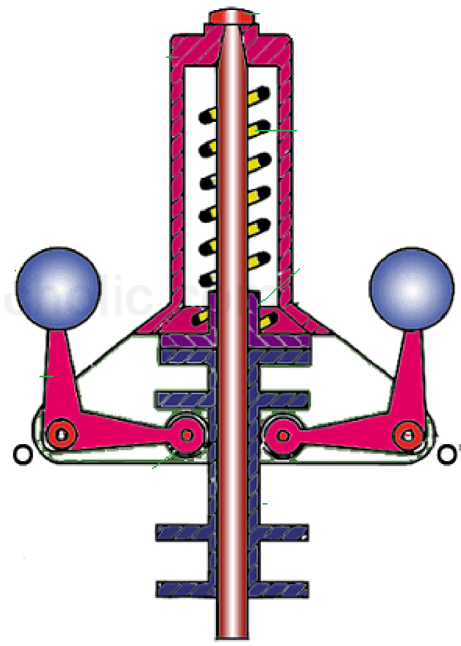
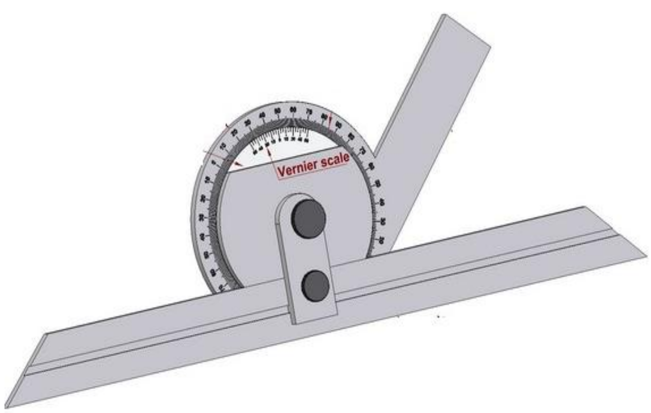
DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF THE LAB : 17MECC86-DYNAMICS AND METROLOGY LAB

REGULATION : 2017

LAB MANUAL





DEPARTMENT OF MECHANICAL ENGINEERING

DYNAMICS AND METROLOGY LAB
LIST OF EXPERIMENTS

1. To perform an experiment on Watt and Porter Governor to prepare performance Characteristic curves and to find stability and sensitivity

2. To determine the position of sleeve against controlling force and speed of a Hartnell Governor and to plot the characteristic curve of radius of rotation

3. To analyse the motion of a motorized gyroscope when the couple is applied along Its spin axis and determine gyroscopic couple

4. Determine the Moment of Inertia by compound pendulum and tri-filar suspension.

5. To determine the frequency of undamped free vibration and damped forced vibration of an equivalent spring mass system.

6. To determine whirling speed of shaft theoretically and experimentally.

7. Angular Measurements using Bevel Protector and Sine Bar

8. Flow Measurement using a Rotameter

9. Fundamental dimension measurement of a gear using a contour projector.

10. Measurement of Displacement using Linear Variable Differential Transducer

11. Measurement of speed of Motor using Stroboscope

12. Measurement of cutting forces using Lathe Tool Dynamometer

1. TO PERFORM AN EXPERIMENT ON WATT AND PORTER GOVERNOR AND TO FIND THE STABILITY AND SENSITIVITY

AIM

To determine the Stability and Sensitivity of the Watt and Porter Governor.

DESCRIPTION:

The governor mechanism under test is fitted with the chosen rotating weights and spring where applicable and inserted in to the following simple procedure may then be followed. The control unit is switched on and the speed control slowly rotated increasing the governor speed until the center sleeves raises the lower stop and aligns with first division on the graduated scale. The sleeve position and speed are then recorded speed may be determined using a hand tachometer on the spindle. The governor speed is then increased in steps to give suitable sleeve movements and readings repeated at each stage through the range of sleeve movement possible. The result may be plotted as curves or speed against sleeve position. Further tests are carried out changing the value of variable at a time to draw curves.

FORMULA:

$$r = r_o + x*a/b$$

Where,

r= radius of rotation at any point
a= length of the vertical arm of bell crank lever (60mm)
b= length of the horizontal of bell crank lever (170mm)
r_o= initial radius of rotation (15.50mm)
x=sleeve displacement in cm
$\omega = 2\pi \mathbf{N}/60$

Sensitivity= $(N_1-N_2)/N$
Where,
N=mean speed
N_1=minimum equilibrium speed
N_2=maximum equilibrium speed

Effort= $(S_1-S_2)/2$
Where,
S_1=Spring force at maximum speed $=2Fc_1.b/a$ (Fc_1=centrifugal force atN_1)
S_2=Spring force at minimum speed $=2Fc_2.b/a$ (Fc_2=centrifugal force atN_2)

PROCEDURE:

1. The control unit is switched on.

2. The speed control knob is slowly rotated thereby increasing the governor speed.

3. This is repeated until the center sleeve rises of the lower stop and stabilizers at any division on the graduated scale.

4. The sleeve position and speed are recorded in the table.

5. The speed rotation is measured by using a tachometer.

6. Tabulate all these values.

7. Calculate the range of speed and sensitivity.

8. Verify with theoretical calculations.

9 Draw graphs for experimental values

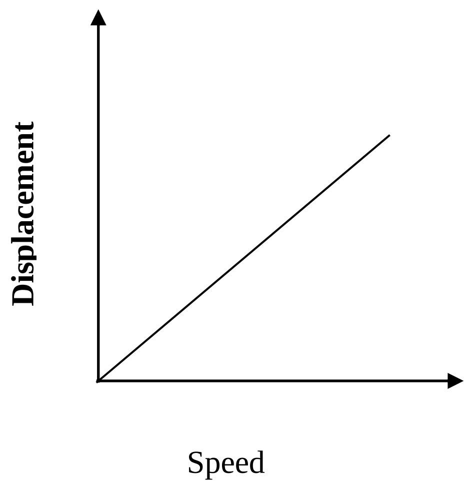
a. Speed vs. displacement

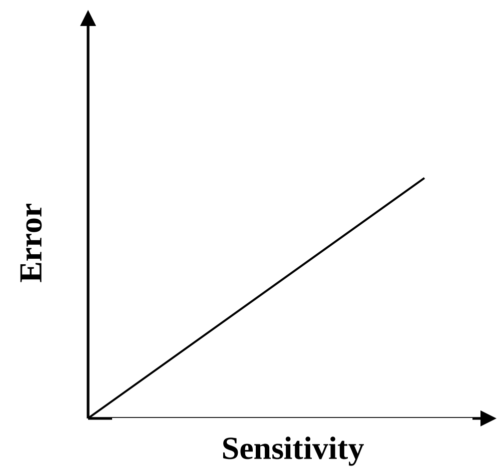
b.Sensitivity and error

TABULATION:

S.N	Motor Speed N	Speed in Rpm $\omega = 2\pi N / 60$	Height x mm	Cos α=h/I	Radius of rotation	Force F= M ω^2r

MODEL GRAPH:





RESULT:

Thus the characteristic curves for the Watt and Porter governor were plotted.

2.TO DETERMINE THE POSITION OF SLEEVE AGAINST CONTROLLING FORCE AND SPEED OF A HARTNELL GOVERNOR.

AIM

To find the controlling force and speed and the characteristic curve of a radius of rotation of a Hartnell Governor.

DESCRIPTION:

The governor mechanism under test is fitted with the chosen rotating weights and spring where applicable and inserted in to the following simple procedure may then be followed. The control unit is switched on and the speed control slowly rotated increasing the governor speed until the center sleeves raises the lower stop and aligns with first division on the graduated scale. The sleeve position and speed are then recorded speed may be determined using a hand tachometer on the spindle. The governor speed is then increased in steps to give suitable sleeve movements and readings repeated at each stage through the range of sleeve movement possible. The result may be plotted as curves or speed against sleeve position. Further tests are carried out changing the value of variable at a time to draw curves.

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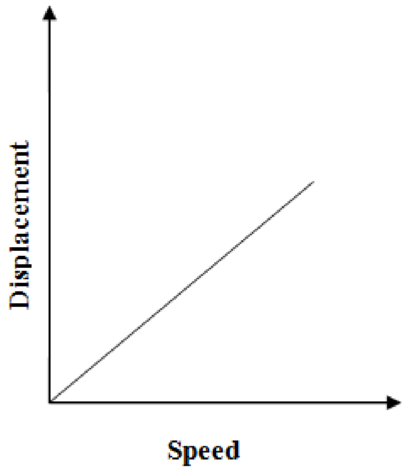
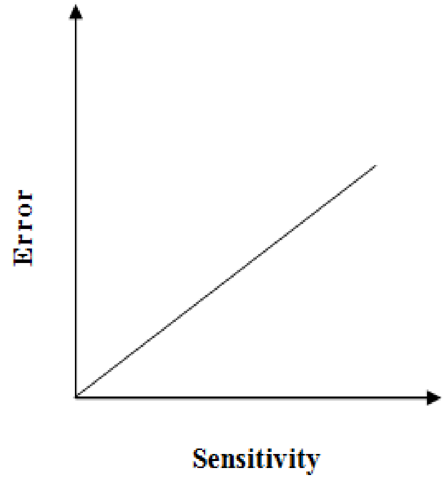




RESULT:

The characteristic curves for the Hartnell governor were plotted.

3. DETERMINATION OF GYROSCOPIC COUPLE USING MOTORIZED GYROSCOPE

AIM:

To analyze the motion of a motorized Gyroscope when the couple is applied along its spin axis and determine the gyroscopic couple.

APPARATUS REQUIRED:

1. Metal disc
2. 1/6 HP AC/DC motor
3. Protractor scale
4. counter Weight
5. Stop watch
6. Tachometer

DESCRIPTION:

When a rotor rotating at an angular velocity 'ώ' (called the spin velocity} about an axis {called the spit axis} has the spin axis rotating with an angular velocity of 'ώρ'about an axis perpendicular to the spin axis, it gives rise to a couple called Gyroscopic couple. The motion of the spin axis is called the "processional motion" and the angular velocity 'ώρ' is called the Velocity of precession. The gyroscopic couple is given by

$$C = I\,\omega\,\omega_P$$

Where

C=the gyroscopic couple

ω =spinning velocity

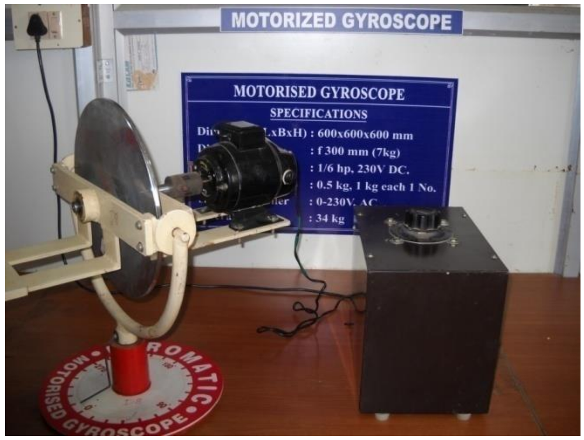
I= mass moment of inertia of the rotor about the spin axis

ω_P = velocity of precession

The following gyroscopic behaviors could be observed.

1) The spinning body exerts a torque or couple in such a direction as to mistake the spin velocity vector coincides with the processional velocity vector.

2) The spinning body processes in such a way as to make the spin vector coincide with the couple vector, when trued through $90^{0.}$



DESCRIPTION OF THE APPARATUS:

The motor is coupled to the disc rotor which is statically and dramatically balanced .The disc shaft rotates about the horizontal axis xx, and is supported by two ball bearing housed in the frame 1.Ball bearing are fixed to the yoke .In steady position frame no. I is balanced by providing a weight on the opposition side of the motor .The yoke frame is free to rotate about the vertical axis zz. Thus freedom of rotation about three perpendicular axes is given to the rotor.

FORMULA USED:

1. Angular velocity ω = $2\pi N/60$
2. Gyroscopic couple C = $I\ \omega\ \omega_P$
3. Torque = Weight x distance of the bolt center of the weight Pan from the disc center.
4. Percentage error = T-C /T x 100
5. ω_P = $d\Theta/dt$
6. $d\Theta$ = $\Theta x\pi/180$

PROCDURE:

To study the first mentioned behavior, the following procedure is adopted

1. Balance the initial horizontal position of the rotor frames No .1
2. Start the motor by increasing the voltage with the autotransformer and wait until it attains constant speed.
3. Press the yoke frame No.2 about vertical axis by applying necessary force by hand to the same. {In the clockwise sense seen from above}.
4. It will be observed that the rotor frame swings about the horizontal axis yy.Motor side is seen coming upward and the weight pan side going downwards.
5. Rotate the vertical yoke in the anti clockwise sense seen from above and observe that the rotor frame swings in the opposite sense {as compared to that in previous case, following the above role}.

To study the second behavior, the following procedure is adopted,

1. Balance the rotor position on the horizontal frame.
2. Start the motor by increasing the voltage with the auto transformer and wait till the motor attains constant speed.
3. Put one of the weights {0.5kg, 1kg, 1.5kg} in the weight pan.
4. The vertical yoke zz processes as per the rule No

TABULATION

CONSTANT SPEED:

$$\omega = 2\pi N / 60$$

S.N	Weight applied	Torque kg-cm	Angle of precession	Time taken for precession	df/dt	%error

CONSTANT LOAD:

S.N	Speed in rpm	Torque kg-cm	Angle of precession	Time taken for precession	df/dt	%error

RESULT:

Thus the experiment for the effect of gyroscope on rotating disc was conducted and experimental values are tabulated.

4. TO DETERMINE THE MOMENT OF INERTIA BY COMPOUND PENDULUM & TRIFILAR SUSPENSION

AIM:

To find the moment of inertia by compound pendulum and tri-filar suspension system.

APPARATUS REQUIRED:

Stop watch
Circular Disc
Wire or Rope
Scale

COMPOUND PENDULUM

To determine the radius of gyration "K" of the given compound pendulums by using the relation given below and thereby verifying it.

$$T\text{-}2\pi\sqrt{(k^2 + (OG)^2 / (g*(OG))}$$

Where, K=radius of gyration about centre of gravity in "cm"
OG=distance of centre of gravity rod from support in"cm"
G=acceleration due to gravity=9.81 m/s²

FORMULA REQUIRED:

Theoretical radius of gyration, $K_{th} = L/2*\sqrt{3}$cm
Where, L=total length of rod in 'cm'

PROCEDURE:

The rod is supported on the knife-edge.
The total length of suspended rod is noted and 'OG' is determined.
The bar is allowed to oscillate and the time taken for 10 oscillations is noted
The time period is calculated.
The same procedure repeated for the other pendulum.
Using the experimental time period the radius gyration is calculated using given relation.
The experimental value is verified with the theoretical value.

TABULATION:

S.N	Length of Compound Pendulum(L) Cm	OG Cm	Time for 10 oscillations 't' Sec	Time period T EXP =t/10 Sec	K EXP m
1					
2					
3					

Mean=

TRIFILAR SUSPENSION SYSTEM

THEORY:

When a rigid body is suspended vertically, and it oscillates with small amplitude under the action of the force of gravity, the body is known as compound pendulum.

The following steps to be carried out to determine the mass moment of inertia of the given body.

Select trifler plates.
With the help of string of chucks tighten at tops.
Adjust length of string to desire values are measure length as it is.
Give small horizontal twist.
Start stop watch and note down time required for 5 or 10 oscillations.
Repeat experiment by adding weight and changing length.

OBSERVATIONS:

Weight of trifler plate M2 = ……………………………………kg
Additional weight added, W = ……………………………………kg
Distance of string from centre of gravity, for trifler plate, b = …..m

CALCULATION:

TRIFILAR SUSPENSION:

First with single plate find out frequency and next with added weights find out the frequency of oscillations.

Period T = N/t

Frequency with only plate fn = 1/T

Frequency with added weight fn = 1/ T

Now moment of inertia plate only, Ip= $\frac{R^2 m_2}{4\pi^2 fn^2 xL}$

Now moment of inertia with added weight, It =$\frac{R^2 m_2 + W}{4\pi^2 fn^2 xL}$

TABULATION:

Type of suspension	Length(L) m	No Oscillation(N)	Time taken(t) sec	Weight added(W) kg
Tri-filar				

RESULT:

Thus the moment of inertia of compound pendulum and tri-filar suspension system was determined.

5. **DETERMINATION OF NATURAL FREQUENCY OF SINGLE DEGREE OF FREEDOM SYSTEM IN A SPRING MASS SYSTEM**

AIM:

To determine the natural frequency of undamped free vibration and damped forced vibration of a spring mass system.

APPARATUS REQUIRED:

1. Spring mass system
2. Weights
3. Digital indicator

FORMULA:

Natural frequency of spring mass system = $(1/2\pi)[\sqrt{(g/\delta)}]$ Hz

Where g = Acceleration due to gravity (9.81 m/s^2)

δ= Deflection of the spring in m.

DESCRIPTION:

It is well known fact that if a body held in position by elastic constraints and if it is displaced from its equilibrium position and then released the amplitude of the resulting vibration gradually diminishes as the vibration energy is dispersed in overcoming friction. And the vibration is used is said to be undamped, if there is no resistance to the motion of the vibration body.

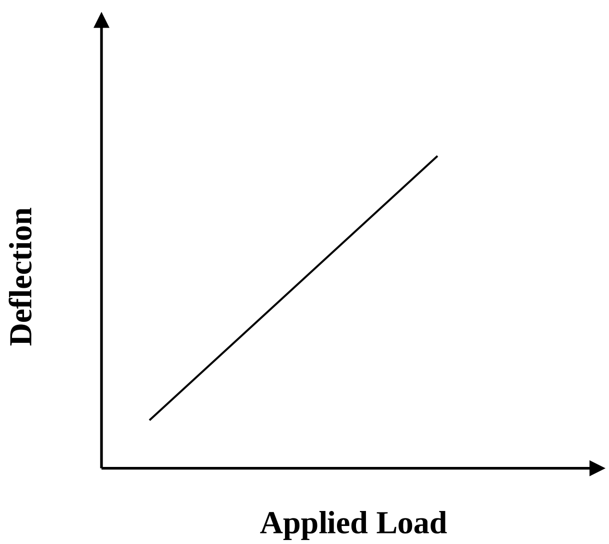
PROCEDURE:

1. Connect the main chord to the 230 Volts / 50 Hz. A.C supply and switch on the instrument.
2. Keep the READ/CAL switch at READ position and turn the zero potentiometer till it displays 00.00.
3. Keep the READ/CAL switch at CAL position and turn the zero till the displays read 10.00.
4. Keep the READ/CAL switch again READ position and ensure 00.00.
5. Supply the load as weights in terms of Kg.
6. Now display read the correct deflection directly in mm.

GRAPH:

APPLIED LOAD Vs DEFLECTION

MODEL GRAPH:



TABULATION

S.N	Applied Load (Kg)	Deflection δ (mm)	Frequency (Hz)
1	0.5		
2	1.0		
3	1.5		
4	2.0		
5	2.5		

RESULT:

Thus, the natural frequency of a spring mass system was found out.

6. **DETERMINATION OF CRITICAL SPEED OF WHIRLING SHAFT**

AIM

To determine the Whirling speed of shaft theoretically and experimentally.

APPARATUS REQUIRED:

1. Shaft
2. Tachometer
3. Variac
4. Scale

DESCRIPTION:

In a rotating shaft at which instability occurs is called whirling or critical speed. When shaft reaches critical speed it will have maximum deflection. It is applicable in power transmitting equipments like turbine, propeller shafts, etc.The mid span disc has a center of masses that due to unbalanced is at a point G a distance 'e' from the geometrical center this distance is known as the eccentricity.

The Experiment will infer that by changing the diameter of the shaft its critical speed and its deflections over its length will change. i.e., if the shaft diameter is increasing then its Speed at Which instability occur will also increase. Similarly if the distance between the Center distances is decreasing then its deflection will decrease.

In the construction of whirling of shaft, the following basic features should be considered. The apparatus basically consist of rectangular bed mounted over the rectangular channel. Then three rectangular block of same size is fixed in the bed. The two blocks are fixing in one side and other one is fixed in opposite side.

A channel is fixed before two rectangular blocks. Above which a D.C Motor of 6000 rpm. And 1/12 hp is fixed. Through which a chuck is fixed in the motor. The two rectangular blocks are fixed in such a way that it carries a chuck. The chuck is used to transmit the power from the motor to shafts.

While in the other rectangular block a bush is connected according to the shaft size. i.e. for 8 mm rod the bush with 8 mm ID should be used. The regulator box is connected with D.C motor for the speed adjustment. Through which variation of speed can be arrived. Beyond this a non-contact speedometer is used to find out the speed of the shaft.

PROCEDURE:

- Check all the shaft has no bends over its length. Fix appropriate bush in the rectangular block.
- Then fix the shaft to the chuck in one end and support the same shaft with bush in other end.
- Now switch on the supply.
- Adjusting the regulator the motor speed can be varied.
- Then according to the calculation the critical speed through which maximum deflection is to be find out.

FORMULA USED :

$f_n = C \sqrt{\{ (E*I) / (m L^4)\}}$

$I = (\pi d^4)/64$

$E = 2.1 * 10^{11}\ N/m^2$

$\rho = m/v$

$\rho = 8 * 10^3\ Kg/m^3$

$V = (\pi d^2) / (4*L)$

$C = 2.45$

Where,

L – Distance between the chuck and the free end of the shaft

d – Diameter of the shaft in meters

E- Young's modulus

TABULATION

Sl.No	Diameter of the shaft (d) in mm	Distance between chuck and free end (L) in mm	Theoretical Critical speed (fn) in rpm	Deflection in mm	Node
1					
2					
3					

RESULT:

Thus the theoretical and experimental of whirling speed of shaft was determined.

7. MEASUREMENT OF VARIOUS ANGLES USING BEVEL PROTRACTOR.

AIM

To Measure the angle of the given specimen by using Bevel protractor

APPARATUS REQUIRED

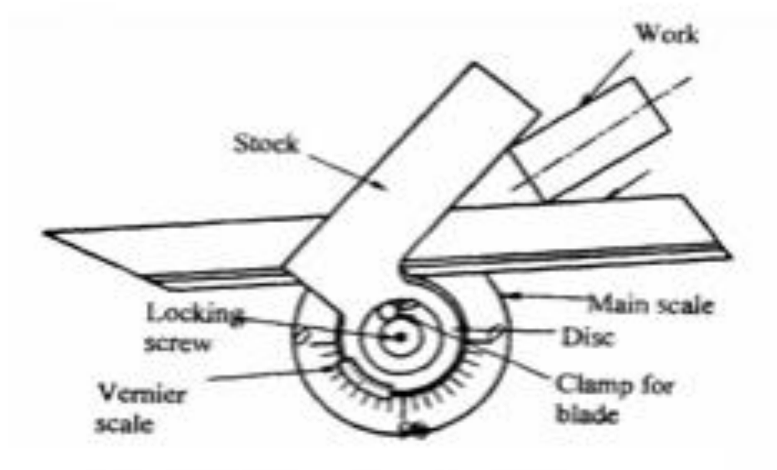
I) Bevel protractor
ii) Specimen

Description

Bevel protractor is an instrument for measuring the angle between the faces of a specimen. It consists of base plate on which a circular scale is engraved. It is graduated in degrees. An adjustable plate is attached to a circular plate containing the venire scale. The adjustable blade can be locked in any position the circular plate has 360 divided in to four parts of 0-90 degree. The adjustable plate has 24 divisions. Half to the right of zero and other towards the left. These scales are used according to the positions of this specimen with respect to movable scale.

PROCEDURE:-

(I) Determine The Least Count Of Bevel Protractor.
(ii) Place the specimen whose taper is to be measured between adjustable Plate and movable with one of its base parallel to the base plate.
(iii) Lock the adjustable plate in this position and note down the main scale Reading (MSR). Depending upon the direction of rotation of adjustable Plate that is clockwise or anticlockwise, note the venire scale reading (VSR)
(iv) Suppose the adjustable plate is rotated clockwise direction then the VSR Right of zero should be taken.
(v) To obtain the actual multiply the VSR with the least count and add to MSR.



BEVEL PROTRACTOR

TABULATION

Least count: 5 Error: Zero

S.NO	Description	MSR (Degree)	VSC (DIV)	VSR=VSC× L.C(degree)	Total reading= MSR+VSR (degree& Minutes)	Average

Least count= 2MSD-1VSD (Because 1 VSD>1 MSD)

GIVEN Bevel protractor, 1MSD=1^0 (one degree)

24 VSD=46^0

Least count=2MSD-1VSD=2^0 –$(46/24)^0$=$(1/12)^0$

LC=$(1/12)^0$×60=5’ (5 Minutes)

RESULT:-

Thus the angle of the given specimens is measured by using bevel protractor.

8. **MEASUREMENT OF FLOW RATE OF LIQUID USING ROTAMETER**

AIM:

To Measure the rate of flow, of the liquid by Rotameter.

APPARATUS REQUIRED:

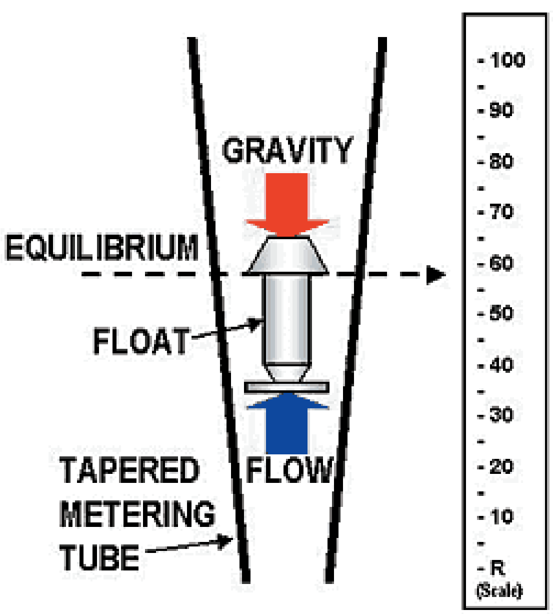
- Collecting tank
- Sump tank
- Timer
- Voltmeter

THEORY:

It is an observation type meter. It consists of float whose density is greater than that of the flowing liquid. The float diameter is such that if completely blocks the inlet tube. The float start raising only when pressure of the flowing liquid plus bouncy is greater than the download pressure due to cut of float rises and stops when pressure of flowing liquid is equal to the download pressure due to weight of float. The raising of the float is proportional to the flow.

PROCEDURE:

1. The time is set for 60 seconds.
2. Keeping the voltage fixed note down the Rota meter discharge and switch off the apparatus.
3. At the same time note down actual discharge in the collecting tank.
4. Empty the collecting tank to zero position Switch on the apparatus and again hold down.
5. We use the experiment and note down the time of different voltage and reading.



TABULATION:-

SL.NO	VOLTMETER READING(volts)	ACTUAL DISCHARGE (lpm)	ROTAMETER DISCHARGE READING	% OF ERROR

CALCULATIONS:

$$\% \text{ of Error} = \frac{\text{Actual Discharge} - \text{Rotameter Discharge}}{\text{Actual Discharge}} \times 100$$

GRAPH:

1. Rotometer Vs Actual Discharge

RESULT:

Thus the given Rotameter calibrated and required graph are drawn and the % of error .

9. MEASUREMENT OF MAJOR, MINOR, PITCH AND INCLUDED ANGLE USING PROFILE PROJECTOR

AIM

To measure the following elements of the given screw thread using profile projector.

a) Major diameter

b) Pitch

d) Included angle

APPARATUS REQUIRED

Profile projector with mounting accessories [magnification=nix, n=10, 20…50]

PROCEDURE

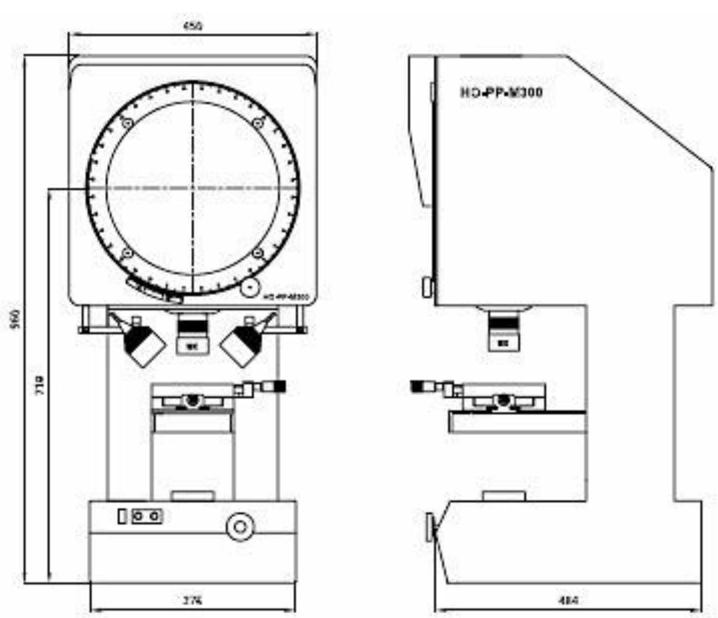
The given specimen is mounted on the worktable so that its axis is parallel to the axis of table. The table is rotated to an angle to helix angle of the given screw thread and to obtain the true shape of the image, any one of cross wires of the screen is adjusted to coincide with the crest of the thread profile on one side and the corresponding reading on the micrometer is noted. The table is moved transversely so that the same crosswire touches the opposite crest and the reading on the micrometer is noted.

The difference between the two readings on the major diameter of the given screw thread. The procedure is repeated by considering crosswire with the roots of the thread profile, to find out the minor diameter.

To measure the pitch, the vertical crosswire is made to coincide with anyone of the crest of the tread profile and corresponding micrometer required pitch of the screw thread. The included angle is measured by keeping any one of the screen is noted. Then the same crosswire is made to coincide with the other flank by suitably adjusting the worktable, if necessary and the angular position of the screen is noted.

The difference between the two readings will give the included angle of the screw thread. The same procedure is repeated for the measurement of various element of other screw thread.

PROFILE PROJECTOR



THREAD PARAMETERS MEASURMENT USING PROFILE PROJECTOR

TABULATION: SPECIMEN

Least count for Angular measurement-2’

Least count for longitudinal micrometer-0.01mm

Least count for Transverse micrometer-0.01mm

S. NO	Description	Initial reading			Final Reading			Actual Reading (mm)
		MSR (mm)	VSR (mm)	TR (mm)	MSR (mm)	VSR (mm)	TR (mm)	
1.	Minor Diameter							
2.	Major Diameter							
3.	pitch							
4.	Included Angle	Degree	Minutes	degree	Degree	minutes	Degree	Degree

MSR= Main Scale Reading

VSC= Venire scale Coincidence

= VSC x L.C

TR= Total Reading

=MSR + VSR

L.C= Least count

RESULT:-

Thus the values of various elements of the give screw threads are measured by using on profile projector

10. **MEASUREMENT OF DISPLACEMENT USING LINEAR VARIABLE DIFFERENTIAL TRANSDUCER (LVDT)**

AIM:

To measure the displacement of core using linear variable differential Transformer.

APPARATUS:

LVDT with Micrometer (±10 mm Capacity), Digital displacement Indicator.

THEORY:

LVDT is a mutual inductance Transducer device which produces an A C Voltage output proportional to the displacement of a core passing through the windings. It consists of a primary A C Coil on each side of which are mounted to secondary coil wired in series opposition along the axis of three coils an iron core is mounted.

The movement of the iron core causes the induced emf in the secondary coils to vary and because of their series opposition connection their combined output will be the difference of EMF induced. Thus the output voltage of the device is an indication of the displacement of the core. When operating in the linear range, the device is called L V D T. Since the secondary coil is connected in series opposition, a null position exists at which the net output voltage is essentially zero. The output voltage undergoes an 180^{O} phase shift from one side of the null position to the other.

In the practical differential transformer is always a capacitive effect between the primary and secondary coils which results in a small output voltage even when the induced emf�Ÿs in the secondary coils are in equal opposition. This is normally less than one percent of the maximum voltage. LVDT provides comparatively high output and is also insensitive to temperature.

PROCEDURE:

1. Connect the LVDT and Digital displacement meter to main supply.
2. Adjust the zero pot of the displacement indicator to indicate zero.
3. Connect the LVDT sensor to the displacement indicator through the cable.
4. Rotate the micrometer knob to clock wise or antilock direction, to bring the LVDT core to null position of the sensor. Where there is no induced EMF. At this position indicator will read zero. Note down the micrometer reading. This is initial reading of micrometer.

TABULAR COLUMN

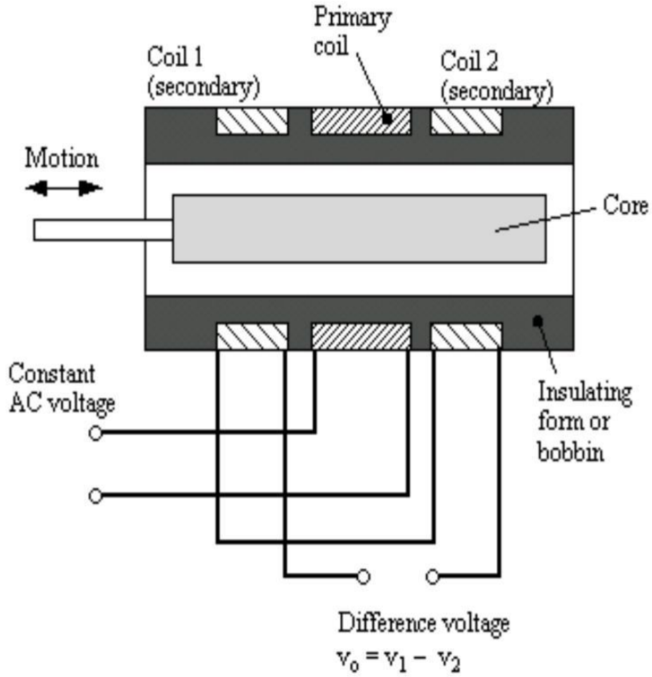
S.N	Push Side Reading			Pull Side Reading		
	Displacement Reading in mm	Micrometer Reading in mm	Indicator Reading in mm	Displacement Reading in mm	Micrometer Reading in mm	Indicator Reading in mm

APPLICATIONS

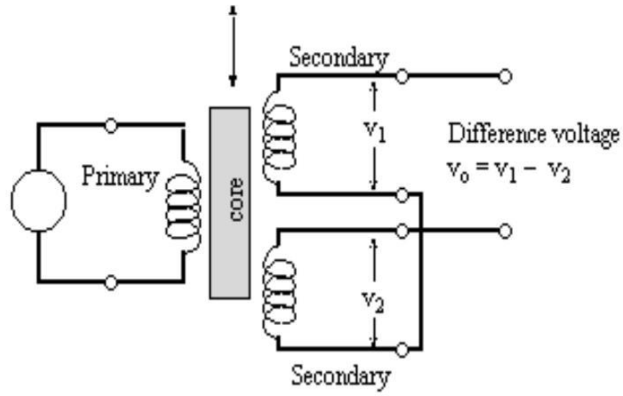
- LVDT‘s are used in position control in machine tools.
- To measure the furnace tilting position in steel melting shops.
- To check the position of an Ailerons in the wing assembly in aerospace.
- In landing gear position, LVDT‘s are used.
- LVDT are suitable for use in applications where the displacements are too large for strain gauge to handle. There are often employed together other transducers for measurement of force, weight & pressure etc.

GRAPHS:

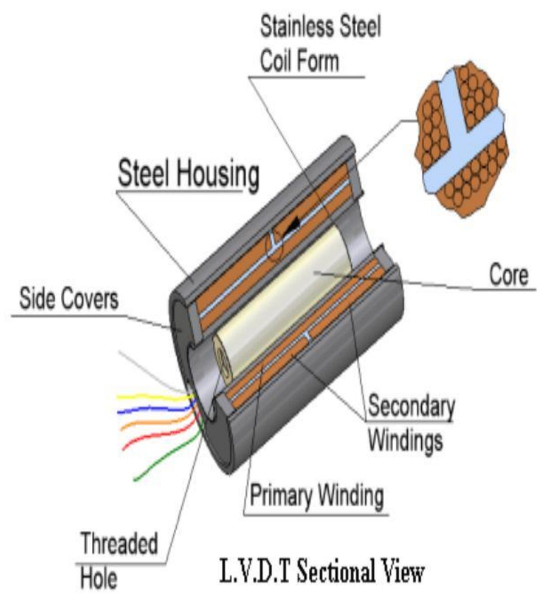
1. Push Side reading **v/s** Indicator Reading
2. Pull Side reading **v/s** Indicator Reading



L.V.D.T Schematic Diagram



L.V.D.T Circuit



L.V.D.T Sectional View

RESULT:

Thus the measurement of displacement is performed using Linear Variable Differential Transducer (LVDT).

11. MEASUREMENT OF SPEED BY USING STROBOSCOPE

AIM:

To verify the measurement of speed of the motor by using Stroboscope.

APPARATUS REQUIRED:

1. Stroboscope
2. Variac
3. Tachometer
4. Light source.

THEORY:

The stroboscope is a simple portable manually operated device which may be for measurement of periodic of rotary motions .Basically, the instrument is a source of variable frequency flashing brilliant light, the flashing frequency being set by the operator. The circuit used based upon variable frequency oscillator which controls the flashing frequency.

The speed is measured by adjusting the frequency so that the moving objects are visible only at specific intervals at time. The method of use of the stroboscope depends upon imperfect dynamic response of human eye. If a strong light is caused to flash on a moving object which at the time each flash occurs, occupies a given position the object will appear to be stationary. Therefore the method is useful for only those types of motions which occur regularly after a fixed interval of time such as oscillation or rotation. The stroboscope consists of a source of flashing light whose frequency can be varied and controlled. The source is called a Strobotron.

PROCEDURE:

1. Connect the stroboscope to a 230/50Hz A.C. Supply.
2. Switch ON' the motor and stroboscope simultaneously.
3. Set the voltage in the variac and vary the frequency of illuminations till the rotating member appears stationary with three leaves in the case of constant marking with the varying voltage.
4. In the case of varying making set the voltage as 50 volts.
5. The indicator gives the stroboscope reading.
6. Repeat the experiments.

GRAPH:

1. Voltage Vs Stroboscope reading speed.
2. Stroboscope reading Vs Number of marking

CONSTANT MARKING:

SL.NO	APPLIED VOLTAGE in Volts	NUMBER OF MARKING	STROBOSCOPE READING	SPEED OF THE MOTOR in RPM	% OF ERROR

CONSTANT VOLTAGE:

SL.NO	APPLIED VOLTAGE in Volts	NUMBER OF MARKING	STROBOSCOPE READING	SPEED OF THE MOTOR in RPM	% OF ERROR

CALCULATIONS:

$$\% \text{ Of Error} = \frac{\text{STROBOSCOPE READING- SPEED OF THE MOTOR in RPM}}{\text{STROBOSCOPE READING}}$$

RESULT:

The speed of motor using stroboscope is determined and corresponding graph were drawn.

12. LATHE TOOL DYNAMOMETER

AIM:
To study the Lathe Tool Dynamometer to determine the Resultant force act on the tool during turning operation and also estimate the force .

APPARATUS REQUIRED:

Lathe tool Dynamometer and Drill tool dynamometer.

TOOLS & MATERIAL REQUIRED:

HSS tool with tool holder, Φ25mm MS bar.

THEORY:

In machining or metal cutting operation the device used for determination of cutting forces is known as a Tool Dynamometer or Force Dynamometer. Majority of dynamometers used for measuring the tool forces use the deflections or strains caused in the components, supporting the tool in metal cutting, as the basis for determining these forces. In order that a dynamometer gives satisfactory results it should possess the following important characteristics:

- It should be sufficiently rigid to prevent vibrations.
- At the same time it should be sensitive enough to record deflections and strains appreciably.
- Its design should be such that it can be assembled and disassembled easily.
- A simpler design is always preferable because it can be used easily.
- It should possess substantial stability against variations in time, temperature, humidity etc.
- It should be perfectly reliable.
- The metal cutting process should not be disturbed by it, i.e. no obstruction should be provided by it in the path of chip flow or tool travel.

PROCEDURE:

Lathe Tool Dynamometer:

Lathe tool dynamometer is used to measure cutting forces acting at the machining zone during turning with a single point cutting tool. All the three directional forces are measured simultaneously.

Forces on a single point tool in turning:

In case of oblique cutting in which three component forces act simultaneously on the tool point as shown. The components are:

Ft = The feed force or thrust force acting in horizontal plane parallel to the axis of the work.

Fr = The radial force, also acting in the horizontal plane but along a radius of Work piece i.e. along the axis of the tool.

Fc = The cutting force, acting in vertical plane and is tangential to the work surface. Also called the tangential force.

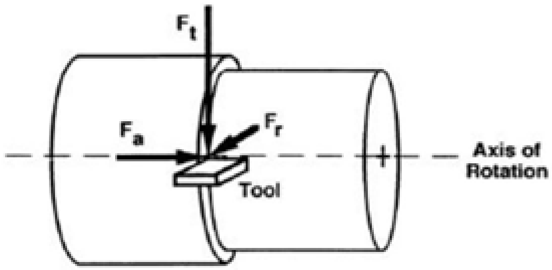
- The work piece is fixed in a 3-jaw chuck with sufficient overhang.
- Fix the dynamometer cutting tool in the tool post in such away that the tip of the tool coincides with the lathe axis.
- Select proper cutting speed, feed and depth of cut.
- Perform turning operation on the work.
- Directly measure the three components of forces acting on the tool using lathe tool dynamometer.
- Repeat the procedure for varying the above three parameters (CS, F & DC).
- The resultant force can be calculated by

$$R = \sqrt{F_c^2 + F_t^2 + F_r^2}$$

- Observe the effect of cutting speed, feed and depth of cut on force.

PRECAUTIONS:

- The tool should be rigidly mounted on the lathe tool post.
- Make sure that there should not be any vibrations in the tool.
- Readings should be noted carefully.
- Select the cutting speed, feed and depth of cut properly.



TABULATION:

SL.No	Dia of the Rod	Speed of the Motor (N) RPM	Forces in Kgf			Resultant Force
			X	Y	z	

RESULT:

Thus the thickness of the chips is measured by using lathe tool dynamometer.

EXP .NO:	MEASUREMENT OF VARIOUS DIAMETER OF SCREW THEREAD USING TOOL MAKERS MICROSCOPE
DATE	

AIM

To measure the following elements of the given screw thread using tool makers microscope.

(a) Major diameter
(a) Minor diameter
(a) Included

APPARATUS REQUIRED

(I) Tool makers microscope

(I) specimen

Description:

The tool maker's microscope is designed for measurement of parts of complex forms. For example various elements of the give screw thread. It can also be used for measuring centre-to-centre distance of the holes in any plane as well as the coordinates of the outline of a complex template gauge using the coordinates measuring system.

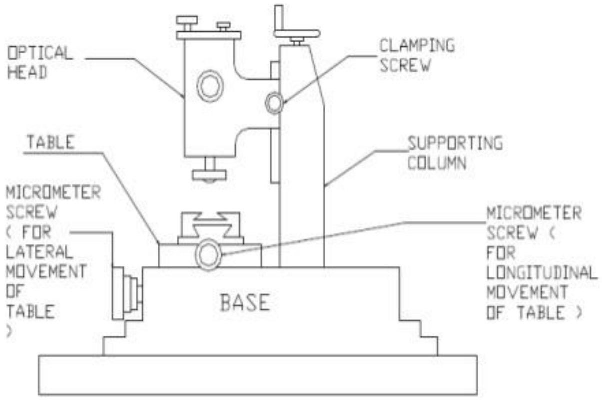
Basically it consists of the optical head can be clamped at any position by a screw. On the worktable (which has a circular base in which there are graduations) the part to be inspected is placed. The table has a compound slide by means of which the part can be measured. For giving these two movements there are two-micrometer screws having thimble scales and venire.

At the back of the base of the base is arranged light source, which provides a horizontal beam of light, which is reflected from a mirror by 90 degrees upward towards the table. The beam of light passes through the transparent glass plate on which flat part to be checked are placed. Observations are made through the eyepiece of the optical head.

PROCEDURE:

- The give specimen is placed in the worktable and all the light sources are switched on and the intensity of the light sources is adjusted unit a clean image of the cross wires and specimen are seen through the eyepiece.
- One of the two extreme edges between which the measurement has to be made is coincided with vertical or horizontal cross wires and depending upon the measurement the appropriate device is used and the reading givens the value of the readings are noted are noted down.
- Different measurements that are to be measured from the specimen and the reading are tabulated.

TOOL MAKERS MICROSCOPE



TABULATION: SPECIMEN

Least count for Angular measurement-6'
Least count for longitudinal micrometer-0.01mm
Least count for Transverse micrometer-0.01mm

S. NO	Description	Initial reading			Final Reading			Actual Reading (mm)
		MSR (mm)	VSR (mm)	TR (mm)	MSR (mm)	VSR (mm)	TR (mm)	
1.	Minor Diameter							
2.	Major Diameter							
3.	pitch							
4.	Included Angle	Degree	Minutes	degree	Degree	minutes	Degree	Degree

MSR= Main Scale Reading
VSC= Venire scale Coincidence
= VSC x L.C
TR= Total Reading
=MSR + VSR
L.C= Least count

RESULT:-

Thus the values of various elements of the give screw threads are measured by using tool maker's microscope.

EXP .NO:	MEASUREMENT OF TEMPERATURE USING THERMOCOUPLES
DATE	

AIM

To Measure the temperature using thermocouples (J-TYPE.K-TYPE)

APPARATUS REQUIRED

Furnace

J-type, K-type

Temperature display unit

DESCRIPTION

Thermocouple

If two dissimilar metals are joined an emf exists which is a function of several factors including the temperature. When junctions of this type are used to measure temperature, they are called thermocouples. The principle of a thermocouple is that if two dissimilar metals A and B are joined to form a circuit as shown in the Fig. It is found that when the two junctions J1 and J2 are at two different temperatures T1 and T2, small emf's e1 and e2 are generated at the junctions.

The resultant of the two emf causes a current to flow in the circuit. If the temperatures T1 and T2 are equal, the two emf will be equal but opposed, and no current will flow. The net emf is a function of the two materials used to form the circuit and the temperatures of the two junctions. The actual relations, however, are empirical and the temperature-emf data must be based on experiment.

It is important that the results are reproducible and therefore provide a reliable method for measuring temperature. It should be noted that two junctions are always required; one which senses the desired or unknown temperature is called the **hot** or **measuring** junction. The other junction maintained at a known fixed temperature is called the **cold** or **reference** junction.

Thermocouple materials and Construction

Any two dissimilar metals can be used to form thermocouple, but certain metals and Combinations are better than others.

The desirable properties of thermocouple materials are:

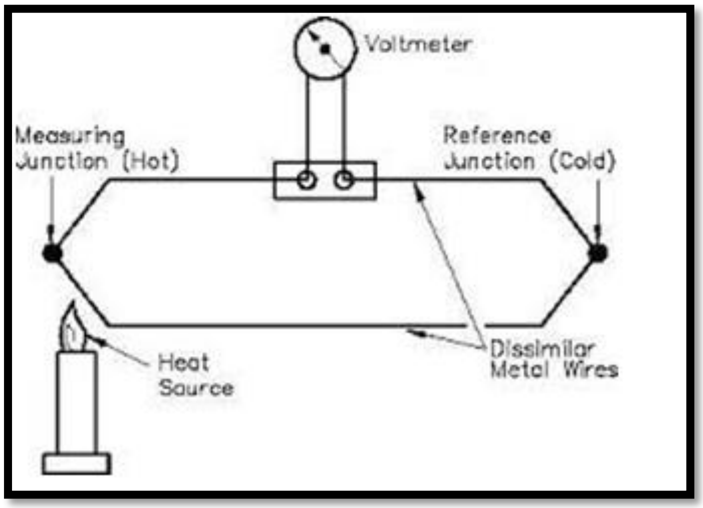
i) Linear temperature-emf relationship
ii) High output emf
iii) Resistance to chemical change when in contact with working fluids
iv) Stability of emf
v) Mechanical strength in their temperature range and
vi) Cheapness.

The thermocouple materials can be divided into two types 1. Rare-metal types using platinum, rhodium, iridium etc and 2. Base-metal types as given in the table.

PROCEDURE

1. Switch on the furnace
2. Turn the type selector to the desired position according to the given T.C. probe.
3. Connect the given thermocouple to the thermocouple temperature display
4. Connect the power supply to the temperature indicator.
5. Note the display temperature, when the furnace temperatue reached 100
6. Repeat the observation of different temperature levels on intersecting (J-Type,K-Type)

DIAGRAM



J-TYPE

S.NO	GIVEN TEMPERATURE (°C)	ACTUAL TEMPERATURE (°C)	DISPLAY TEMPERATURE (°C)	% OF ERROR
1	100			
2	200			
3	300			

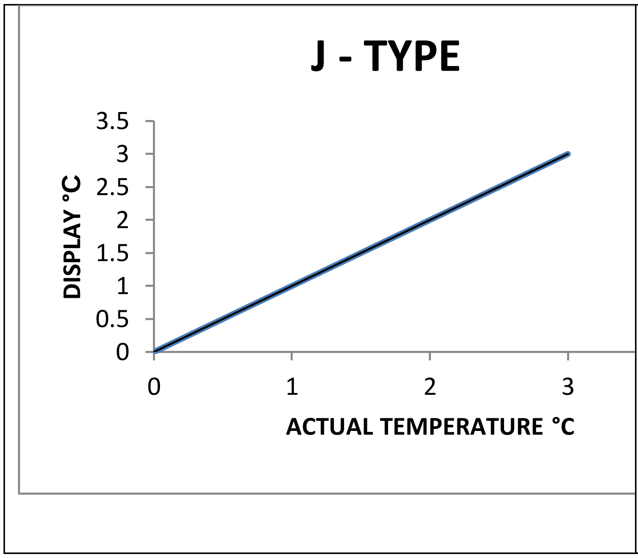
K-TYPE

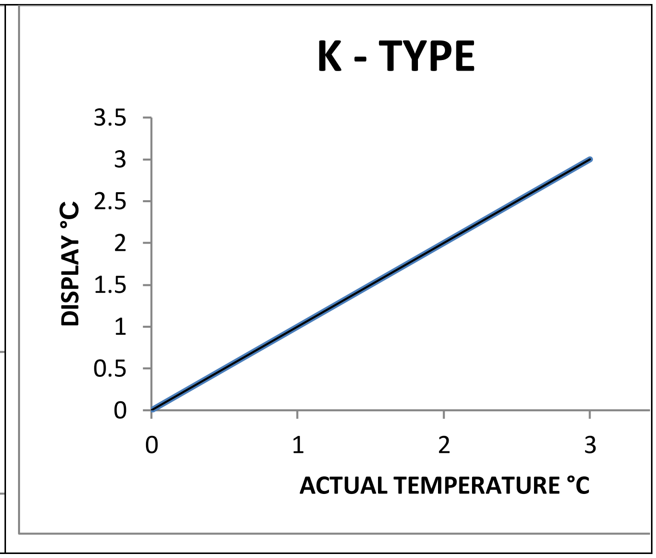
S.NO	GIVEN TEMPERATURE (°C)	ACTUAL TEMPERATURE (°C)	DISPLAY TEMPERATURE (°C)	% OF ERROR
1	400			
2	500			
3	600			

CALCULATIONS

ERROR=ACTUAL TEMPERATURE-DISPLAY TEMPERATURE

MODEL GRAPH





RESULT

Thus the temperature is measured by using thermocouples (J type & K Type)