should be moved till the micrometer reads20.0 mm. LVDT should be mounted too the center plate by the two nuts provided. The core of the LVDT should be aligned with the core of the micrometer. Adjust the core of the LVDT till it touches the micrometer core and lighten thenut.

C O N N E C T I O N D E T A I L S

CONNECTING INSTRUMENT TO MAINS

3 Pin power chord is provided, attached to the instrument. Connect the 3 pin plug to 230V 50Hz socket. Before connecting ensure that the power On switch is in OFF position.

SENSOR CONNECTION

6 core shielded cable is connected to the LVDT with male connectors of different colors are fixed to each wire. Connect the male pins to the socket matching the color correctly.

O P E R A T I N G P R O C E D U R E

1. Connect the power supply chord at the rear panel to the 230V 50Hz supply. Switch on the instrument by pressing down the toggle switch. The display glows to indicate the instrument isON.
2. Allow the instrument in ON position for 10 minutes for initialwarm-up.
3. Rotate the micrometer till it reads“20.0”.
4. Adjust the CAL potentiometer at the front panel so that the display reads“10.0”
5. Rotate the core of micrometer till the micrometer reads “10.0” and adjust the ZERO potentiometer till the display reads“00.0”.
6. Rotate back the micrometer core upto 20.0 and adjust once again CAL Potentiometertill the display read

10.0. Now the instrument is calibrated for +/- 10.0 mm range. As the core of LVDT moves the display reads the displacement in mm.

7. Rotate the core of the micrometer in steps of 1 or 2 mm and tabulate the readings. The micrometer will show the exact displacement given to the LVDT core the display will read the displacement sensed by the LVDT. Tabulate the readings and Plot the graph Actual V/s indicatorreadings.

E X P E R I M E N T & T A B U L A R C O L U M N

Measurement of displacement through LVDT is well accepted method in process control instrumentation. In measurementRepeatability,Linearity.Accuracyareimportantfactors.SotheexperimenttotesttheLVDT forallthese factors.

EXPERIMENT is the known displacement is given to the LVDT core through micrometer and the displacementsensed by the micrometer can be noted down. Graph of Micrometer reading versus LVDT reading can be Plotted. Accuracy and the linearity of the LVDT can be calculated by the graphs. Repeatability can be calculated by repeating the experiment 3 to 4 times and tabulating the readings both for ascending and descending ofdisplacement.

TABULAR COLUMN

A SL.NO.	B ACTUAL MICROMETER READINGS (MM)	C INDICATR READINGS LVDT (MM)	D ERROR B.C.	E % ERROR

Questions:

1. What is the principle of working ofLVDT?
2. What iscalibration?
3. How LVDT used for displacementmeasurement?
4. What are the advantages ofLVDT?
5. What is the replacement for displacement measurement if LVDT is notthere?

EXPERIMENT NO.3

STUDY OF RESISTANCE TEMPERATURE DETECTOR FOR TEMPERATUREMEASUREMENT.

Temperature measurement by RTD

CONTENTS

1. THEORY
2. PANELDETAILS
3. SPECIFICATIONS
4. OPERATINGPROCEDURE

Theory

RESISTANCE TERMPERATURE DETECTORS (RTD)

The change in the resistance of metals with temperature provides the basic for a family of temperature measuring sensors known as resistance temperature detectors. The sensor is simply a conductor fabricated either as a wire would coil or as a film or foil grid. The change in resistance of the conductor with temperature is given by the expression.

$\Delta R / R_0 = \lambda_1 (T-T_0) + \lambda_2 (T-T_0)^2 + \lambda_n (T-T_0)^n$

Where T_0 is a referencetemperature.

R_0 is the resistance at temperature T_0

$\lambda_1, \lambda_2,$ .... λ_n are temperature co-efficient ofresistance.

Platinum is widely used for sensor fabrication since it is the most stable of all the metals, is the least sensitive to contamination, and is capable of operating over a very wide range of temperature. The dynamic response of on RTD depends almost entirely on construction details.

CIRCUIT EXPLANATION

The circuit comprises of three parts.

1. POWERSUPPLY
2. SIGNAL CONDITIONING ANDAMPLIFYING
3. ANALOG TO DIGITALCONVERTER.

1. POWERSUPPLY.

Inbuilt power supply use power to all electronic devices inside the circuitry. High stable regulated Power supply is used for better performance.

There are three different power supply inside the unit.

+12-0 012 V 500mA to drive digital integrated circuitry.
+5-0—5V 250mA to drive A to D converter.

2. SIGNAL CONDITIONING ANDAMPLIFYING

The circuitry comprises of signal conditioner and amplifier. The output of the sensor is amplified to required level. The Thermocouple gives out directly which is amplified. Thermistor and RTD are connected to the ground through a resister, and the voltage is applied to the other end of the sensor. The resistance change in the sensor will gives the mV out put which is amplified and controlled. Analog out put is fad to the ADC.

3. ANALOG TO DIGITALCONVERTER.

The output from the amplifier is a linearised analog DC voltage. This analog output is converted into digital output with the help of IC 7107 3.5 digit 200mA. A to D converter. Then it is displayed through seven segmented LEDs.

PANEL DETAILS

DISPLAY : 3 ½ Digit LED Display of 200 mVFSD.
INITIALSET : Single turn potentiometer to set InitialTemperature (Room Temperature)
FINALTEST : Single turn potentiometer to Calibrate theinstrument (Max. Temperature)
SELECT : 3 Way rotary switch to select RTD, Thermocoupleand Thermister.
POWERON : Rocker switch to control power supply tothe instrument.

CONNECTION DETAILS

POWER : 3 pin mains cable is provided with theinstrument.
Connect the 3 pin socket to the instrument at the rear panel and to the AC mains 230v supply.

NOTE : Before connecting ensure the voltage is 230 V and the Power switch is in offposition)

SENSORS : Connect RTD, Thermistor and Thermocouple tothe connector on the rear panel.

OPERATING PROCEDURE

Check connection made and Switch ON the instrument by rocker switch at the front panel. The display glows to indicate the instrument is ON.

Allow the instrument in ON Position for 10 minutes for initial warm-up.
Pore around 3/4th full of water to the kettle and place sensors and thermometer inside the kettle. Note down the Initial water temperature from the thermometer.
Select the sensor on which the experiment to be conducted through selection switch on the front panel. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature.
Switch on the kept and wait till the water boils note down the reading inn the thermometer and set Final set potentiometer till the display reads boiling water temperature.
Remove the sensor from the boiling water immerse it I the cold water. Set the cold water temperature using initial set potentiometer.
Repeat the process till the display reads exact boiling water and cold water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle.
Experiment can be repeated for all the three sensors. Temperature in the thermometer and the indicator readings in steps of 10^0 C can be tabulated.

EXPERIMENTS AND TABULAR COLUMN-1

EXPERIMENT TO MEASURE TEMPERATURE USING RTD:

Experiment can be conducted on the instrument as per the operating instruction given above for the RTD and and various parameters like Linearity. Accuracy, Hysteresis etc, can be calculated. The readings can be tabulated and graphs can be plotted to calculated the above parameters.

TABULAR COLUMN-1

SL. NO	THERMOMETER REARING ^{0}C (Actual Temperature)	RTD ^{0}C

Graphs: Actual reading V/s indicator Reading

EXPERIMENTS AND TABULAR COLUMN –2

EXPERIMENT TO STUDY THE CHARACTERISTICS OF RTD.

- Remove the YELLOW & GREEN terminals of the sensors from theinstrument
- Connect RTD to Ohm-meter to measureohms.
- Repeat the Experiment 1 but measure the resistance changes ofRTD.
- Tabulate the readings in the tabular column given below. Plot the graphs for

Temperature change inthe thermometer V/s Change in themillivolt/Resistance

TABULAR COLUMN-1

EXPERIMENT-2

SL. NO	THERMOMETER REARING ^{0}C (Actual Temperature)	RTD ^{0}C

Questions:

1. What is the principle ofRTD?
2. What iscalibration?
3. How RTD used for Temperaturemeasurement?
4. What are the advantagesRTD?
5. What is the replacement for temperature measurement if RTD is notthere?

EXPERIMENT NO.4

CALIBRATION OF THERMOCOUPLE FOR TEMPERATURE MEASUREMENT.

Temperature measurement by THERMOCOUPLE

CONTENTS

1. INTRODUCTION
2. THEORY
3. PANELDETAILS
4. SPECIFICATIONS
5. OPERATINGPROCEDURE

INTRODUCTION

The primary object of the INSTRUMENTATION TAINERS (TEMPERATURE TRAINER) is to introduce and to educate electronic instrumentation systems in a manner sufficiently complete that the students will acquire proper knowledge and the idea about the transducers and their applications measure mechanical and thermal quantities. The mechanical quantities include strain, force, pressure, torque, displacement, acceleration, frequency, etc. The thermal quantities include temperature and heat flux.

It is understood that the students will have a conceptual understanding of these quantities through exposure of mechanics or physics courses, such as static's, dynamics, strength of materials or thermodynamics. The student's experience in actually measuring these quantities by conducting experiments, however, will usually be quit limited. It is an objective of this tutor to introduce methods commonly employed in such measurements and the usage of such electrical components such as capacitance, resistance, inductance, intensity,etc.,

Emphasis in the instrumentation tutor will be directed toward electronic instrumentation systems rather than mechanical systems. In most cases electronic systems provide better data more accurately and than mechanical systems. In most cases electronic systems provide better data more accurately completely characterize the design or process being experimentally evaluated. Also, the electronic system provides an electrical out put signal that can be used for automatic data reduction or for the control of the process. These advantage of the electronic measurement system over the mechanical measurement system have initiated and sustained trend in instrumentation toward electronicmethods.

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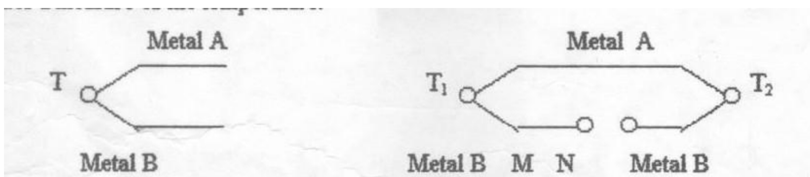
1. THERMOCOUPLE

When two dissimilar materials are brought into contact, a potential develops as a result of an effect known as the "seeback effect". A Thermocouple is a very simple temperature sensor operates based on the seeback effect, which results in the generation of a thermoelectric potential when two dissimilar metals are joined together to a junction. The electric potential of the material accepting electrons becomes negative at the interface, while the potential of the material providing the electrons become positive. Thus an electric field is established by the flow of electrons across the interface. When this electric field becomes sufficient to balance the diffusion forces, a state of equilibrium with respect to electron migration is established. Since the magnitude of the diffusion force is controlled by the temperature of the thermocouple junction, the electric potential developed at the junction provides a measure of thetemperature.



The electric potential is usually measured by introducing a special junction in an electric circuit. The voltage across terminals M-N can be represented approximately by an empirical equation having the form.

$E_0 = C_1 (T_1 - T_2) + C_2 (T_1^2 - T_2^2)$

When C1 and C2 are thermoelectric constants that depend on the material used to form the junction T1 and T2 are junction temperature.

CIRCUIT EXPLANATION

The circuit comprises of three parts.

1. POWERSUPPLY
2. SIGNAL CONDITIONING ANDAMPLIFYING
3. ANALOG TO DIGITALCONVERTER.

1. POWERSUPPLY.

Inbuilt power supply use power to all electronic devices inside the circuitry. High stable regulated Power supply is used for better performance.
There are three different power supply inside the unit.

+12-0 012 V 500mA to drive digital integrated circuitry.
+5-0—5V 250mA to drive A to D converter.

2. SIGNAL CONDITIONING ANDAMPLIFYING

The circuitry comprises of signal conditioner and amplifier. The output of the sensor is amplified to required level. The Thermocouple gives out directly which is amplified. Thermistor and RTD are connected to the ground through a resister, and the voltage is applied to the other end of the sensor. The resistance change in the sensor will gives the mV out put which is amplified and controlled. Analog out put is fad to the ADC.

3. ANALOG TO DIGITALCONVERTER.

The output from the amplifier is a linearised analog DC voltage. This analog output is converted into digital output with the help of IC 7107 3.5 digit 200mA. A to D converter. Then it is displayed through seven segmented LEDs.

PANEL DETAILS

DISPLAY : 3 ½ Digit LED Display of 200 mVFSD.
INITIALSET : Single turn potentiometer to set InitialTemperature (Room Temperature)
FINALTEST : Single turn potentiometer to Calibrate theinstrument (Max. Temperature)
SELECT : 3 Way rotary switch to select RTD, Thermocoupleand Thermister.
POWERON : Rocker switch to control power supply tothe instrument.

CONNECTION DETAILS

POWER : 3 pin mains cable is provided with theinstrument. Connect the 3 pin socket to the instrument at the rear panel and to the AC mains 230v supply.

NOTE : Before connecting ensure the voltage is 230 V andthe Power switch is in offposition)

SENSORS : Connect RTD, Thermistor and Thermocouple tothe connector on the rear panel.

OPERATING PROCEDURE

Check connection made and Switch ON the instrument by rocker switch at the front panel. The display glows to indicate the instrument is ON.
Allow the instrument in ON Position for 10 minutes for initial warm-up.
Pore around $3/4^{th}$ full of water to the kettle and place sensors and thermometer inside the kettle. Note down the Initial water temperature from the thermometer.
Select the sensor on which the experiment to be conducted through selection switch on the front panel. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature.
Switch on the kept and wait till the water boils note down the reading inn the thermometer and set Final set potentiometer till the display reads boiling water temperature.
Remove the sensor from the boiling water immerse it I the cold water. Set the cold water temperature using

initial set potentiometer.
Repeat the process till the display reads exact boiling water and cold water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle.
Experiment can be repeated for all the three sensors. Temperature in the thermometer and the indicator readings in steps of 10^0 C can be tabulated.

EXPERIMENT AND TABULAR COLUMN-1

EXPERIMENT TO MEASURE TEMPERATURE USING THERMOCOUPLE. Experiment can be conducted on the instrument as per the operating instruction given for Thermocouple and various parameters like Linearity. Accuracy, Hysteresis etc, can be calculated. The readings can be tabulated and graphs can be plotted to calculate the above parameters.

TABULAR COLUMN-1

EXPERIMENT-1

SL.NO	THERMOMETER REARING ^{0}C (Actual Temperature)	THERMOCOUPLE ^{0}C

% Error = Column No. 4 X 100
Max. Load

Graphs: Actual reading V/s indicator Reading

EXPERIMENTS AND TABULAR COLUMN –2

EXPERIMENT TO STUDY THE CHARACTERISTICS OF THERMOCOUPLE

- Remove the YELLOW & GREEN terminals of the sensors from theinstrument
- Connect Thermocouple terminals to a Millivolt meter.
- Repeat the Experiment 1 but measure the thermocouple output through millivoltmeter.
- Tabulate the readings in the tabular column given below. Plot the graphs for Temperature change inthe thermometer V/s Change in themillivolt/Resistance

TABULAR COLUMN-1

EXPERIMENT-2

SL.NO	THERMOMETER REARING ^0C (Actual Temperature)	THERMOCOUPLE ^0C

Questions:

1. What is the principle ofThermocouple?
2. What iscalibration?
3. How Thermocouple used for Temperature measurement and what is the range ofthermocouples?
4. What are the advantages ofThermocouple?

EXPERIMENT NO.5

CALIBRATION OF THERMISTOR FOR TEMPERATURE MEASUREMENT.

Temperature measurement by THERMISTOR

CONTENTS

1. THEORY
2. PANELDETAILS
3. SPECIFICATIONS
4. OPERATINGPROCEDURE

Theory

THERMISTORS.

Temperature – measuring sensor based on the fact that the resistance of a material may change with temperature is known as a THERMISTOR. Thermostats differ from resistance temperature detectors in that they are fabricated from semi conducting materials instead of metals. The semi – conducting materials, which include oxides of copper, cobalt, manganese, nickel and titanium, exhibit very large change in resistance with temperature.

Resistance with temperature can be expressed by an equation of the form

$I_n p = A_0 + A_1 / T + A_2 /T^2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + A_n /T^n$

Where P is the specific resistance of the material.

A1, A2, ...An are materialconstants.

T is the absolute temperature.

Thermistor have many advantage over other temperature sensors and are widely used in industry. They can be small and consequently, permit point sensing and rapid response to temperature change. Their high resistance minimizes lead – wire problems. Their out put is more than 10 times that of a resistance temperature detector. The disadvantages of thermistor includesnon linearout put with temperature and limited range.

Since the instrumentation tutors are not instrument as a whole the accuracy of the measurement cannot be claimed. It is very clear that the instrumentation tutor are only for demonstration purpose and cannot be used for any external measurement other than conducting experiments.

CIRCUIT EXPLANATION

The circuit comprises of three parts.

1. POWERSUPPLY
2. SIGNAL CONDITIONING ANDAMPLIFYING
3. ANALOG TO DIGITALCONVERTER.

1. POWERSUPPLY.

Inbuilt power supply use power to all electronic devices inside the circuitry. High stable regulated Power supply is used for better performance.

There are three different power supply inside the unit.

+12-0 012 V 500mA to drive digital integrated circuitry.

+5-0—5V 250mA to drive A to D converter.

2. SIGNAL CONDITIONING ANDAMPLIFYING

The circuitry comprises of signal conditioner and amplifier. The output of the sensor is amplified to required level. The Thermocouple gives out directly which is amplified. Thermistor and RTD are connected to the ground through a resister, and the voltage is applied to the other end of the sensor. The resistance change in the sensor will gives the mV out put which is amplified and controlled. Analog out put is fad to the ADC.

3. ANALOG TO DIGITALCONVERTER.

The output from the amplifier is a linearised analog DC voltage. This analog output is converted into digital output with the help of IC 7107 3.5 digit 200mA. A to D converter. Then it is displayed through seven segmented LEDs.

PANEL DETAILS

DISPLAY	:	3 ½ Digit LED Display of 200 mVFSD.
INITIALSET	:	Single turn potentiometer to set InitialTemperature (Room Temperature)
FINALTEST	:	Single turn potentiometer to Calibrate theinstrument (Max. Temperature)
SELECT	:	3 Way rotary switch to selectThermister.
POWERON	:	Rocker switch to control power supply tothe instrument.

CONNECTION DETAILS

POWER : 3 pin mains cable is provided with theinstrument.
Connect the 3 pin socket to the instrument at the rear panel and to the AC mains 230v supply.

NOTE : Before connecting ensure the voltage is 230 V andthe Power switch is in offposition)

SENSORS : Connect Thermistor to the connector on the rearpanel.

OPERATING PROCEDURE

Check connection made and Switch ON the instrument by rocker switch at the front panel. The display glows to indicate the instrument is ON.
Allow the instrument in ON Position for 10 minutes for initial warm-up.
Pore around 3/4th full of water to the kettle and place sensors and thermometer inside the kettle. Note down the Initial water temperature from the thermometer.
Select the sensor on which the experiment to be conducted through selection switch on the front panel. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature.
Switch on the kept and wait till the water boils note down the reading inn the thermometer and set Final set potentiometer till the display reads boiling water temperature.
Remove the sensor from the boiling water immerse it I the cold water. Set the cold water temperature using initial set potentiometer.
Repeat the process till the display reads exact boiling water and cold water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle.
Experiment can be repeated for all the three sensors. Temperature in the thermometer and the indicator readings in steps of 10^0 C can betabulated.

EXPERIMENTS AND TABULAR COLUMN-1

EXPERIMENT TO MEASURE TEMPERATURE USING THERMISTOR:

Experiment can be conducted on the instrument as per the operating instruction given above for Thnermistor and various parameters like Linearity. Accuracy, Hysteresis etc, can be calculated. The readings can be tabulated and graphs can be plotted to calculated the aboveparameters.

TABULAR COLUMN-1

SL. NO	THERMOMETER REARING ^0C (Actual Temperature)	THERMISTER ^0C

Graphs: Actual reading V/s indicator Reading

EXPERIMENTS AND TABULAR COLUMN –2

EXPERIMENT TO STUDY THE CHARACTERISTICS OF THERMISTER.

- Remove the YELLOW & GREEN terminals of the sensors from theinstrument
- Connect Thermistor to Ohm-meter to measureohms.
- Tabulate the readings in the tabular column given below. Plot the graphs for Temperature change inthe thermometer V/s Change in themillivolt/Resistance

TABULAR COLUMN-1

EXPERIMENT-2

SL. NO	THERMOMETER REARING ^{0}C (Actual Temperature)	THERMISTER ^{0}C

Questions:

1. What is the principle of Thermistor?
2. What is calibration?
3. How Thermistor used for Temperaturemeasurement?
4. What are the advantages of Thermistor?
5. What is the replacement for temperature measurement if Thermistor is notthere?

EXPERIMENT NO.7CALIBRATION OF PRESSUREGAUGES

Dead Weight Tester

C O N T E N T S

1. THEINSTRUMENT
2. CIRCUITEXPLANATION
3. SPECIFICATION
4. PANELDETAILS
5. CONNECTION DETAIL & OPERATINGPROCEDURE

THE INSTRUMENT

UNIQUE Digital pressure measuring setup comprises of pressure indicator and pressure cell with loading system. Pressure indicator is a strain gauge signal conditioner and amplifier used to measure pressure due to load applied on the pressure cell. The strain gauge are bonded on the diaphragm and are connected in the form of whetstones bridge. A foot pump ofcapacity 7Kg/cm^2 is provided to load the Pressure cell UNIQUES Pressure measuring setup in a complete system which can be used to conduct measurement of pressure applied on the Pressure cell. The pressure indicator is provided with zero balancing facility through adjustable potentiometer. Digital display will enable to take error free readings.

The digital indicator comprises of four parts.
1. Power supply 2.Signalconditioning 3. Amplifier
4. Analog and digitalconverter.
The inbuilt regulated power supply used will provide sufficient power to electronic parts and also excitation voltage to the strain gauge bridge transducers. The signal conditioner Buffers the output signals of the transducers. Amplifier will amplifies the buffered output signal to the required level where it is calibrated to required unit. Analog to digital converter will convert the calibrated analog out put to digital signals and display through LED's.

THEORY:

Transducers that measure force, torque or pressure usually contains an elastic member that converts the quantity to be measured to a deflection or strain. A deflection sensor or, alternatively, a set of strain gauges can be used to measure the quantity of interest (force, torque or pressure) indirectly. Characteristics of transducers, such as range, linearity and sensitivity are determined by the size and shape of the elastic member, the material used in its fabrication.
A wide variety of transducers are commercially available for measuring force. Torque and pressure the different elastic member employed in the design of these transducer include link, columns, rings, beams, cylinders, tubes, washers, diaphragms, shear webs and numerous other shapes of special purpose applications. Strain gauges are usually used as sensors; however linear variable differential transformers (LVDT) and linear potentiometers are some time used for static or quasistatic measurement.

PRESSURE MEASUREMENT (PRESSURE CELL).

Pressure cells are divisors that convert pressure into electrical signal through a measurement of either displacement strain or Piezoelectric response. Diaphragm type pressure transducers with strain gauges as sensor is used here for measurement of pressure.

This type of pressure transducers uses diaphragm as the elastic element. Diaphragms are used for low and middle pressure ranges. Strain gauges are bonded on the diaphragm and the pressure force is applied to the specimen the material gets elongated or compressed due to the force applied i.e., the material get strained. The strain incurred by the specimen depends on the material used and its elastic module. This strain is transferred to the strain gauges bonded on the material resulting in change in the resistance of the gauge. Since the strain gauges are connected in the form of whetstones bridge any change in the resistance will imbalance the bridge. The imbalance in the bridge will intern gives out the output in mV proportional to the change in the resistance of the strain gauge.

C I R C U I T E X P L A N A T I O N

The circuit comprises of three parts.

1. POWERSUPPLY
2. SIGNAL CONDITIONING ANDAMPLIFYING
3. ANALOG TO DIGITALCONVERTER.

1. POWERSUPPLY:

Inbuilt power supply use power to all electronic devices inside the circuitry. High stable regulated Power supply is used for better performance

There are two different power supply inside the unit

+12 – 0 -12V 500mA to drive digital integrated circuitary.

+5 – 0 - -5V 250mA to drive A to D converter.

2. SIGNAL CONDITIONING ANDAMPLIFYING

Signal conditioner will process the output of transducer and presents a linear DC voltage to the amplifier. This circuit will also buffers the inputs signal given to the differential amplifier. The operations amplifier is used as a differential amplifier where the signal gets amplified to required level. The amplifier gives out the analog output.

This output is controlled and calibrated to get the linear to micro strain. This analog output is sed to the A to D converter.

3. ANALOG TO DIGITALCONVERTED.

The output from the amplifier is a linearised analog DC voltage. This analog output is converted into digital output with the help of IC 7107 3.5 digit 200mV A to D converter. Then it is displayed through seven segmentedLED’s.

S P E C I F I C A T I O N SMEASUREMENT OF PRESSURE

PRESSURE CELL :

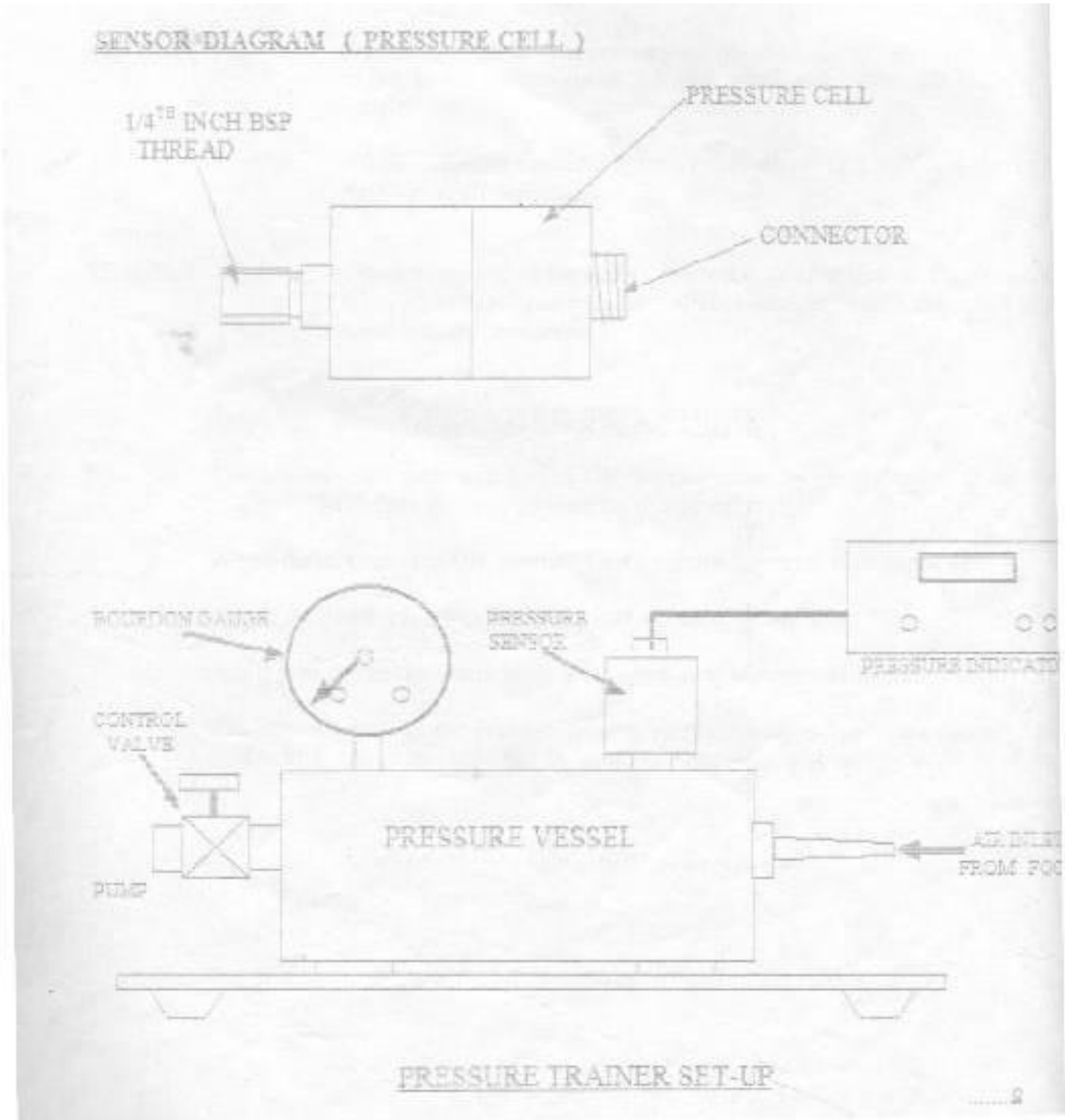
SENSOR : strain gauges bonded on steel diaphragmfor pressuremeasurement.

TYPE : Diaphragm

RANGE : $10Kg/cm^2$
CONNECTION : Through four cure shielded cable with theconnector Attached
EXCITATION : 10V DC
ACCURACY : 1%
LINEARITY : 1%
MAXOVERLOAD :
MECHANICAL : 150%
CONNECTION : 1/4 INCH BSPthread.

INDICATOR:

DISPLAY : 3 ½ digit seven segment LED display is used for the indicator of 200mV full scale deflection to read +/-1999'
EXCITATION : 10 V DC
ACCURACY : 1%
TARE : Front panel zero adjustment throughPotentiometer
POWERSUPPLY : 230 V +/- 10% 50Hz



CONNECTION DETAILS

POWER : 3 pin mains cable is provided with the instrument. Connect the 3 pin socket to the instrument at the rear panel and to the AC mains 230v supply.

NOTE: Before connecting ensure the voltage is 230 V and the Power switch is in off position.

SENSOR : Connect one end of the cable attached with connectorto the sensor and the other end to the instrument. While connecting match the colors of the wires with the connectors.

OPERATING PROCEDURE

* Check connection made and switch ON the instrument by rocker switch at the front panel. The displayglows to indicate the instrument isON.
* Allow the instrument in ON Position for 10 minutes for initialwarm-up.
* Adjust the Potentiometer in the front panel till the display reads“000”
* Apply pressure on the sensor using the loading arrangementprovided.
* TheinstrumentreadsthepressurecomingonthesensoranddisplaythroughLED.Readingscanbet abulated and % error of the instrument, linearity can becalculated.

EXPERIMENTS AND TABULAR COLUMN

Experiments can be conducted on the instrument as per the Operating Instruction given and various parameters like Linearity. Accuracy, Hysteresis etc of the Pressure indicator can be calculated. The readings can be tabulated and graphs can be plotted to calculate the above parameters.

TABULAR COLUMN

EXPERIMENT-1

1 SL.NO.	2 ACTUAL PRESSURE Kg cm^2	3 INDICATOR READING Kg/cm^2	4 3-2 ERROR	5 % ERROR

% Error = $\frac{ColumnNo.4}{MaxLoad} X100$

Graphs: Actual reading V/s indicator Reading

SPECIMEN READINGS

EXPERIMENT-1

1 SL.NO.	2 ACTUAL PRESSURE Kg/cm^2	3 INDICATOR READING Kg/cm^2	4 3-2 ERROR	5 % ERROR
1	1.0	0.9	-0.1	
2	2.0	2.0	0	

3	3.0	3.0	0	
4	4.0	4.0	0	
5	5.0	5.1	0.1	
6	6.0	6.1	0.1	
7	7.0	7.1	0.1	

EXPERIMENT NO. 8
CALIBRATION OF STRAIN GAUGE FOR TEMPERATURE MEASUREMENT.

C O N T E N T S

1. INTRODUCTION
2. SPECIFICATION
3. CANTILIVER BEAMDIAGRAM
4. CONNECTIONDETAILS
5. OPERATINGPROCEDURE

S P E C I F I C A T I O N

DISPLAYRANGE : 31/2 digit RED LED display of 200 mV FSD to read up to +/- 1999 micro strain.
GAUGEFACTORSETTING : 2.1
BALANCE : Potentiometer to set zero on the panel
BRIDGEEXCITATION : 12V DC
BRIDGECONFIGURATIONS : FullBridge
MAX. LOAD : 1Kg
POWER : 230 V+/- 10% at 50Hz with perfect Grounding

All specification nominal or typical at 23^0 C unless noted.

CANTILEVER BEAM SPECIFICATION

MATERIAL	:	StainlessSteel
BEAMTHICKNESS(1)	:	0.25 Cm
BEAMWIDTH(b)	:	2.8Cms
BEAM LENGTH(Actual)	:	22Cms
YOUNGSMODULUS(ε)	:	$2X10^6$ Kg /cm^2
STRAINGAUGE	:	Foil typegauge
GAUGELENGTH(F)	:	5mm
GAUGERESISTANCE(R)	:	300Ohms
GAUGEFACTOR(g)	:	2.01

I N T R O D U C T I O N

The primary object of the INSTRUMENTATION TRAINER is to introduce and to educate electronic instrumentation systems in a manner sufficiently complete that the students will acquire proper knowledge and the idea about the transducers and their applications to measure mechanical and terminal quantities. The mechanical quantities include strain, force, pressure torque, displacement, acceleration frequency, etc. The terminal quantities include temperature and heat flux.

It is understood that the students will have a conceptual understanding of these quantities through exposure of mechanics or physics courses, such as static's, dynamics, strength of materials or thermodynamics. The students experience in actually measuring these quantities by conducting experiments, however, will usually the quit limited. It is an objective of this tutor to introduce methods commonly employed in such measurements and the usage of such electrical components such as capacitance, resistance, intensity, etc.

Emphasis in the instrumentation trainer will be directed toward electronic instrumentation systems rather than mechanical systems. In most cases electronic systems provide better data more accurately and completely characterize the design or process being experimentally evaluation. Also the electronics system provides an electrical out put signal that can be used for automatic data reduction or for the control of the process. These advantage of the electronic measurement system over the mechanical measurement system have initiated and sustained trend in instrumentation toward electronic methods.

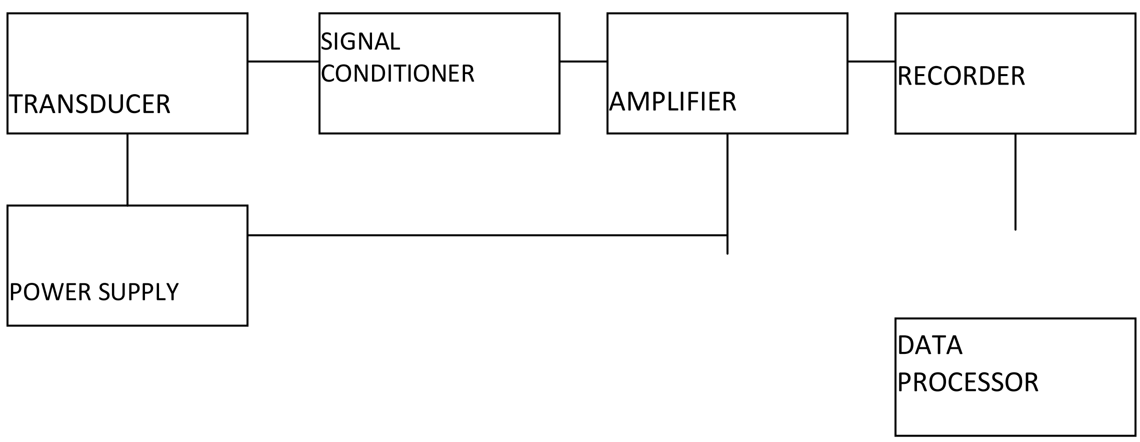
An attempt is made through these "Instrumentation trainer" to make as easy as possible for the students to learn about the electronic instrumentation system and various transducers used for the measurement of mechanical component. The instrumentation tutor panels are design in such a way that the block diagrams of the stages of electronic instrumentation system are clearly pictured on them. This makes the instrumentation tutor self-explanatory and also the best teaching aid for Engineeringstudents.

Since the instrumentation tutors are not instruments as a whole the accuracy of the measurement cannot be claimed. It is very clear that the instrumentation tutor are only for demonstration purpose and cannot be used for any external measurement other than conducting experiments.

THE ELECTRONIC INSTRUMENTATION SYSTEM.

The complete electronic instrumentation system usually contains six sub systems or elements.

The **TRANSDUCER**is a devise that convert a change in the mechanical or thermal quantity being measured into a change of an electrical quantity. Example strain gauges bonded in to an specimen, gives out electrical out put by changing its resistance when material is strained.



The **POWER SUPPLY** provides the energy to drive the Transducers, example differential transformer, which is a transducer used to measure displacement required an AC voltage supply to excite the coil.

SIGNAL CONDITIONERS are electronic circuits the convert, compensate, or manipulate the out put from in to a more usable electronic quantity. Example the whetstone bridge used in the strain transducer converts the change in resistance. AR to a change in the resistance AE.

AMPLIFIERS are required in the system when the voltage out put from the transducer signal conditioner combination is small. Amplifiers with game of 10 to 1000 are used to increase their signals to levels they are compatible with the voltage – measuring devices.

RECORDERS are voltage measuring devices that are used to display the measurement in a form that can be read and interpreted Digital/Analog voltmeters are often used to measure static voltages.

DATA PROCESSORS are used to convert the out put signals from the instrument system into data that can be easily interpreted by the Engineer. Data processors are usually employed where large amount of data are being collected and manual reduction of these data would be too time consuming and costly.

THE INSTRUMENT

UNIQUE Digital strain measuring setup comprises of Strain Indicator and Cantilever Beam setup strain Indicator is a strain gauge signal conditioner and amplifier used to measure strain due to load applied on the cantilever beam. The strain gauge are bonded on the cantilever beam and are connected in the form of whetstones bridge. A pan and weights upto 1 Kg is provided to load the cantilever beam. Unique strain measuring setup is a compete system which can be used to conduct measurement on strain gauge. The strain indicator is provided with zero balancing facility through adjustable potentiometer. Digital display will enable to take error free readings.

The digital indicator comprises of four parts.

1. Power supply
2. Signal conditioning
3. Amplifier
4. Analog and digital converter.

The inbuilt regulated power supply used will provide sufficient power is electronics parts and also excitation voltage to the strain gauge bridge transducers. The signal conditioners Buffers the output signals of the transducers. Amplifier will amplifies the buffered output signal to the required level where it is calibrated to required unit. Analog to digital converter will convert the calibrated analog output to digital signals and display throughLED's.

THEORY BEHIND IT

When a material is subjected to any external load, there will be small change in the mechanical properties of the material. The mechanical property may be, change in the thickness of the material or change in the length depending on the nature of load applied to the material. This change in mechanical properties will remain till the load is released. The change in the property is called strain in the material or the material get strained. So the material is mechanically strained this strain is defined as. The ratio between change in the mechanical property to the original property. Suppose a beam of length L is subjected to a tensile load of P Kg the material gets elongated by a length of □1. So according to the definition strain S is giveby

S=□1/L Eq1

Since the change in the length of the material is very small it is difficult to measure □1. So the strain is always read in terms of micro strain. Since it is difficult to measure the length Resistance strain gauges are used to measure strain in the material directly. Strain gauges are bonded directly on the material using special adhesives. As the material get strained due to load applied, the resistance of the strain changes proportional to the applied. This change in resistance is used to convert mechanical property in to electrical signal which can be easily measured and stored noranalysis.

The change in the resistance of the strain gauge depends on the sensitivity of the strain gauge. The sensitivity of strain gauges is usually expressed in terms of a gauge factor S_g where S_g is given as

$\Delta R/R = Sg$...Eq 1

Where □is Strain in the direction of the gauge length.

The output □R / R of a strain gauge is usually converter in to voltage signal with a Whetstones bridge, If a single gauge is used in one arm of whetstones bridge and equal but fixed resistors is used in the other arms, the output voltage is

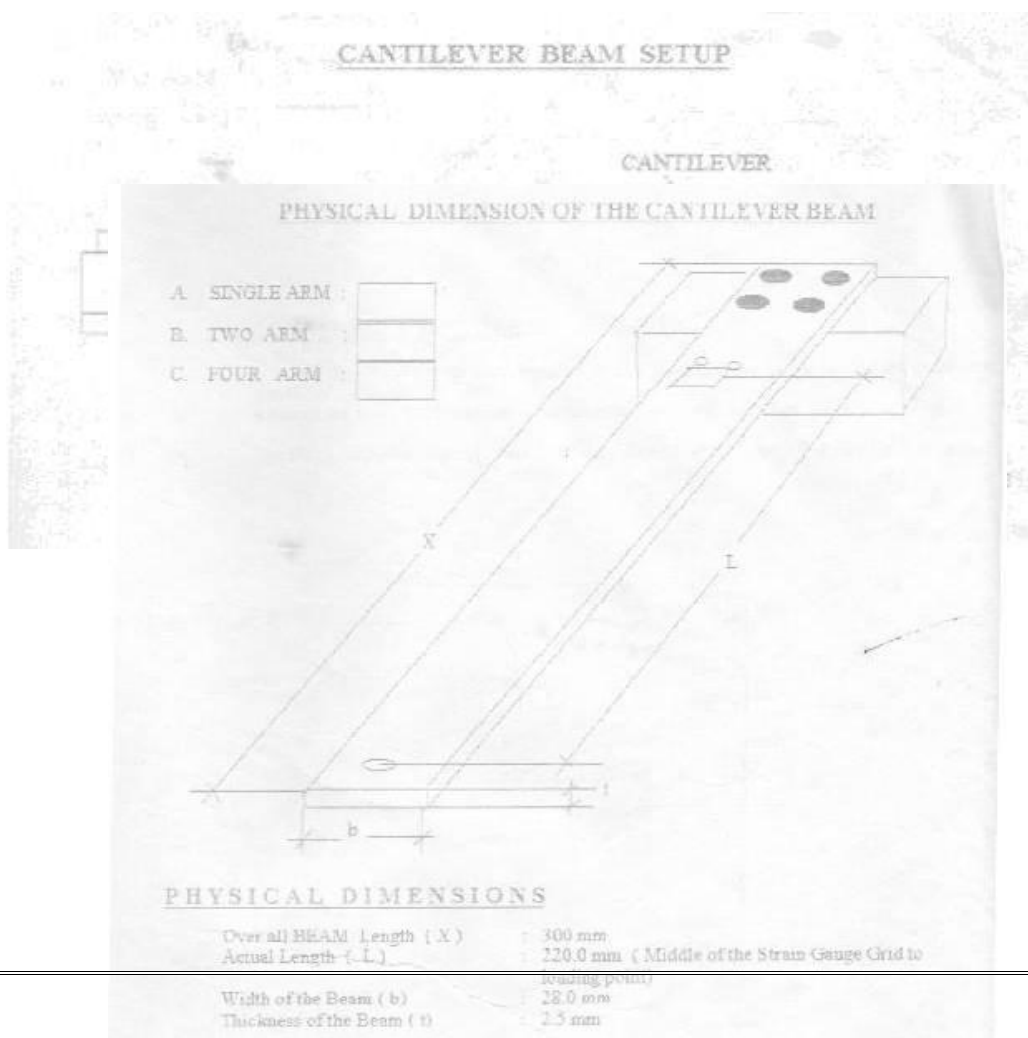
Eo = Ei /4(□Rg/Rg) .... Eq3.

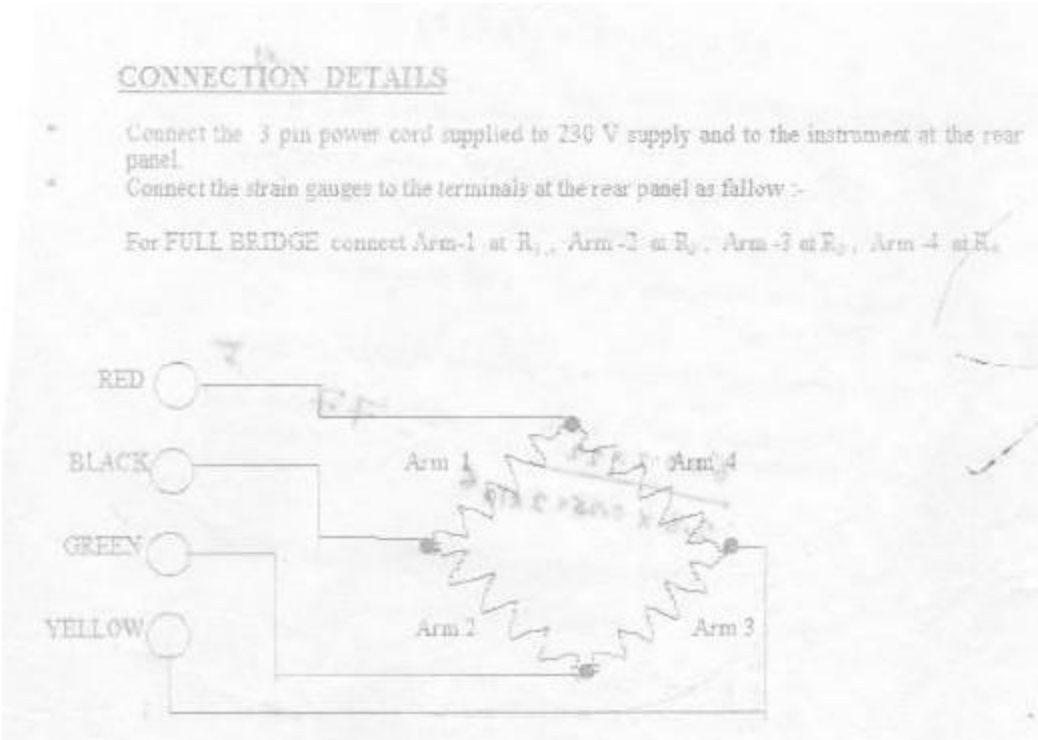
Substituting Eq2 into Eq3 gives

Eo = Ei 1 / 4 (EiSg□)..Eq3.

……. Eq 4

The input voltage is controlled by the gauge size (the power it can dissipate) and the initial resistance of the gauge. As a result, the output voltage Eo usually ranges between 1 to 10 □ V/micro units ofstrain.





CONNECTION DETAILS

- Connect the 3 pin power cord supplied to 230 V supply and to the instrument at the rear panel.
- Connect the strain gauges to the terminals at the rear panel as fallow :-

For FULL BRIDGE connect Arm-1 at R_1, Arm-2 at R_2, Arm-3 at R_3, Arm-4 at R_4

OPERATING PROCEDURE

- Check connection made and Switch ON the instrument by toggle switch at the back of the box. The display glows to indicate the instrument isON.
- Allow the instrument in ON Position for 10 minutes for initialwarm-up.
- Adjust the ZERO Potentiometer on the panel till the display roads 'OOP'.
- Apply load on the sensor using the loading arrangement provided in steps of 100g upto 1Kg.
- The instrument display exact microstrain strained by the cantileverbeam.
- Note down the readings in the tabular column. Percentage error in the readings. Hysteresic and Accuracy of the instrument can be calculated by comparing with the theoreticalvalues.

<u>Specimen Calculation For Cantilever Beam</u> S=(6pl) BT^{2}E

P = Load applied in Kg (1 Kg) – 0.2 kg
L = Effective length of the beam in Cms. (22 Cms) B = Width of the beam (2.8 Cms)
T = Thickness of the beam (0.25 Cm)
E = Young's modulus ($2X10^6$) S = Micro strain

Then the micro strain for the above can be calculated as follows.

$$S = \frac{6X1X\ 22}{2.8X\ 0.25X\ (2X10^{6})}$$

$$S = 3.77X10^{4}$$

S = 377 microstrain

EXPERIMENT NO.9

STUDY AND CALIBRATION OF PHOTO AND MAGNETIC SPEED PICKUPS FOR THEMEASUREMENT OF SPEED

Speed Measurement by Stroboscope

Aim: To measure the Speed by an optical method called as Stroboscope.

Introduction:

Theory:

Apparatus:

1. Xenon FlashLamp
2. AdjustableMotor
3. Marked RotatingWheel
4. Stand for setup
5. Power Supply

Procedure:

1. Check the connections of theequipment.
2. Select the mode of operation on Xenon flash lamp(Hi/lo).
3. Make a mark on the rotatingwheel.
4. Now switch on the Xenon flash lamp and adjust that the light exactly projected on the rotatingwheel.
5. AdjustthespeedofthemotorsuchthatONESTATIONARY markisvisibleonthe wheel.Notedownthe reading in the tabularcolumn.
6. Now adjust the sped of the motor such that Two Stationary marks are visible and note thereadings.
7. Similarly for Three and more marks and note thereadings.

Tabular column:

S.No	No. of images	Reading on the Xenon Flash Lamp	Frequency

Questions:

1. What is the Principle of Stroboscope?
2. What are the applications of Stroboscope?
3. Specifications of Stroboscope?
4. What are the Applications of Stroboscope?
5. What are the advantages and disadvantages of Stroboscope?

EXPERIMENT NO.10
STUDY AND CALIBRATION OF A ROTAOMETER FOR FLOW MEASUREMENT.

ROTAMETER

The obstruction is a float that rises in a vertical tapered column. The lifting force and thus the distance to which the float rises in the column is proportional to the flow rate. The lifting force is produced by the differential pressure that exists across the float, because it is a restriction in the flow. This type of sensor is used for both liquids and gases. A moving vane flow meter has a vane target-immersed in the flow region, which will be roted out of the flow as the flow velocity increases. The angle of the vane is a measure of the flow rate.

FLOW CONTROL SYSTEM

TURBINE METER:

The turbine flow meter consists of a multi-bladed rotor that is supported centrally in the pipe along which the flow occurs. The fluid results in rotation of the rotor. The angular velocity bring approximately proportional to the flow rate. The rate of revolution of the rotor can be determined using a magnetic pick-up. The pulses are counted and so the number of revolutions of the rotor can be determined.

FLOW CONTROL SYSTEM

Control & Operations:

1. Press flow: This is a D.P.D.T Switch to set the required flowrate.
2. Flow Control: This is a potentiometer to set the flowrate.

Operation:

1. Connect the turbine flow sensor with indicator marked as flow sensorinput.
2. Connect the two pin of the motor to theinstrument.
3. Now vary the flow control potentiometer to any required setlevel.

Note: While controlling the flow make sure the pointer in Rotometer floats.

4. Compare the Rotameter reading and digital reading with set reading.
5. Take reading for different set of flowsrate.
6. Plot the graph of Rotameter Reading with Digital IndicatorReading.

Description Rotometer:

The air source is centrifugal blower which controlled by the set valve of flow of air measured in L.P.M. The flow is measured directly on the rotameter. The turbine flow meter senses the flow rate and through microprocessor based signal conditioner. The flow is measure din digital form and acts us a set point controller also.

Tabular Column

Sl.No.	Set Flow in L.P.M.	Rotameter Reading in L.P.M.	Digital Reading	Error Between Rotameter & Digital reading

Note: **The range of Flow is 30 L.P.M. to 100L.P.M.**