UNIVERSAL GOVERNOR APPARATUS

Code:AM 317

OBJECTIVES

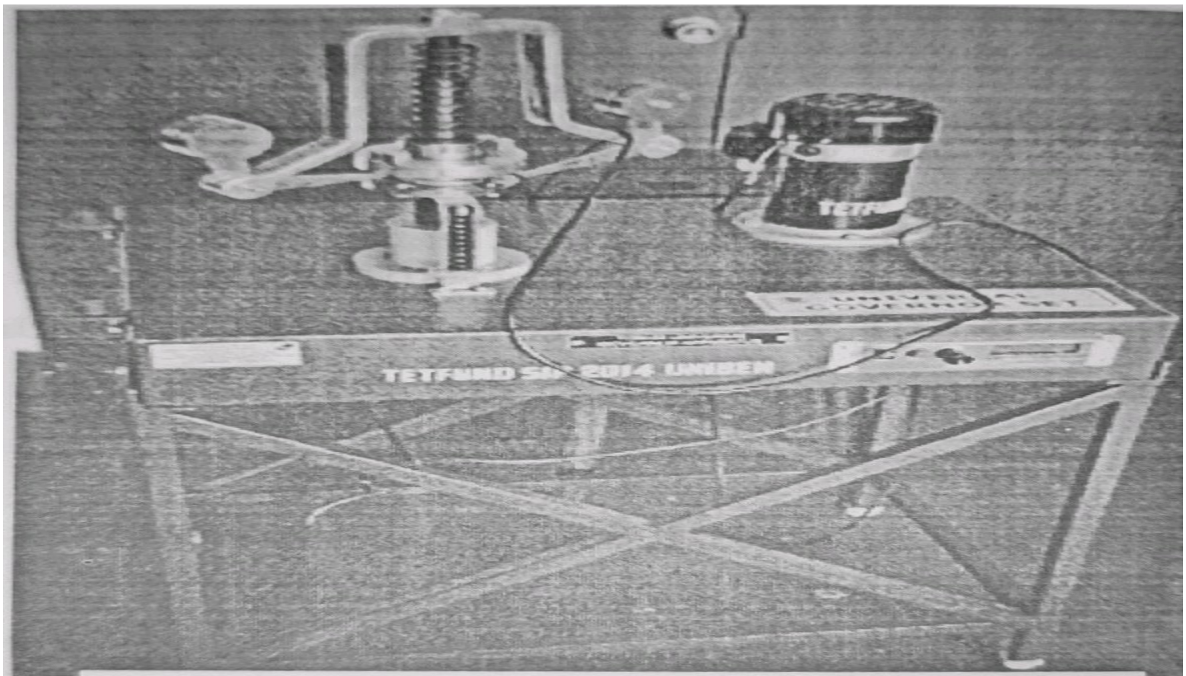
(i) To determine the characteristics of sleeve position against controlling force and speed.

(ii) To obtain of graph of characteristic of radius of rotation against force

(iii) To obtain the graph of governor speed vs sleeve displacement.

(iv) To obtain the governor characterisde i.e the graph of controlling force vs radius of the ball centre

THEORY



UNIVERSAL GOVERNOR APPARATUS (AM317)

The function of a governor is to regulate the mean speed of an engine, when there are variations in load e.g when load on an engine increase or decrease, obviously it speed will respectively decrease or increase to the extent of varintion of load. This vanation of speed has to be controlled by the governor, within small limits of mean speed. This necessitate that when the load increase and consequently the speed decrease, the supply of fuel to the engine has to be increased accordingly to compensate for the loss of the speed, so as to bring back the speed to the mean speed. Conversely, when the load decreases and speed increases, the supply of fuel has to be reduced.

The function of the governor is to maintain the speed of an engine within specific limit whenever there is a variation of load. The governor should have it's mechanism working in such a way, that the supply of fuel is automatically regulated according to the load, requirement for maintaining approximately a constant speed.

This is achieved by the principle of centrifugal force. The centrifugal type of governor, are based on the balancing of centrifugal force on the rotating balls by an equal and opposite radial force, known as the controlling force.

Governors are broadly classified as;

(a) Cernrifugal Governor

(b)inertia Governor

The centrifugal governors are based on the balancing of centrifugal force on the rotating balls by an equal and opposite radial force, known as controlling force. In inertia governor the position of the balls are affected by the forces set by an

angular acceleration or deceleration of the given spindle in addition ia centrifugal forces on the ball

This apparatus is designed to exhibit the characteristic of the spring loaded governor and centrifugal governor. The experiment shall be performed on the following centrifugal type governors:

(1) Watt governor

(2) Porter governor

(3) Proell governor

(4) Hartnell governor

GENERAL OPERATION PROCEDURE

(1) Arrange the set up as a watt, proell. e.t.c. governor this can be done by removing the upper sleeve on the verticaI speeded of the governor by the help of a spanner 16-17 mm and using proper linkage provided

(2) Switch on the control panel

(3) Increase the motor speed gradually

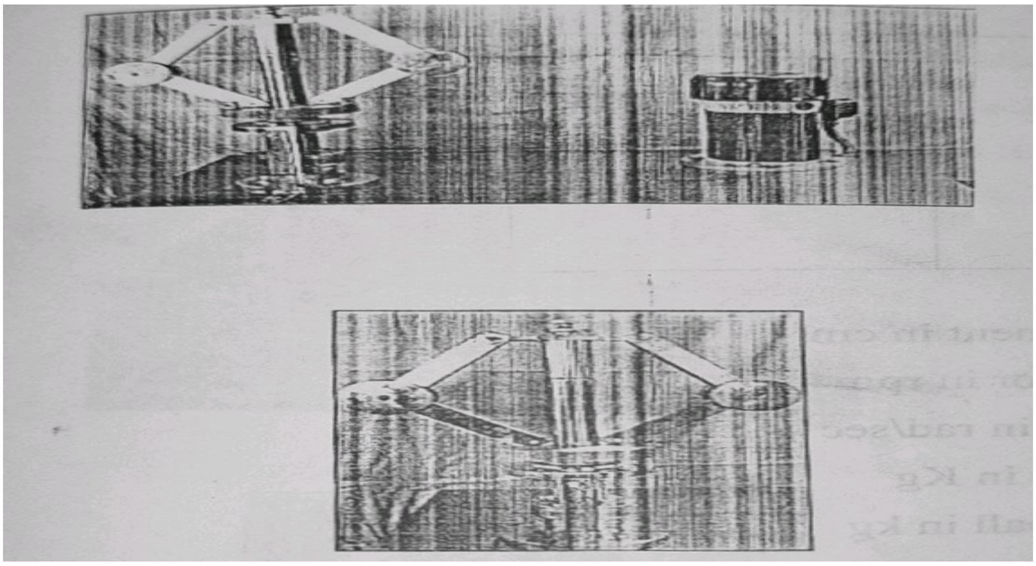
(4) Note the sleeve displacement on the scale provided and switch on the digital rpm meter

(5) Plot the graph speed vs sleeve displacement for the watt porter, proell and Hartnell governor.

(6) Plot the graph of speed vs governor height for watt governor. Plot the governor characteristics after doing the increasing calculation.

Note. Let the speed of the governor stabilize before taking the sleeve displacement.

EXPERIMENT NO 1: **WATT GOVERNOR**



WATT GOVERNOR

The simplest form of a centrifugal governor is a watt governor as shown in figure (1) It is the original form of the governor used by watt on early steam engines. It is basically a conical pendulum with links attached to a sleeve of negligible weight.

Length of each link (L) 125mm

Initial height of governor (h_o) = 95mm

Initial radius of rotation (r_o) = 132 mm

Weight of each ball (W)=0.0328kg

Go on increasing the speed gradually and take the reading of the speed of rotation 'N' and corresponding sleeve displacement 'X', radius of rotation 'r' at any point.

S/N	N(rpm)	X(mm)
1		
2		
3		
4		
5		

Where X = Sleeve Displacement in cm

N =Speed of Governor in rpm

ω = Angular velocity in rad/sec

F_c =Centrifugal force in Kg

W= Weight of each ballin kg

r = radius of rotation in cm

RESULTS

h = Height of the Governor in meter h = h_o - x/2

α = Angle ofincIination of the arm (or upper link) to the vertical

$$\cos(\alpha)\frac{h}{L}=(h_0-\frac{x}{2})/L$$

r = radius of rotation in meter

r = 50 + L sin α or θ

ω= angular velocity in rad/sec

$$\omega = \frac{2\pi N}{60}$$

F_c = centrifugal Force i Kg

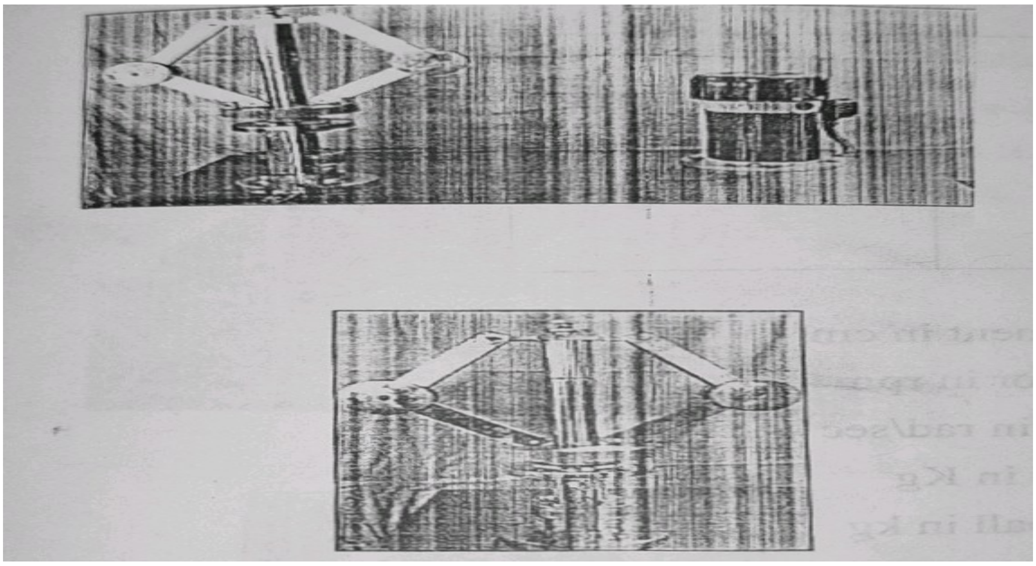
$$F_c = \frac{w}{g}\omega^2 r$$

<u>GRAPH</u>

(1) Plot a graph of force vs radius of rotation

(2) Plot a graph of speed vs sleeve displacement.

EXPERIMENT NO 2:**PORTER GOVERNOR**



PORTER GOVERNOR

The porter governor is a modification of a watt’s governor. With the center load attached as shown below.The load moves up and down the central spindle .This additional downward force, increase the speed of revolution required to enable the ball to rise to any predetermined level.

Length of each link (L)= 125mm

Initial height of governor (ho) = 95mm

Weight of each ball (W) =0.328kg

Initial radius of rotation = 132mm

Go on increasing the speed gradually and take the readings of speed of N rotation 'N' and corresponding sleeve displacement 'x', radius of rotation 'r' at any position.

S/N	N(rpm)	X(mm)	W(kg)
1			

2			
3			
4			
5			

Where X = Sleeve Displacement in cm

N =Speed of Governor in rpm

ω = Angular velocity in rad/sec

F_c =Centrifugal force in Kg

W= Weight of each ballin kg

r = radius of rotation in cm

RESULTS

h = Height of the Governor in meter h = h_o - x/2

α = Angle ofincIination of the arm (or upper link) to the vertical

$$\cos(\alpha)\frac{h}{L}=\left(h_0-\frac{x}{2}\right)/L$$

r = radius of rotation in meter

r = 50 + L sin α or θ

ω= angular velocity in rad/sec

$$\omega = \frac{2\pi N}{60}$$

F_c = centrifugal Force in Kg

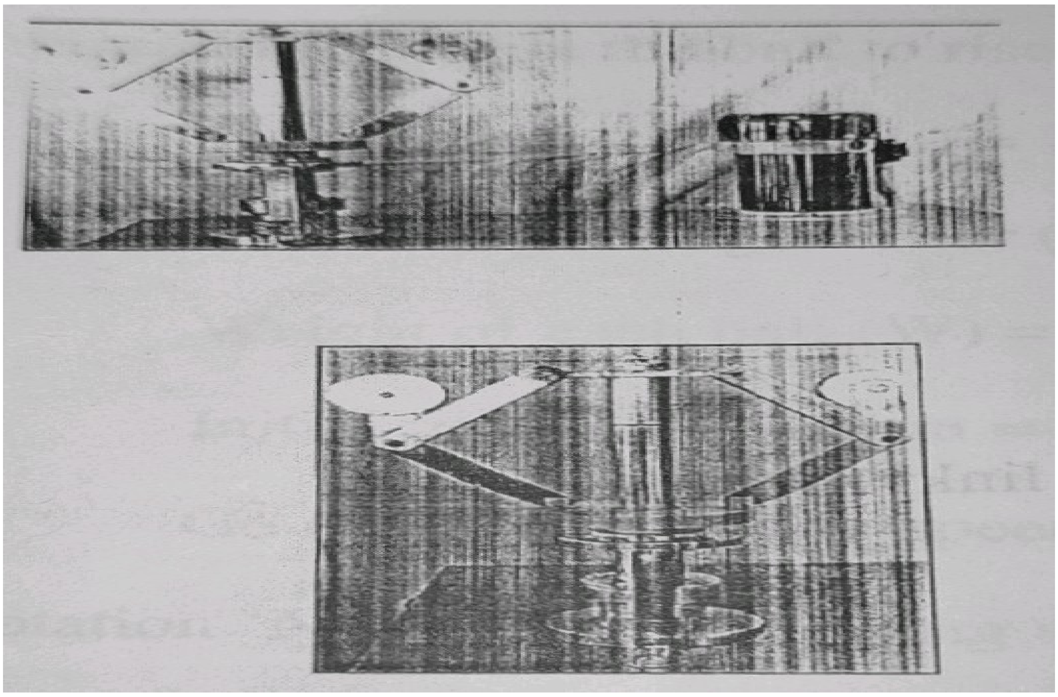
$F_c = \frac{w}{g}\omega^2 r$

<u>GRAPH</u>

(3) Plot a graph of force vs radius of rotation

(4) Plot a graph of speed vs sleeve displacement.

EXPERIMENT NO 3 : **PROELL GOVERNOR**



PROELL GOVERNOR

In the proell Governor, with the use of flyweights (forming full ball) the governor becomes highly sensitive under these conditions, large sleeve displacement is observed for very Small change in speed

Proell governor is similar to the porter governor. having a heavy central Load at sleeve. But it differs, from porter governor in the arrangement of balls. The balls are carried on the extension of the Lower arms instead of at the junction of the upper and lower arms.

The center sleeve of the porter and proell governor incorporates a weight sleeve to which weights can be added.

In order to make it suitable, it is necessary to cany out the experiments by using halt balI flyweights on each side

Length of each Link (L) = 125mm

Initial height of governor (ho) =95mm

Initial radius of rotalion (ro) =130mm

Weight on sleeve W2= 0.28Okg each

Weight of each ball W1 =0.328kg

Go on increasing the speed gradually and take the readings of speed of rotation 'N' and corresponding sleeve displacement 'x', complete the following table.

S/N	N(rpm)	X(mm)	W(kg)
1			
2			
3			
4			
5			

For any displacement ‘x’ of sleeve it is possible to find ‘r’ and ‘N’ force ‘F’ can be found by knowing ‘r’ and ‘N’

Where x= Sleeve Displacement in cm

N =Speed of Governor in rpm

ω = Angular velocity in rad/sec

F_c =Centrifugal force in Kg

W= Weight of each ballin kg

r = radius of rotation in cm

RESULTS

h = Height of the Governor in meter h = h_o - x/2

$$h = h_0 - \frac{x}{2}$$

α = Angle ofincIination of the arm (or upper link) to the vertical

$$\cos(\alpha)\frac{h}{L} = \left(h_0 - \frac{x}{2}\right)/L$$

r = radius of rotation in meter

r = 50 + L sin α or θ

ω= angular velocity in rad/sec

$$\omega = \frac{2\pi N}{60}$$

F_c = centrifugal Force in Kg

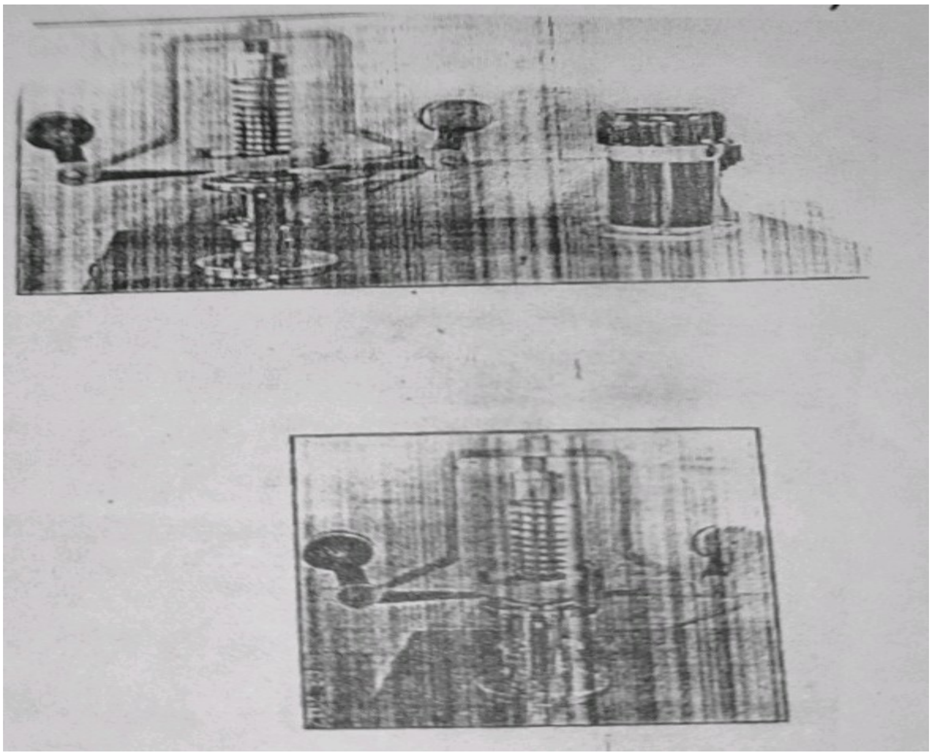
$F_c = \frac{w}{g}\omega^2 r$

GRAPH

(5) Plot a graph of force vs radius of rotation

(6) Plot a graph of speed vs sleeve displacement.

EXPERIMENT NO 4: **HARTNELL GOVERNOR**



HARTNELL GOVERNOR

A hartnell governor is a spring loaded governor.it is spring controlled .it consists of two Bell crank levers pivoted at the points 0,0 to the frame the frame is attached to the governor spindle and therefore rotates with it. Each lever carries a ball at the end of the vertical arm OB and a roller at the end of the horizontal arm OR. A Helical spring on compression provides equal downward forces on the two rollers through a cover on the sleeve

Length of vertical (a) = 75mm

Length of horizontal (b) = 12.1 mm

Initial radius of rotation (r.) of 165 mm

Free height of spring =132mm

Weight of sliding sleeve = 0.712kg

Weight of sliding sleeve =0.220kg

Measure initial compression of the spring, go on increasing the speed gradually and take the readings of speed of rotation 'N' and corresponding sleeve displacement 'x', radius of rotation r at any position could be found as follows.

S/N	N(rpm)	X(mm)	W(kg)
1			
2			
3			
4			
5			

Where x= Sleeve Displacement in cm

N =Speed of Governor in rpm

ω = Angular velocity in rad/sec

F_c =Centrifugal force in Kg

W= Weight of each ballin kg

r = radius of rotation in cm

RESULTS

h = Height of the Governor in meter

$$h = h_0 - \frac{x}{2}$$

α = Angle ofincIination of the arm (or upper link) to the vertical

$$\cos(\alpha)\frac{h}{L} = \left(h_0 - \frac{x}{2}\right)/L$$

r = radius of rotation in meter

r = 50 + L sin α or θ

ω= angular velocity in rad/sec

$$\omega = \frac{2\pi N}{60}$$

F_c = centrifugal Force in Kg

$$F_c = \frac{w}{g}\omega^2 r$$

GRAPH

(7) Plot a graph of force vs radius of rotation

(8) Plot a graph of speed vs sleeve displacement.

CONCLUSION

Sum up the characteristics of each governor mechanism and discuss their individual merit as engine speed control device. Also do a comparism of the governor’s types in term of sensitivity,stability and governor effort.

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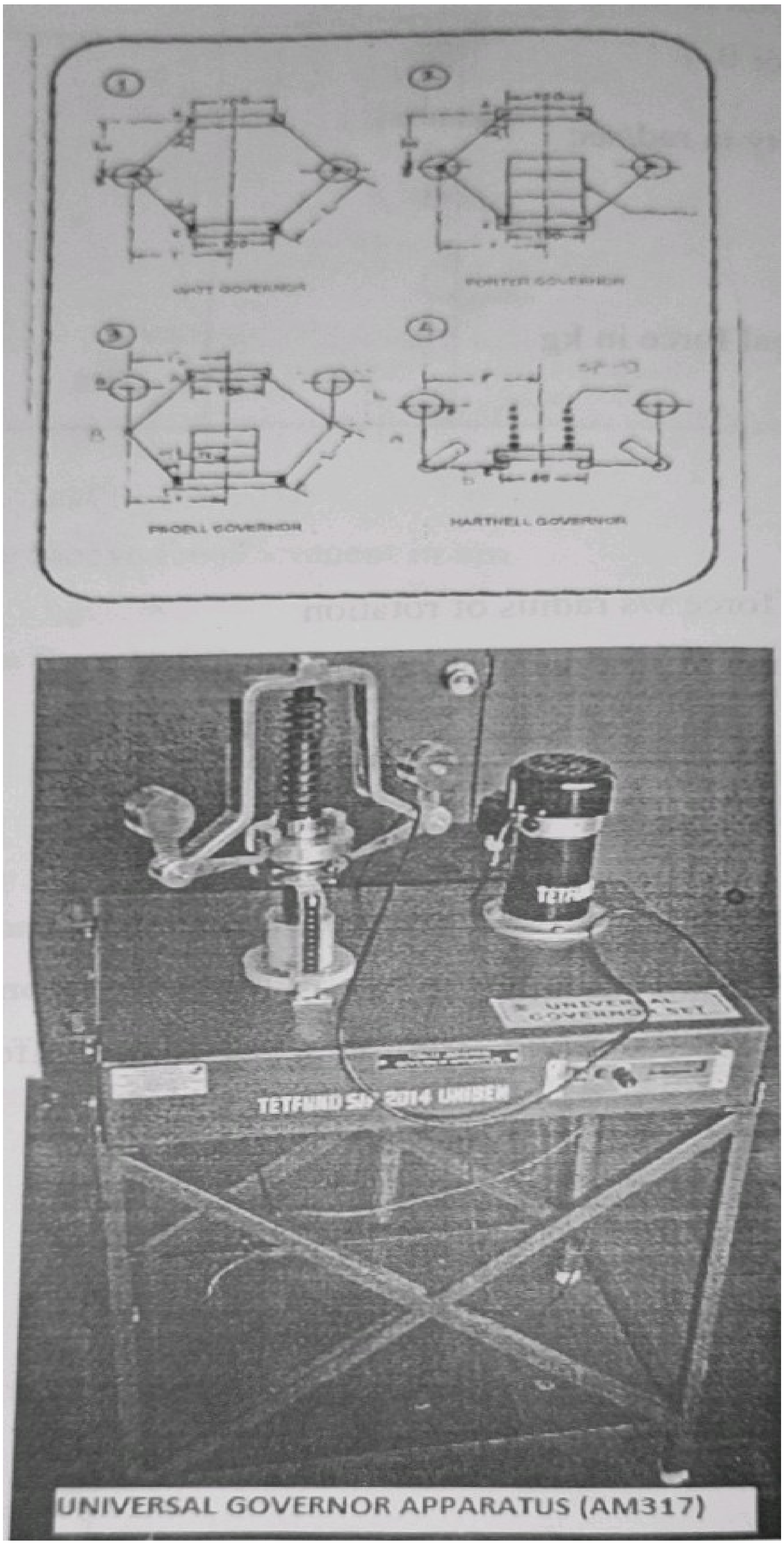


CNC MILLING MACHINE

Code:TPS-3910

OBJECTIVES

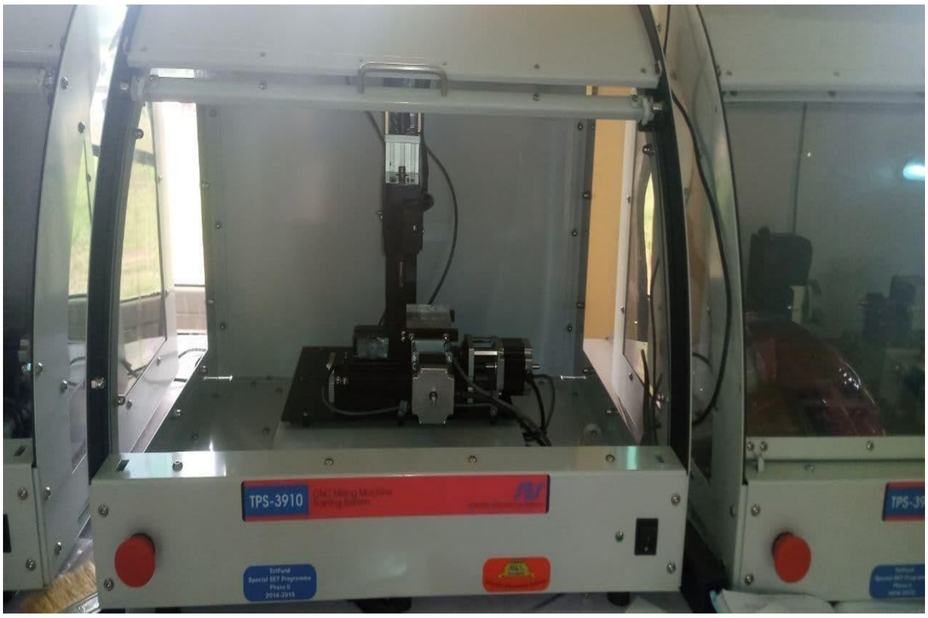
I. Writing the first milling program according to a drawing.

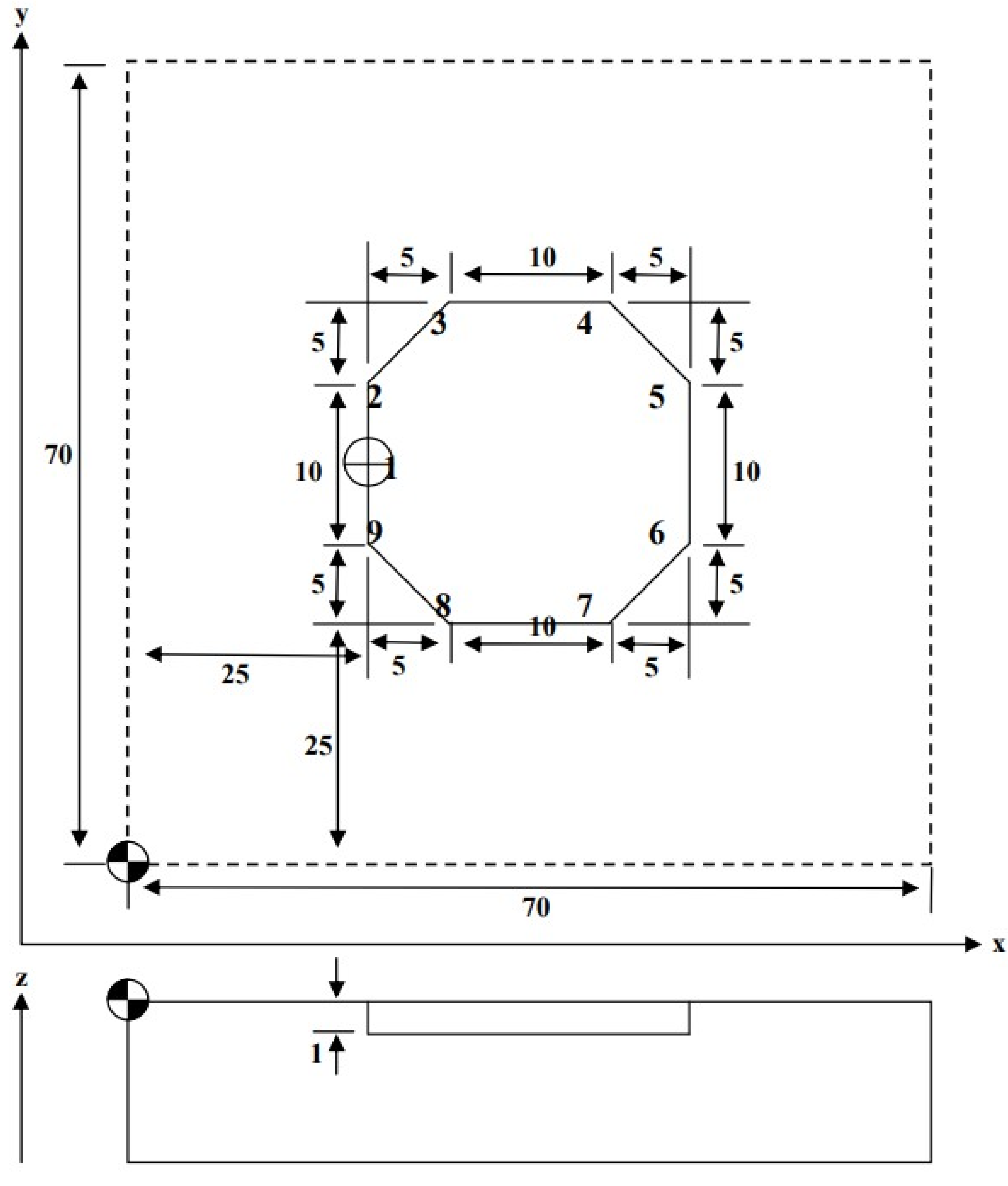
II. Understanding slot processing.

III. Running the program on simulation.

IV. To setup the material using the monitor.

V. Milling the material.





y
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z
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APPARATUS/EQUIPMENTS

I. PC computer (with MILLsoftware installed)

II. TPS-3910 CNC Milling Machine Training System

III. 3mm milling cutter

IV. 70x70x20 mm Acrylic workpiece

THEORY

The TPS-3910 is a computerized system called CNC (Computer Numerical Control) for sliver processing of plastic and aluminium products. The system enables us to manufacture products from these materials. The system includes a rotating mill cutter operated by a spindle DC motor. The mill motor is located above a table, which is operated by a DC motor, which raises and lowers it. The processed material is installed on a table, which moves on two axes (X and Y). In this way, the processed material moves on the X-Y plane and the miller moves up and down (goes into and out of the material) on axis Z. The movement of each axis is done by a DC step motor. Limit switches are located on each axis for home positioning and end range identify. The system is located in a metal structure with a transparent door in the front. The door operates two limit switches when it is closed. The system includes a computerized control unit. The control unit operates the motors, reads the limit switches status and operates the spindle DC motor of the miller. The system stops each time the front door is opened. A special language was created for CNC machines called G&M-Code. This language is a universal language and despite this, each machine has its own unique commands. The CNC system enables us to manufacture the exact amount of products we need. All it takes is to load the computer with the appropriate file and run the program. The TPS-3910 system is accompanied with the MILL software. This software enables us to create and edit a G&M-Code file and run it. Running the file can be done in two ways – by simulation or by operating the machine. In the simulation method, the software draws the mill's movement on the screen and drags lines accordingly. Each line receives a colour according to the milling depth. In the machine operation method, the computer sends a movement commands to the system's control unit and the control unit executes the processing

PROCEDURE

Step 1: Connect the power cable to the TPS-3910 power inlet.

Step 2: Connect the USB cable to the USB terminals of the PC and the TPS-3910.

Step 3: Connect the power supply of the TPS-3910 to the Mains.

Step 4: TPS-3910 has an emergency pushbutton on the front panel. Turn it ON by turning it to the right. The pushbutton will go out.

Step 5: Turn ON the power supply Main switch.

Step 6: Click with the mouse over the MILL icon on your desktop. An introductory screen will appear on the screen.

Step 7: Select the FILE function and the NEW sub-function. An editor window appears and more functions are added to the menu line. The added functions are EDIT, VIEW, and RUN.

Step 8: Type the following G&M-Code milling program:

M4 S2000	start spindle motor at 2000 RPM
G0 Z3 G0 X25 Y35	move to point 1 at maximum feed (clearance = 3mm)
G1 Z-1 F100 G1 Y40	move to point 2 feed=100 Z=-1mm
G1 X30 Y45	move to point 3
G1 X40	move to point 4
G1 X45 Y40	move to point 5
G1 Y30	move to point 6
G1 X40 Y25	move to point 7
G1 X30	move to point 8
G1 X25 Y30	move to point 9

G1 Y35 move to point 1 back

G0 Z3 G0 X0 Y0 move to HOME position

M5 stop spindle motor

Step 9: Compare the program with the drawing. Check each instruction.

Step 10: Select the function FILE and the SAVE AS sub-function. A dialog window is opened requesting the file name.

Step 11: Type the name SLOT1 and click OK. The program is saved under the name SLOT1.TAP.

Step 12: Select the OPTIONS function again. Select the SIMULATION sub-function. In simulation mode, the software simulates the machine behaviour on the screen, without processing the material. This option enables us to check our program before milling the material.

Step 13: Select the function RUN and the RUN sub-function. A graph window appears. The program is executed step by step graphically on the window. Observe the drawing. The colours of the lines describe the Z-dimension of the lines.

Step 14: If the graph is not correct according to the program, correct the program and run it again.

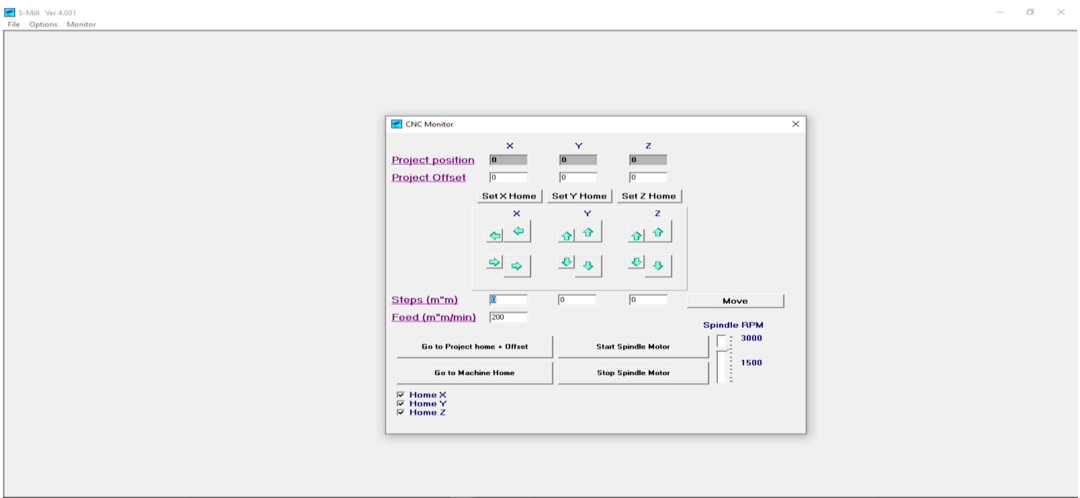
Installing material and defining project home

Step 15: Install the material (70x70x10 mm plastic material) on the table of the TPS-3910 and tighten it with the handy screws. Check that the material lies horizontally on the table.

Step 16: Select the OPTIONS function and the MACHINE sub-function in order to operate the system

Step 17: Select the function MONITOR and the sub-function CNC MONITOR.

The CNC monitor appears.



Make sure that all the check boxes of 'Home X', 'Home Y' and 'Home Z' are checked, and press the "GO TO MACHINE HOME" button. The machine should move to the absolute home position. Moving to MACHINE HOME position is needed when the material is installed or the machine is cleaned. It is not needed for the milling. The milling is done according to the milling program and the defined project home.

Step 18: Turn ON the milling motor by clicking over the "Start Spindle Motor" button.

Step 19: Lower the cutter slowly until the cutter almost touches the material surface.

Step 20: Enter 0 into the field above 'Set Z Home' button and click on this button. The field project position of Z will be changed to 0.

Step 21: Move the cutter out of the material on X direction.

Step 22: Lower the cutter slowly until the cutter a little below the material surface.

Step 23: Move the cutter on X direction until it touches the material side.

Step 24: Enter the required offset (half of the cutter diameter) into the field above 'Set X Home' button and click on this button. The field project position of X will be changed to this number.

Step 25: Move the cutter on Y direction until it touches the material side.

Step 26: Enter the required offset (half of the cutter diameter) into the field above 'Set Y Home' button and click on this button. The field project position of Y will be changed to this number.

Step 27: Raise the cutter above the material surface.

Step 28: Click on the button 'Go to Project Home'.

Step 29: Select the RUN function and the RUN sub-function. The system should mill the material according to the program.

CNC Lathe Machine

<u>Code</u>: TPS-3920

<u>OBJECTIVES</u>

I. Writing the first turning program according to a drawing.

II. Understanding turning processing.

III. Running the program on simulation.

<u>APPARATUS/EQUIPMENTS</u>

I. PC computer (with MILLsoftware installed)

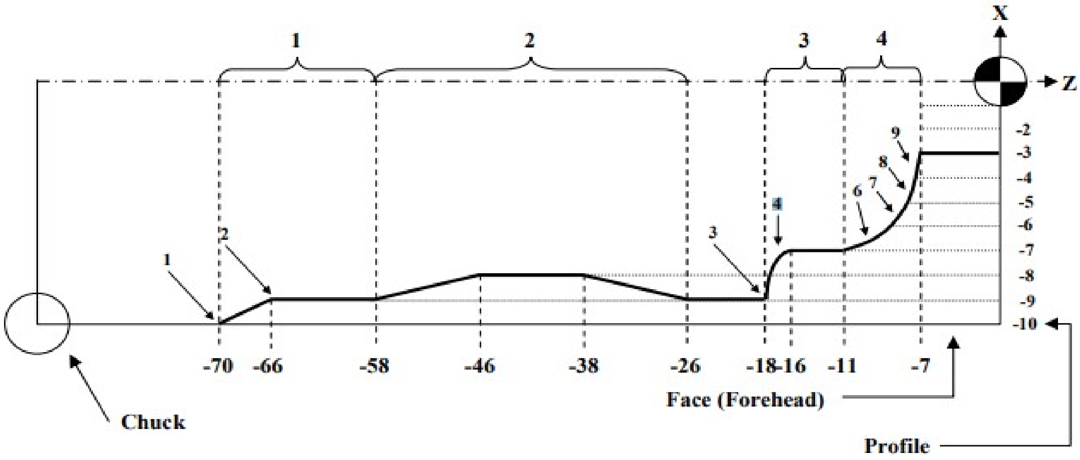
II. LATHE software

III. TPS-3920 CNC Lathe Machine Training System

IV. 180mm ø20 mm plastic material

<u>THEORY</u>

<u>TPS-3920 CNC Lathe Machine</u>



cut profile of a workpiece

The TPS-3920 is a computerized lathe machine system for sliver processing of plastic and aluminum products. The system enables us to manufacture products from these materials. The system includes a spindle motor operated by a DC motor. The processed material is tightened into the spindle bore. The turning tool is installed on a table, which moves on two axes (X and Z). The processed material is a round rod that rotates and the turning tool movement on X direction cuts it on its perimeter. The turning tool movement on Z direction is along the rod. The movement of each axis is done by a DC step motor. Limit switches are located on each axis for home positioning and end range identify. The system is located inside a metal structure with a transparent door in the front. The door operates two limit switches when it is closed. The system includes a computerized control unit. The control unit operates the motors, reads the limit switches status and operates the DC motor of the spindle. The system stops each time the front door is opened. A computerized system for sliver processing is called CNC (Computerized Numeric Control). The system's controller receives data, which determine

the movement of the turning tool (location and speed) and moves it accordingly in a controlled manner. A special language was created for CNC machines called G&M-Code. The CNC system enables us to manufacture the exact amount of products we need. All it takes is to load the computer with the appropriate file and run the program. This process turned the manufacturing significantly flexible. Flexibility means an easy transfer from one product to another. These machines are called FMS (Flexible Manufacturing Systems). The TPS-3920 system is accompanied with the LATHE software. This software enables us to create and edit a G&M-Code file and run it. Running the file can be done in two ways – by simulation or by operating the machine. In the simulation method, the software draws the turning tool movement on the screen.

PROCEDURE

Step 1: Connect the power cable to the TPS-3920 power inlet.

Step 2: Connect the USB cable to the USB terminals of the PC and the TPS-3920.

Step 3: Connect the power supply of the TPS-3920 to the Mains.

Step 4: TPS-3920 has an emergency pushbutton on the front panel. Turn it ON by turning it to the right. The pushbutton will go out.

Step 5: Turn ON the power supply Main switch.

Step 6: Click with the mouse over the LATHE icon on your desktop. An introductory screen will appear on the screen.

Step 7: Select the FILE function and the NEW sub-function. An editor window appears and more functions are added to the menu line. The added functions are EDIT, VIEW, and RUN.

Step 8: Type the following G&M-Code milling program:

M4 S2000	start spindle motor at 2000 RPM
G0 X-9	range 1 move to 9mm from the rod center.

G1 Z-66 F200 move to point 2

G1 X-10 Z-70 move to point 1

G0 X-11 G0 Z0 return

M5 stop spindle motor

Step 9: Compare the program with the drawing. Check each instruction.

Step 10: Select the function FILE and the SAVE AS sub-function. A dialog window is opened requesting the file name.

Step 11: Type the name PART1 and click OK. The program is saved under the name PART1.TAP.

Step 12: Select the OPTIONS function again. Select the SIMULATION sub-function. In simulation mode, the software simulates the machine behaviour on the screen, without processing the material.

Step 13: Select the function RUN and the RUN sub-function. A graph window appears. The program is executed step by step graphically on the window. Observe the drawing.

Step 14: If the graph is not correct according to the program, correct the program and run it again.

Installing material and defining project home

Step 15: Select the OPTIONS function and the INITIAL MACHINE sub-function in order to operate the system. This function initializes the TPS-3920 controller and loads it with the lathe machine program.

The program is loaded into non-volatile memory of the controller. This initialization should be done once while installing the TPS-3920.

Step 16: If there is no communication between the PC and TPS-3920, do the following:

I. Check the communication cable connections.

II. Press RST.

III. Check the COM port. If it is necessary, change the COM port number by selecting the OPTIONS function and the COM port sub-function.

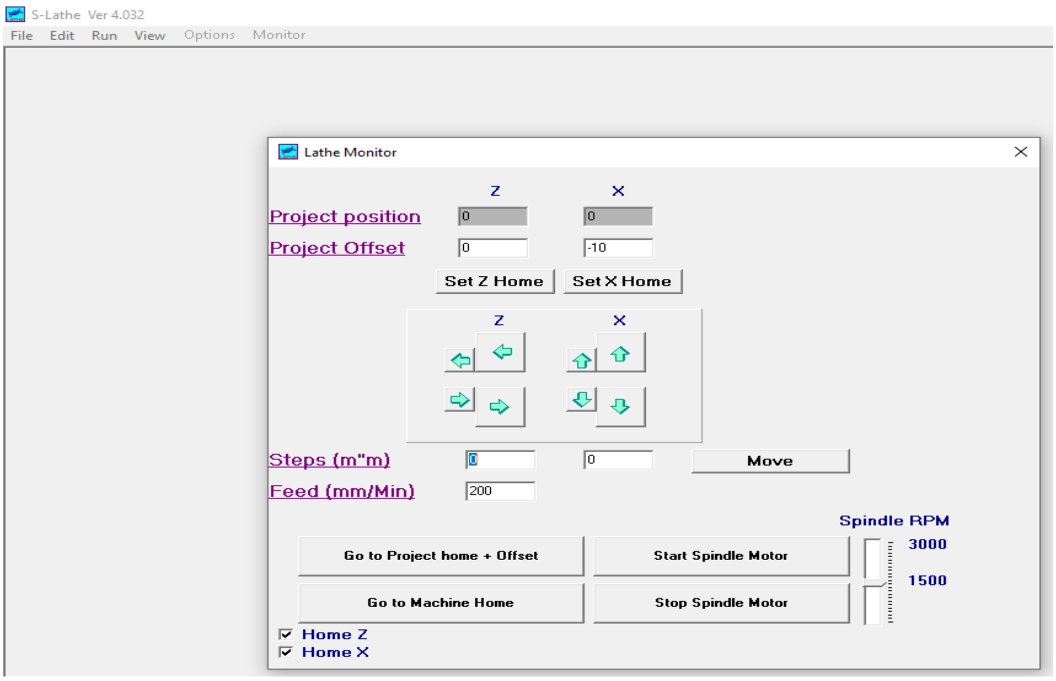
IV. Initial the TPS-3920 controller again by the OPTIONS function and the INITIAL MACHINE sub-function

*** Checking and selecting COM port**

Click with the mouse right button on 'My Computer' and select 'Properties'. Select 'Hardware' sub-menu. Select 'Device Manager'. Open 'Ports (COM & LPT). Check the COM number indicated inthe line: 'Silicon Labs CP210x USB to UART Bridge. Select the OPTIONS function. Select the COM port.Select the PC COM port and click OK.

Step 17: Select the function MONITOR and the sub-function CNC MONITOR.

The CNC monitor appears.



The monitor window enables us to control the TPS-3920 manually and to bring the material and the turning tool to home position (the turning start point).

Step 18: The button "Start Spindle Motor" turns ON the spindle. Close the TPS-3920 door and click over the "Start Spindle Motor" button. The motor turns ON and starts speeding according to the speed bar. Move the speed bar and press the "Start Spindle Motor" button again.

Step 19: The TPS-3920 has 2 limit switches that indicate the absolute home position for each axis. The monitor has three home check points (Home X and Home Z). Clicking over the check points add/delete the check mark in the check point. Clicking over the GO TO MACHINE HOME button returns the marked axis to home position. Check that. The TPS-3920 has other 2 limit switches that do not allow the system to go out its movement ranges.

Step 20: After checking that the system is in place, click on the file and Select the RUN function and the RUN sub-function. The system should process the material according to the program.

PNEUMATICS SYSTEMS

Code:TPS-3810

AIM

Operation of a SingleActing Cylinder Controlled by 3-Way Valve

OBJECTIVE

In this experiment, we will learn thework of a pneumatic press and its operation. In the industry, presses are used to producedifferent elements, pressure, perforation etc.

APPARATUS/EQUIPMENTS

I. TPS-3810/B + PNE-381H
II. PNE-381B – Single acting cylinder 80mm + flow control valve module
III. PNE-381C – 3/2 way valve with pushbutton switch
IV. Air compressor
V. 4mm flexible tubes

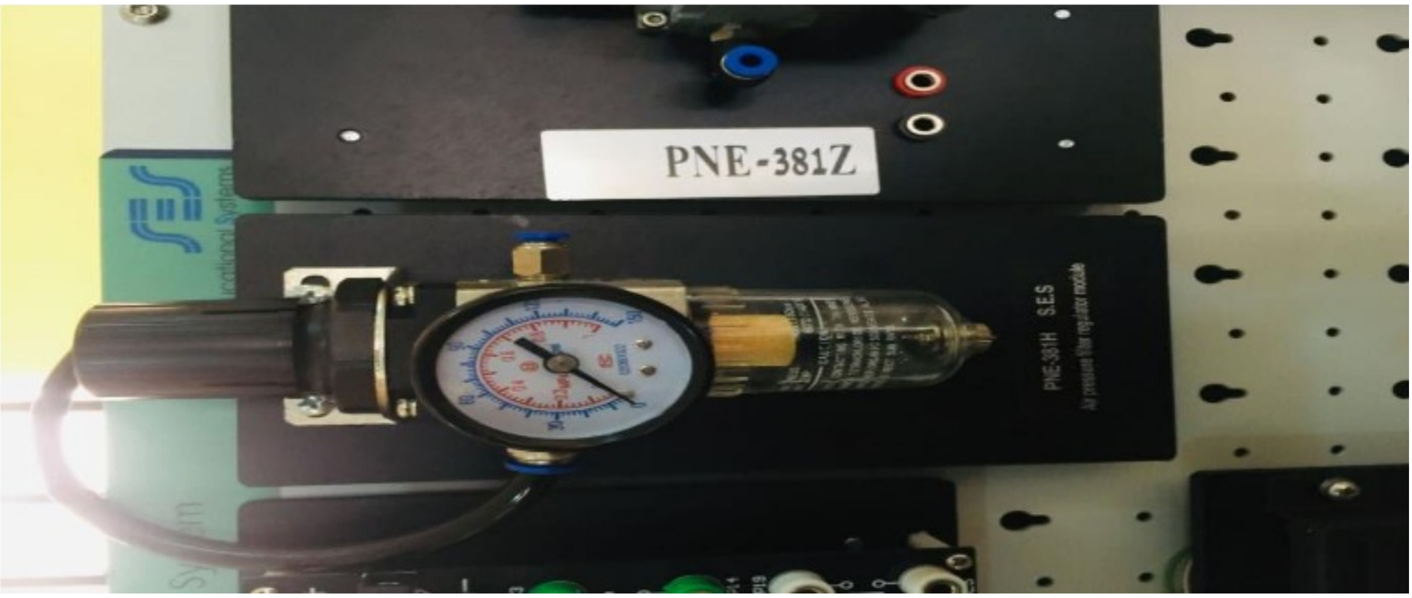
THEORY

In a world where robots, computers and machines are becoming an integral part of our lives, the automation technology evolved and became a major and important part in most of the different industries all over the world. A main part of the automation field is the pneumatics. The meaning of the word comes from Greek – 'pneuma' means air. This is the idea behind the pneumatics technology, using compressed air to execute different automatic actions. The pneumatics systems are divided into three types:

1. **Pure pneumatics systems –** these systems include only pneumatic components such as: cylinders,
valves, pneumatic control components, pneumatic motors etc.

2. **Electro-pneumatic systems –** these systems, in addition to their pneumatic components, also

combine electric components such as: solenoids valves, limit switches, switches, pushbuttons and



relays.

3. **Computerized pneumatics systems –** these electro-pneumatic systems also include

computerized

control units such as: switches, sensors and solenoid valves. These systems are controlled by a PLC (Programmable logic controller). The PLC program turns the system to a computerized one. Using air to operating mechanical actuators is simple and easy. Compressed air can be supplied anywhere in a factory. Air is available everywhere and the compressors which compress it are simple and inexpensive machines.

The components needed for this experiment are:

I. **Compressor –** In every pneumatic system we need a compressor, which provide compressed air. The compresses air reaches the service unit from the compressor via a suitable pipe system. A compressor is a noisy device (even the air pressure coming through pulsations). A tank for stocking the compressed air is attached to the compressor to avoid working constantly. The compressor fills the tank with compressed air up to a certain predetermined pressure and then stops working. As soon as the pressure in the tank drops below a certain predetermined value, the compressor start working automatically and raises again the pressure in the tank to a higher level. In this way, the tank supplies air pressure in relatively small intensity changes. As bigger as the tank is, its regulation is better and the compressor's operation spacing is longer.

Air compressor

II. **Air supply regulator –** A service unit. This unit drains the moisture accumulating in the compressed air and regulates the pressure coming into the system. The unit does the above with a button on the regulator and a pressure gauge attached to the service unit. The unit includes a small tank where the moisture, sometimes found in the air coming from the compressor, is condensed to water. In this way this unit empties the moisture accumulating in the compressed air. The collected fluids exit through an opening at the bottom of the small tank. The air goes into the regulator through a gate to an 8mm pipe and comes out through a gate to a 4mm pipe (as all the pneumatic components in the training system). The air pressure regulation button is located at the upper part of the regulator. This button includes a locking cover that should be raised before turning the buttonand afterwards it should be lowered. This cover prevents a random turning of the button.

Note: **Before opening the button, it is important to make sure that the regulator's air output is connected to any closed valve input via a pipe. Otherwise, the air from the compressor will flow freely into the room space.**

III. **A single acting cylinder –** A cylinder with a piston, rod and spring. The compressed air activates the cylinder: the rod exits and pushes out the element. The rod returns back by a spring located inside the cylinder, when the air in the cylinder port is released.

Single Acting Cylinder module

IV. **Flow control valve –** This component is similar to a regular water tap, only in this case we regulate the amount of air by rotating the screw on the component. Sometimes, the flow regulation valves include a non-return valve in parallel. This valve causes the flow regulation to be performed only in one air flow direction, while the air flows freely in the other direction. It includes a marble that blocks the air flow that comes from its direction and it should flow through the regulator.

V. **3/2 pushbutton valve –** Any valve is defined by its number of ports, its number of positions and its way of activation. This valve has 3 ports and 2 positions. The valve is operated by a pushbutton. Figure 1-4 3/2 Pushbutton Valve The air pressure is supplied to the P port. The A port is connected to

the activated element. The R port enables the air to exhaust from the activated element while it is deactivated. The valve's two positions are described using the two cube drawings. The lower cube describes the valve's normal position (the pushbutton is not pressed). In this position, the air is routed from gate A to the release gate R. The upper cube describes the air paths while the pushbutton is pressed. If you put the upper cube on the lower cube, you will see that the air flows from the input gate P to the output gate A while the release gate is blocked.

PROCEDURES

Step 1: Identify the 3/2 pushbutton valve module.

Step 2: Check the 3/2 pushbutton valve and identify the air input (P) and the air output (A). Also identify the air release gate (usually covered with a filtering net).

Step 3: Install the 3/2 pushbutton valve module on the system's panel.

Step 4: Identify the 80mm single acting cylinder module and install it on the system's panel alongside the manual operation valves module.

Step 5: Identify the air input gate and the flow control valve installed on it.

Step 6: Connect a pipe between the air supply regulator output and the 3/2 pushbutton valve input gate.

Step 7: Connect a pipe between the 3/2 pushbutton valve output gate and the single acting cylinder input.

Step 8: Adjust the air pressure on the air supply regulator to 2 ATM.

Step 9: Press the pushbutton and release it..

Step 10: While pressing the pushbutton, the piston pops out, and pops in when the pushbutton is released.

Step 11: Describe the path the air makes when the pushbutton is pressed and when the pushbutton is released.

Step 12: Copy the system's diagram to your notebooks and mark (in different colors) the air's path when the pushbutton is pressed and when it is released.

Step 13: Close the flow control valve (located on the cylinder's port) by turning the button clockwise and try operating the cylinder.

Step 14: Slowly open the flow control valve and try to operate the cylinder. Repeat this until the cylinder works normally.

Step 15: Press the pushbutton shortly and release it. Observe the cylinder and describe its operation.

Questions:

I. What is the function of the spring in the pushbutton valve?

II. State 10 industrial uses of pnematics?

III. Describe the advantages and disadvantages in using a single acting cylinder.

IV. Describe a use for the FCV (Flow Control Valve)

ENGINEERING MEASUREMENT

AIM

STUDY OF WORKSHOP MEASURING DEVICES

Code: EM 301

OBJECTIVES

After studying this unit, you should be able to:

I. To familiarize yourself with various type of angular measuring devices,
II. To familiarize yourself with various type of comparators and
III. To choose a suitable angular measuring device according to the precision required.

APPARATUS/EQUIPMENTS

Angular measuring instrument for precision measuring instrument

INTRODUCTION

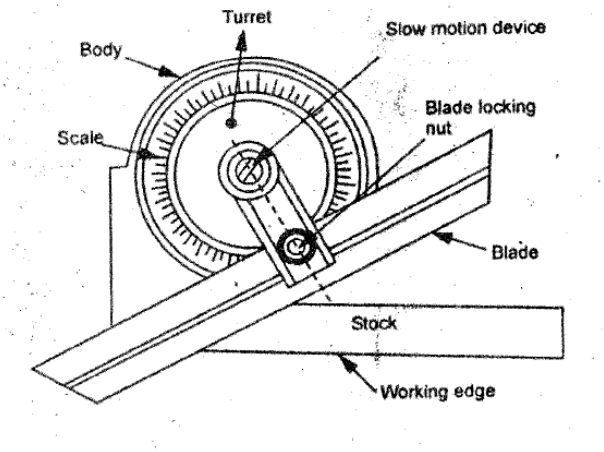
There are a wide variety of geometric features that are measured in angular inits. These varieties include angular separation of bounding planes, angular spacing conditions related to circle, digression from a basic direction etc. because of these diverse geometrical forms, different types of methods and equipment are available to measure angles in common angular units of degree, minute and second. Several factors come into picture in selection of suitable angular measuring instruments. These factors may be the size and general shape of the part, the location and angular accessibilities of the feature to be measured, expected range of angle variations, the required sensitivity and accuracy of measurement etc. Because of the different systems and techniques in angular measuring instruments, it is difficult to categorize them completely. As in linear measurement, they can be categorized in two groups. The first one is line standard instrument. It includes divided scales like protractors, bevel gauges. The second category of angular measuring instruments is called face standard instruments. Sine bars and angle gauges falls in this category. In this unit, we will discuss both types of angular measuring devices and the techniques used in determining the angle. In addition to that, we will have an overview of angle comparators (autocollimators).

LINE STANDARD ANGULAR MEASURING DEVICES

Line standard gives direct angular measurement from the engraved scales in the instruments. They are not very precise. Hence they are not used when high precision is required. However, they can be used in initial estimation of the angles in measurement. We will discuss some of the line standard angular measuring devices in the following sub-sections.

Protractors

It is the simplest instrument for measuring angles between two faces. It consists of two arms and an engraved circular scale. The two arms can be set along the faces between which the angle is to be measured. The body of the instrument is extended to form one of the arms, and this is known as the stock. It is the fixed part of the protractor and should be perfectly straight. The other arm is in the form of a blade that rotates in a turret mounted on the body. One of the bodies of the turret carries the divided scale and the other member carries a vernier or index. The ordinary protractor measures angles only in degrees and used for non-precision works. By using angular vernier scale along with it, precision up to 5 can be achieved. Figure 6.1 shows the diagram of a protractor.



Protractor

Universal Bevel Protractors

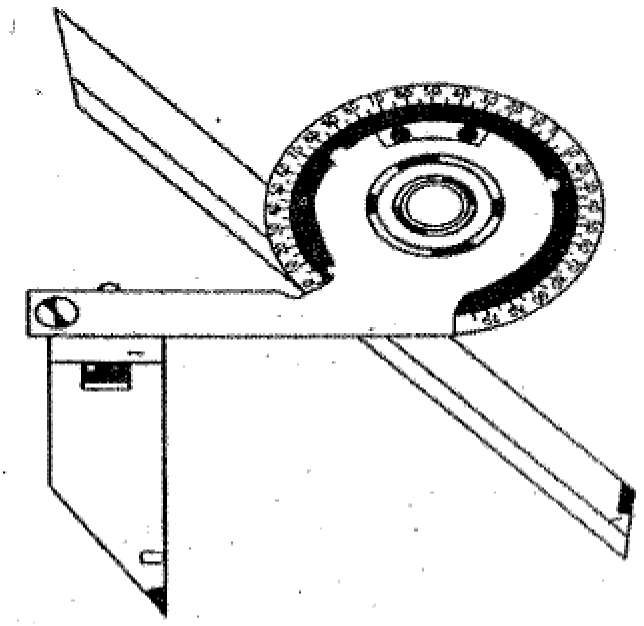
It is an angular measuring instrument capable of measuring angles to within 5 min. The name universal refers to the capacity of the instrument to be adaptable to a great variety of work configurations and angular interrelations. It consists of a base to which a vernier scale is attached. A protractor dial is mounted on the circular section of the base. The protractor dial is graduated in degrees with every tenth degree numbered. The sliding blade is fitted into this dial; it may ba extended to either direction and set at any angle to the base. The blade and the dial are rotated as a unit. Fine adjustment are obtained with a small knurled headed pinion that, when turned, engages with a gear attached to the blade mount The protractor dial may be locked in any position by means of the dial clamp nut.

Measurement in a universal bevel protractor is made either by embracing the two bounding elements of the angle or by extraneous referencing, for example, the part and the instrument resting on a surface plate.

The vernier protractor is used to measure an obtuse angle, or an angle greater than 90° but less than 180°. An acute angle attachment is fastened to the vernier protractor to measure angles of less than 90°. The main scale is divided into two arcs of 180°. Each arc is divided into two quadrants of 90° and has graduation from 0° to 90° to the left and right of the zero line, with every tenth degree numbered.

The vernier scale is divided into 12 spaces on each side of its zero (total 24). The spacing in the vernier scale is made in such a way that least count of it corresponds to 1/12th of a degree, which is equal to 5°.

If the zero on the vernier scale coincides with a line on the main scale, the number of vernier graduations beyond the zero should be multiplied by 5 and added to the number of full degrees indicated on the protractor dial.



A Universal Bevel Protractor

FACE STANDARD ANGULAR MEASURING DEVICES

Face standard angular measuring devices include angle gauges and sine bars.

The measurements are done with respect to two faces of the measuring instruments. Precision obtained in such instruments is more than the precision obtained in line standard angular measuring devices. Some commonly used face standard angular measuring devices are discussed in the following sub¬sections.

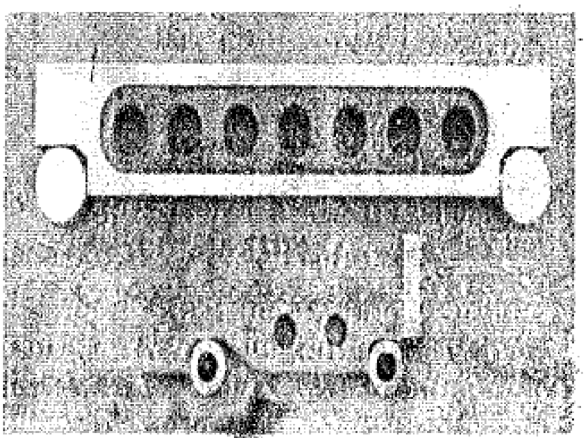
Sine Bar

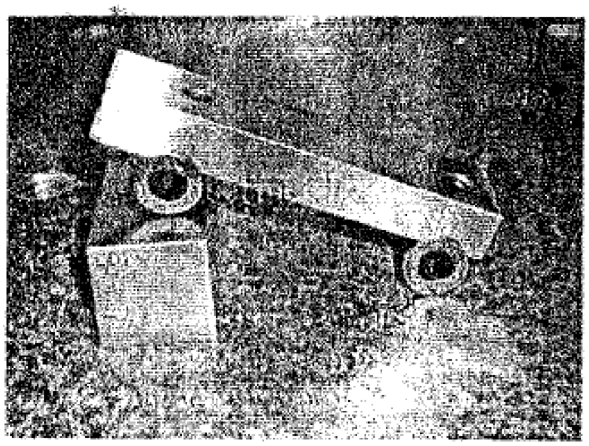
A sine bar is made up of a hardened steel beam having a flat upper surface. The bar is mounted on two cylindrical rollers. These rollers are located in cylindrical grooves specially provided for the purpose. The axes of the two rollers are parallel to each other. They are also parallel to the upper flat surface at an equal distance from it.

Uniike bevel protractors sine bars make indirect measurements. The operation of a sine bar is based on known trigonometric relationship between the sides and the angle of a right angle triangle. Here, dimension of two sides determine the size of the third side and of the two acute angles. The accuracy attainable with this instrument is quite high and the errors in angular measurement are less than 2 seconds for angle up to 45°. Generally, right-angled triangle is obtained by using a horizontal and precise flat plate on which gage blocks ar^ stacked in the direction normal to the plane of the plate.

Sine block itself is not a measuring instrument. It acts as an important link in the angle measuring process. The actual measurement consists in comparing the plane of the part's top element to the plane of supporting surface plate. Mechanical or electronic height gauges are essentially used in the process.

The sine principle uses the ratio of the length of two sides of a right triangle in deriving a given angle. The measurement is usually limited to 45°from loss of accuracy point of view.



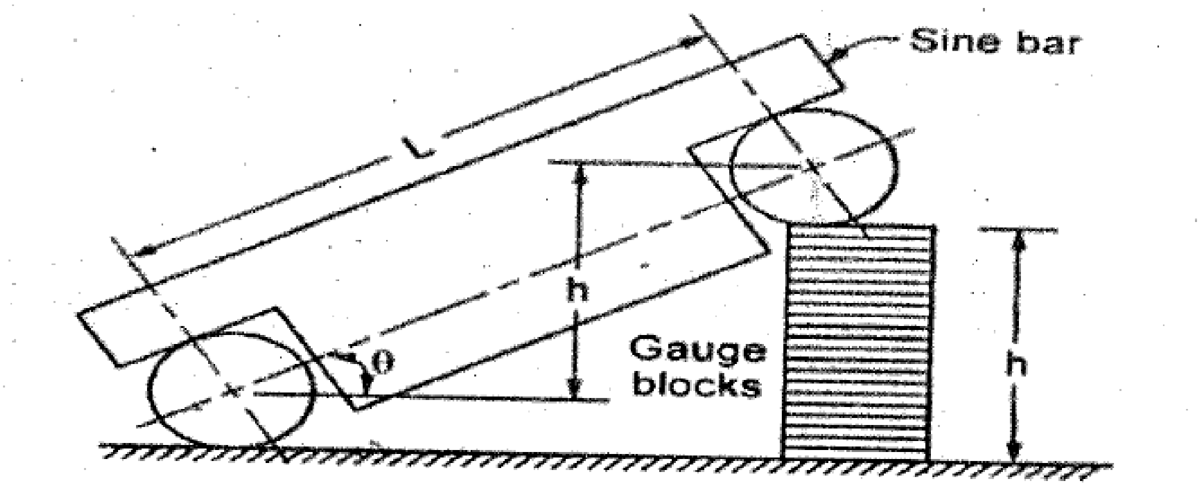


A

Sine Bar

The figure below shows the schematic diagram of a sine bar. It is specified by the distance between the two centres of two rollers. The high degree of accuracy and precision available for length measurement in the form of slip and block gauges may be utilized for measurement of angle using the relationship as shown in Figure.

$sin\theta = h/l$



Use of Sine Bar for Angle Measurement

Apparently, the accuracy of angle measurement depends upon the accuracy with which length L, of the sine bar and height h under the roller is known. Since the gage blocks incorporate a very high degree of accuracy, the reliability of angle measurement by means of sine bar depends essentially on the accuracy of the sine bar itself.

Now, differentiating h with respect to θ, we have

$$cos\theta = \frac{1}{L} \cdot \frac{dh}{d\theta}$$

$$\frac{dh}{d\theta} = \frac{1}{Lcos\theta} = \frac{sec\theta}{L}$$

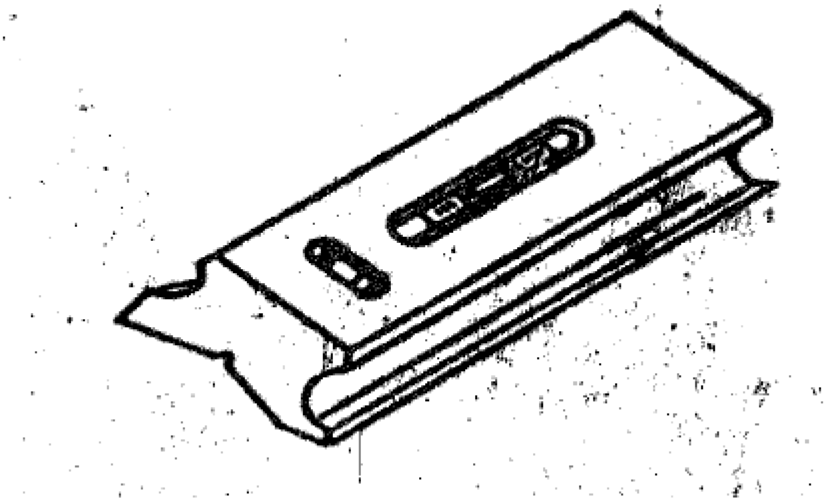
Therefore, the error in angle measurement $d\theta$, due to an error, dh in height h is proportional to sec θ. Now sec θ increases very rapidly for angle greater than 45°. Therefore, sine bars should not be used for measurement of angles greater than 45° and if at all they have to be used, sine bars should measure the complement of the angle rather than the angle itself.

MEASUREMENT OF INCLINES

Inclination of a surface generally represents its deviation from the horizontal or vertical planes. Gravitational principle can be used in construction of measurements of such inclinations. Spirit levels and clinometer are the instruments of this category. We will discuss these instruments in brief in the following sub-sections.

Spirit Level

Spirit level is one of the most commonly used instruments for inspecting the horizontal position of surfaces and for evaluating the direction and magnitude of minor deviation from that nominal condition, ft essentially consists of a close glass tube of accurate form which called as vial. It is filled almost entirely with a - liquid, leaving a small space for th§ formation of an air or gas bubble. Generally, low viscosity fluids, such as ether, alcohol or benzol, are preferred for filling the vial. The liquid due to its greater specific weight tends to fill the lower portion of the closed space. Upper side of the vial is graduated in linear units. Inclination of a surface can be known from the deviation of the bubble from its position when the spirit level is kept in a horizontal plane. Temperature variations in the ambient condition cause both liquid and vial to expand or contract. Therefore, selection of proper liquid and material for the spirit level is very important for accurate result. To reduce the effect of heat transfer in handling spirit levels are made of a relatively stable casting and are equipped with thermally insulated handles.



A Spirit Level

Sensitivity of the vial used in spirit level is commonly expressed in the following two ways.

Each graduation line representing a specific slope is defined by a tangent relationship, e.g. 0.01 cm per meter.

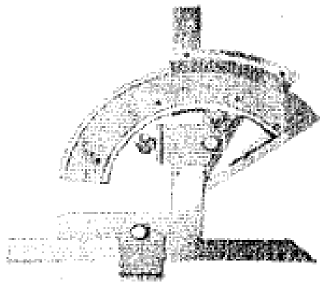
An angular value is assigned to the vial length covered by the distance of two adjacent graduation lines, i.e. the distance moved by the bubble from the zero will correspond the angle directly.

Protractor

Engineer's Protractor

Engineer's protractor is a general purpose tool used for the measuring / checking of angles e.g. the angle of drill head, angle of cutting tool, and even for the marking out of angles on a component part.

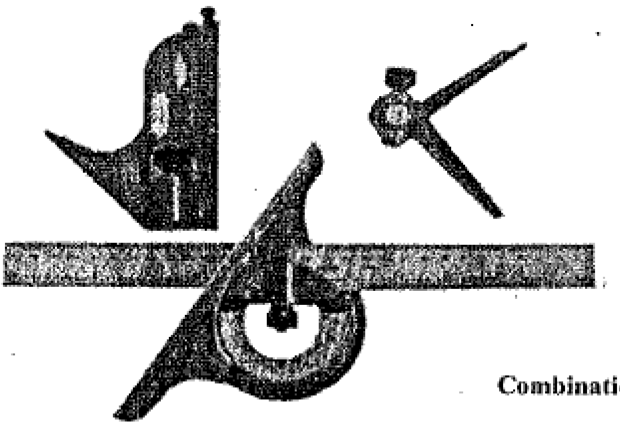
Engineer's Protractor



Vernier Protractor

Combination Set

Combination set is a set of equipment combining the functions of protractor, engineer square, steel rule, Centre finder, level rule, and scriber.



Combination Set

Sample Questions

I. 1. Describe different types of protractors for measuring the angular dimensions.

II. 2. Students should be given different samples of work pieces and be made to select the most appropriate angular measuring tool for the job

III. 3. Students should be given work pieces of know distance to measure using any of the various tools describe in this section

IV. 4. Students should use sine bars to determine the angle of an inclined plane

V. 5. Describe the principles of operation of a spirit level

TRANSISTOR CHARACTERISTICS

CODE EE302

APPARATUS/ EQUIPMENTS:

- D. C. Power Supply Units (2-No.)

-MicrovoltmeterPM2434 (2-No.)
-Ammeter(0 30mA) (1-No.)

-Testing Unit.

PROCEDURE:

1. SET-UP

1.1 Read and understand the operating instructions for the d. c. microvoltmeter PM2434.

(a) Set-up the microvoltmeter for d. c. voltage measurement.

(b) Set the range selector to 10 .V range.

1.2 Connect up the ammeter, microvoltmeter, and the d. c. power supplies as shown in the working diagram Fig. 302 1.

1.3 Before switching on the d. c. power supplies, turn their level controls (coarse and fine) to minimum, i.e. fully anti-clockwise.

1.4 Switch on both a. c. and d. c. power to the system. Switch on the microvoltmeter.

READINGANDRECORDINGOFDATA

NOTES:

A transistor collector relates collector current (I_c) for a given value of base current (I_B). In this experiment, the base current is not measured directly. It is obtained by measuring the potential (V_1) across the base resistor 100 K.ohm) and applying OHM's law. Collector current (I_c) is measured by A_2 and V_{ce} by V_2.

2.1 For each given value of V_1 (Table 302-1) measure and record.

(a) Emitter Base potential V_1 using microvoltmeter V_2 for this measurement.

(b) Collector currents (A_2) for given values of V_2. Note that the setup requires you to press switch S W to read A_2.

2.2 Calculate and record the value of IB (= V ,/l 00/micro-amperes).

3.1 Plot the collector characteristics ($I_c V_{ce} cur\,v\,e$) for the transistor.

3.2 Plot the input characteristics ($I_B V_{BE} cur\,v\,e$) for the transistor.

Sketch the working diagram for determining the characteristics of a NPN transistor, showing the polarities of instruments and power supplies.

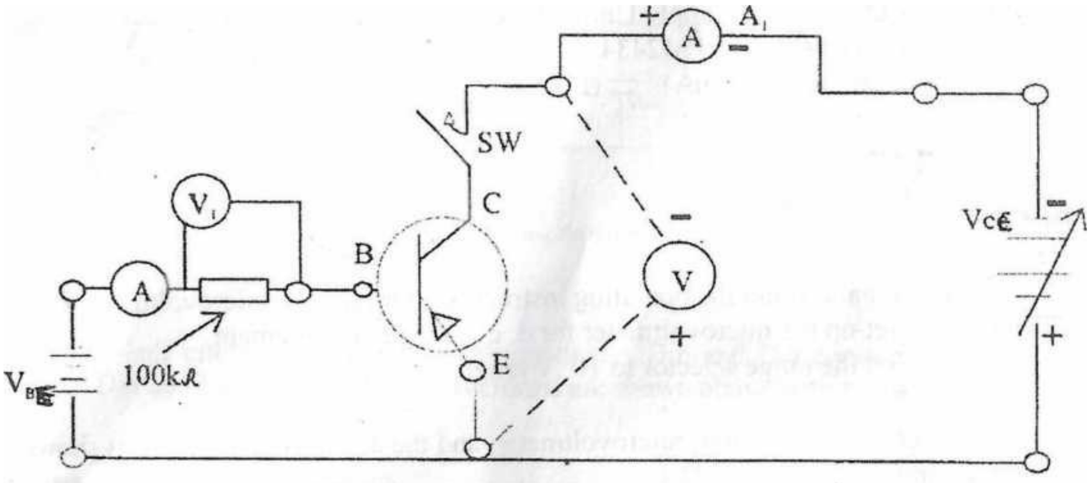


Fig. 302 I Working Diagram

TABLE 302 1

$V_{BE} V_I I_I$ (v)(V)(MA)	$V_{CE}=V_1$		
0			
1	x.		
2			
3	TOR		
4	RANS1S'		
5	YPE NO		

TRANSISTOR AMPLIFIERSEXPERIMENT 303

AIM: To design and construct a transistor amplifier.

APPARATUS/ EQUIPMENTS:

Transistor n-p-n-type BCY30-2

Resistor 2,2K-1
Resistor 1,8K-1
Resistor 390-1
Capacitor 05KF-1
Capacitor 1-1
D.C. Supply unit 12V
D.C. voltmeter
V.T.V.M

THEORY:

In order to utilize the transistor in the C. E. configuration, the base emitter junction is forward biased and a load resistor is connected to the collector as shown in Fig. 303 1.

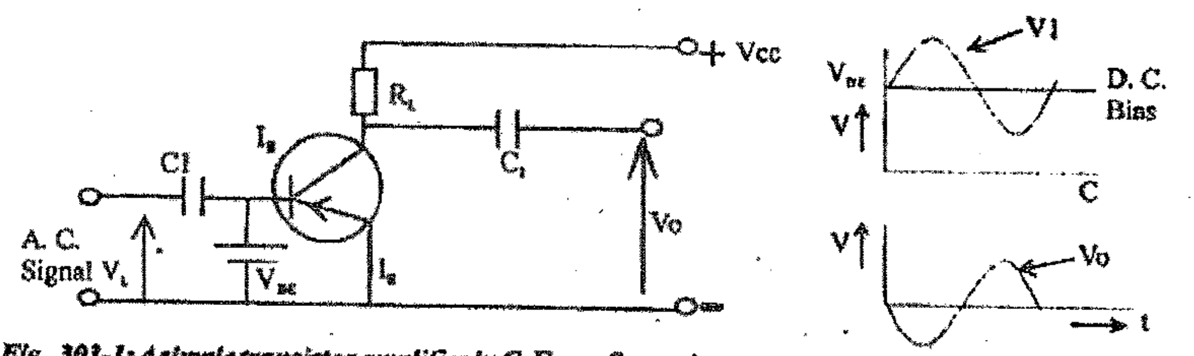


Fig. 303-1: A simple transistor amplifier in C. E. configuration.

The signal source is connected in series with the base connection and the reluctant variation of base current causes changes in collector current. The bias voltage VRE fixes the operating point of the transistor. It is determined graphically by drawing a load line on the static characteristics as shown in Fig. 303.2

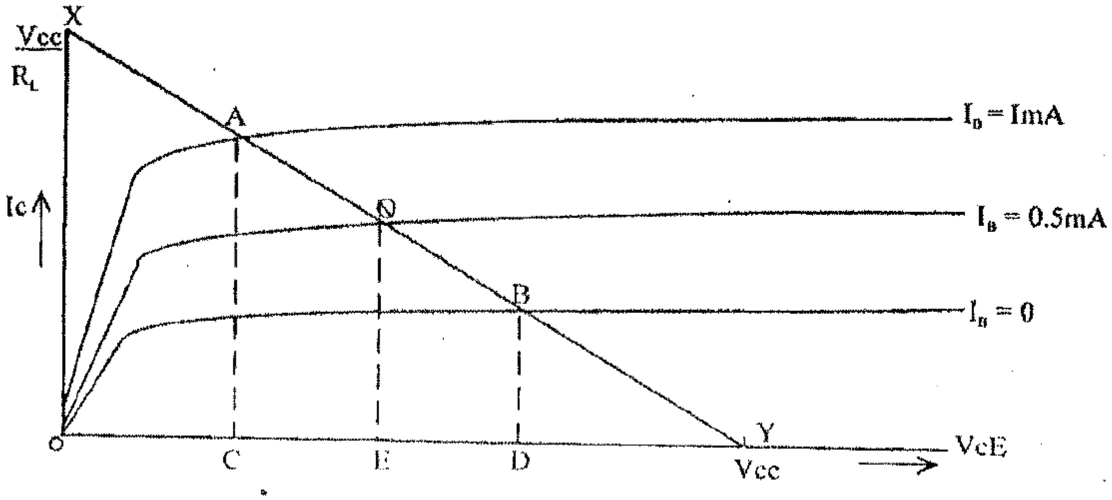


Fig. 303.2 Output characteristics of a transistor with load line. The collector current I_c must satisfy the $V_{CE}=V_0=V_{OC}-1_C R_L$

(when $V_{CE}=O¿I_C=V_{CC}$ (point x in Fig. 302.2)

(when $I_C=O¿V_{CC}=V_{CE}$ E (point Y in Fig. 302.2)

St. line X Y is called the load line. It is the characteristics of collector current vs collector voltage. Its slope is $\frac{-1}{R_L}$The operating bias (IB = 0.5mA) is selected at convenient point Q so that I_C vs V_{CE} characteristics for different values of la are equally spaced for extreme values of hj. if the signal a.c. voltage superimposed on D. C. bias V_{BE} causes base current to vary with a peak value of 0.5mA. The operating bias current will vary from 0 to 1mA as shown by points Aand B on load line. The output voltage varies from OC to OD as shown by C and D on the VCE axis.

When the input signal causes In to increase, I_C increases so that voltage drop $I_C R_L$ increases. The ouput voltage $V_{CE}=V_{CC} I_C R_L$ decreases. There is 180O phase difference between output voltage and input signal. If the base bias is a direct D. C. voltage source as shown in Fig. 303,1, it does not compensate for changes in transistor characteristics, supply voltage and temperature. That is why automatic base bias circuits as shown in Fig. 303.3 are normally used.

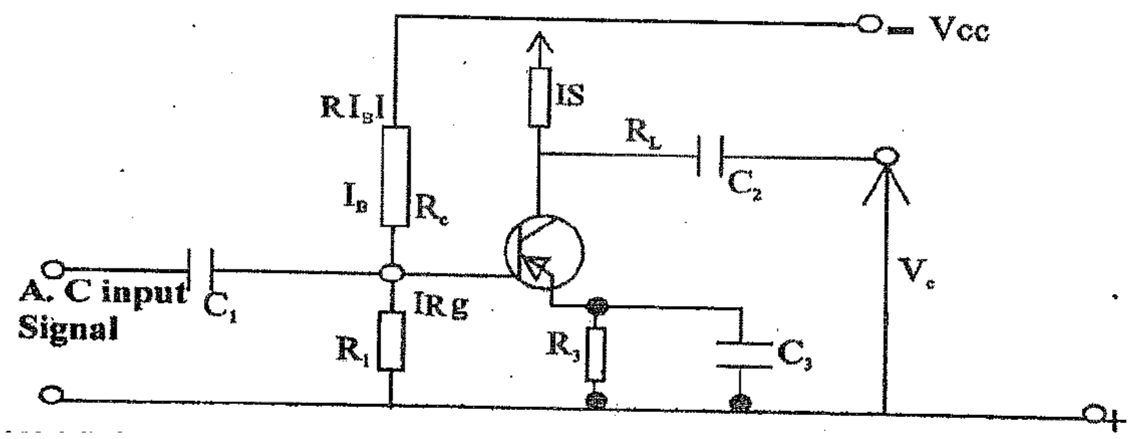


Fig 303.3 Stabilized Self-bias

Input signal a. c. is connected through capacitor C, which passes only a. c. signals. Similarly output signal is taken through capacitor C_2. D. C. voltages are provided from D. C. sourceV_{BE}. Since T is a p-n-p transistor collector is reverse-biased by V_{CC}. R_1 and R_2constitute a voltage divider which establishes the direct voltage of the transistor base. Base current flowing through R_2 is negligible compared with the current supplied through $R_1$and $R_2$by V_{CC} and therefore the potential of the base remains constant, independent of base current. Collector current I_C flows around the loop of R_1 and R_3 and *rc* and *r* of the transistor. The collector resistance *r*, is temperature sensitive. Suppose temperature increases, decreasing r_C thus causing I*r* to increase. Voltage drop $I_r R_3$ increases. Emitter base voltage (V_{BE} = $I_1 R_3 I_1 R_3$) is decreased. This decreases I_B and I_{CE}. Thus temperature changer of I_C are compensated. In order that this *I*, and R_3 drop may not reduce a. c. signals R_3 for a. c. signals we put C_3 across R_3.

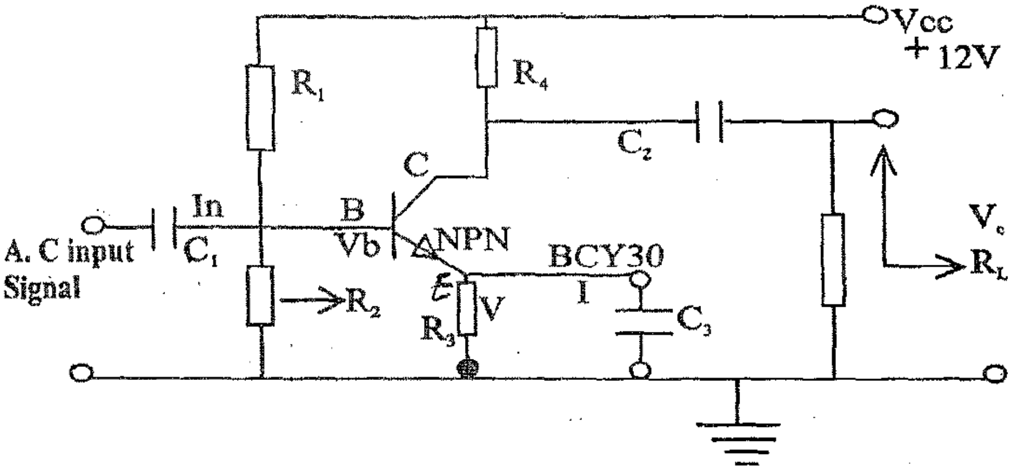
PROCEDURE

To design a common emitter R. C. Amplifier for BCY30 Transistor (Silicon n- p-n).

$h_{Hc} = 1.5\,k\,h_{21c} = 49\,h_{22} = 50 \times 10_6$ for silicon input resistance = 2.5 k ohm.

output resistance = 70 k ohm.

Consider the transistor R. C. Amplifier (i.e. Resistance Capacitance Coupled). Shown in Fig.303.4



Fig, 303.4 R. C, Coupled n-p-n Transistor Amplifier.

For static curves operating point is selected $I_E\, ImA, \wedge V_E = IV$

For silicon base emitter voltage is 0.7.

$V_B = V_E + 2V_{20E} = 1 + 0.7 = 1.7\,V$

$$V_B = \frac{V_{CC} R_2}{R_1 + R_2}$$

For $V_{CC} = 12\,V\; V_B = 1.7\,V$

$R_1 = 70\,K\; R_2 = 10\,K$

The Collector quiescent current = 1 mA.

For load line of R_L = 15000 ohms

$Vc =$ 7V

$$R4 = \frac{V_{CC} V_C}{I_C} = \frac{127}{10^{-3} A} = 5 \times 10^3\, ohms$$

$C_1 = C_2 = 100\,MP$

$$R_3 = \frac{IV}{1\,mA} = 1\,k$$

$C_3 = 250\, MP¿$

Q (la) Write a brief theory of transistor as a Amplifier

Connect the Transistor Circuit as shown in Fig. 303.4. Connect a signal of 1000Hz from signal generator to input points and see the output on an oscilloscope.

(1b)Draw the circuits diagram of an NPN Transistor Amplifier and explain its principle and explain its principle of operation.

(1c)Trace the curves on the graph sheet and show their amplitudes.

(1d)Calculate the gain from your reading.

Given below is the speech amplifier in a Walkie Talkie

Q (2a) Explain the working of each part?

Questions:

(i) Given below is the speech amplifier in a walkie talkie

Explain the working of each part.

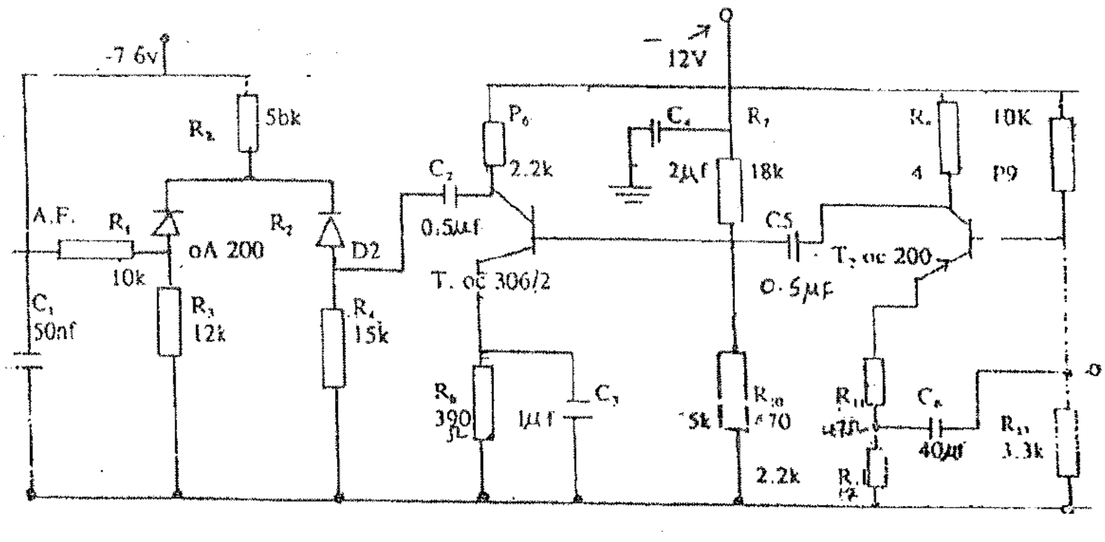


Fig 303-5 Speech Amplifier for Walkie Talkie

Note: it is a two state amplifier. Diodes are used as clamping circuits.

$C_6$and $R_{11}$are for feedback

(i) What are the main differences in a circuit using an n-p-n from that of p-n-p transistors?

References

(1) “Electronic Devices and Circuits” by P. McGraw Hill 1969 J. Hillmar and C. C. Halkias

(2) “Transistor Circuit Analysis and Design” by P. C. Fitchen O. Van Nostrend

2(b) What are the main differences in a circuit using an n-p-n from that of p-n-p with transistors with symbols

2(c) What are the differences between common Base: Common Collector and Common Emitter Amplifier, with diagrams?

3(a) Name five (5) applications of a Transistors Amplifier

(b) What are your Observation?

(c) Draw a D. C- Load line...

(d) What is your Conclusion?

References

(1) “Electronic Devices and Circuits” by P. McGraw Hill 1969 J. Hillmar and C. C. Halkias

(2) “Transistor Circuit Analysis and Design” by P. C. Fitchen O. Van

(3) Electronics Systems Part II and Third Year by G. N. Patchett.

(3a) Name five (5) applications of a Transistor Amplifier

(3b) What are your Observation?

(3c) Draw a D.C. Load line

(3d) What is your Conclusion?