



# STUDENT HAND BOOK

Polytechnic

Semester- 3<sup>rd</sup>

Study Scheme- 2010 onwards

DEPARTMENT OF MECHANICAL ENGINEERING  
ASRA COLLEGE OF ENGINEERING & TECHNOLOGY  
BHAWANIGARH (SANGRUR)

## Department of Mechanical Engineering

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## 3.1 COMPUTER APPLICATIONS IN MECHANICAL ENGINEERING

### DETAILED CONTENTS

L T P

3 – 2

#### 1. MS Power Point

(16 hrs)

- 1.1 Creating a presentation: using the auto content, wizard, using a template, creating a blank presentation.
  - Saving the presentation.
  - Power point's five views: slide view, outline view, slide sorter view, notes page view, slide show view.
  - Creating and editing slides.
- 1.2 Developing your presentation.
  - Changing the layout of a slide.
  - Modifying a slide master.
  - Changing the design template.
  - Outlining your presentation - creating a presentation from a word outline.
  - Rearranging your slides.
  - Previewing your slide show.
- 1.3 Bringing a presentation to life.
  - Inserting objects in your presentation like graph/chart from excel, pictures, sound, video clip and organization chart
  - Drawing objects in power point: Auto shapes, other objects repositioning, resizing and aligning.
  - Objects, working with border fills, shadows and 3-D effects, selecting and grouping objects.
  - Animating an object: setting preset animations, setting custom animations, playing a sound or video clip.
- 1.4 Analyzing the presentation: assigning transitions and timings, creating build slides, creating hidden slides, setting slide timings when rehearsing
- 1.5 Setting up the slide show

#### 2. MS Access

(08 hrs)

Introduction to databases and MS-access, Creating a new database, opening and moving around an existing database, adding new data and editing a database table, displaying and searching for data, printing data from an access database, creating reports in access

#### 3. Programming Fundamentals

(08 hrs)

- 3.1 Algorithm, pseudo language, flow charts; advantages and disadvantages
- 3.2 Decision Table-type, advantages and disadvantages.
- 3.3 Structured programming, structuring the control flow, modular programming
- 3.4 Exercise on making Algorithm and flow charts.

#### 4. C ++ Programming

(16 hrs)

- 4.1 Fundamentals Introduction, OOP, character set , C++ tokens, keywords, identifiers, constants, basic data type, declaration of variables, defining symbolic constants,

assignment statement, comments in a programme, structure of c++programme, output using COUT, output using CIN, manipulators.

#### 4.2 Operators and Expressions

Arithmetic operators, relational operators, logical operators, shorthand assignment operator, increment and decrement operators, conditional operators, bit wise generators, precedence in C++ operators. Casting of data, standard mathematical functions.

#### 4.3 Control Structures

If statements, IF-ELSE statements, nested IF statement, switch statements, go to statements, repetitive structures, while statements, do statement, for loop, break statement, continue statement, nested loops.

### **LIST OF PRACTICALS**

1. Exercise on MS-Power Point
2. Exercise on MS-Access.
3. Write a program to check if a number is even or odd
4. Write a program to find the smallest of 3 members
5. Write a program to find longest of 4 members
6. Write a program to find the roots of quadratic equation.
7. Write a program to find the sum of the first N natural numbers using a for-do doops.
8. Preparing a project using PowerPoint/Access
9. Write a program that needs N numbers and finds the smallest number among them.
10. Write a program to find the sum of squares of the digits of number.

#### **Assignment-1**

- Q:1 What you mean by templates ?
- Q:2 Explain in brief the steps of creating a program.
- Q:3 Write steps to include headers and footers in presentation.
- Q:4 What you mean by algorithm?
- Q:5 Explain flow chart symbols in detail.

#### **Assignment-2**

- Q:1 Define Is Presentation Software ?
- Q:2 What Are The Features Of PowerPoint ?
- Q:3 What Are The Steps To Move Text In Power Point ?
- Q:4 Explain In Steps Of Program Development.
- Q:5 Explain The Use Of Decision Tables.

### Assignment-3

Q:1 What you mean by oops ?

Q:2 What is the difference between procedural and oops?

Q:3 Explain in detail data abstraction data encapsulation and inheritance.

Q:4 What you mean by polymorphism ?

### Assignment-4

Q:1 how will you update data in a table ?

Q:2 Explain the different types of relations supported by access? ?

Q:3 Explain the steps to create relationships ?

Q:4 what are the steps to create forms in design view?

### Assignment-5

Q:1 What Is The Use Of Assignment Operator ?

Q:2 Explain The Different Arithmetic Operators Supported By C++.

Q:3 Explain The Various Relational Operators Of C++.

Q:4 Calculate The Amount That Will Be Returned To The Depositor After Taking The Principal Amount , Rate Of Interest , Duration From The User.

Q:5 WAP To Calculate The Total Salary Of An Employ By Reading The Basic Salary And Adding Allowances .

## PRACTICAL PROBLEMS ON C++

### 1. Write a program to check if a number is even or odd.

```
#include<iostream.h>
#include<conio.h>
void main()
{
int num;
cout<<"\n Enter a number";
cin>>num;
if(num%2 == 0)
cout<<"\nThe number is Even";
else
cout<<"\nThe number is Odd";
getch();
}
```

**2. Write a program to find the smallest of 3 numbers**

```
#include<iostream.h>
#include<conio.h>
void main()
{
int n1,n2,n3,small;
small=0;
cout<<"\nEnter 3 numbers";
cin>>n1>>n2>>n3;
    if((n1<n2)&&(n1<n3))
        cout<<"n1 is smallest";
    else if((n2<n1)&&(n2<n3))
        cout<<"n2 is smallest";
    else if((n3<n1)&&(n3<n2))
        cout<<"n3 is smallest";

getch();
}
```

**3. Write a program to find the largest of 4 numbers.**

```
#include<iostream.h>
#include<conio.h>
void main()
{
int n1,n2,n3,n4,small;
small=0;
cout<<"\nEnter 4 numbers";
cin>>n1>>n2>>n3>>n4;
    if((n1>n2)&&(n1>n3)&&(n1>n4))
        cout<<"n1 is largest";
    else if((n2>n1)&&(n2>n3)&&(n2>n4))
        cout<<"n2 is largest";
    else if((n3>n1)&&(n3>n2)&&(n3>n4))
        cout<<"n3 is largest";
    else if((n4>n1)&&(n4>n2)&&(n4>n3))
        cout<<"n4 is largest";

getch();
}
```

4. Write a program to find the sum of first N natural numbers using for – do loop.

```
#include<iostream.h>
#include<conio.h>
void main()
{
int i, sum=0,num;
cout<<"How many numbers to add ???";
cin>>num;
    for(i=1;i<=num;i++)
        sum+=i;
cout<<"\nThe sum of "<<num<<" numbers is"<<sum;
getch();
}
```

5. Write a program to find the sum of squares of the digits of a number.

```
#include<iostream.h>
#include<conio.h>
void main()
{
int i,n,num,small=1;
cout<<"\nEnter how many numbers to enter ";
cin>>n;
cout<<"Enter the number";
cin>>num;
small=num;
    for(i=1;i<n;i++)
    {
        cout<<"\nEnter the number";
        cin>>num;
        if(num<small)
            small=num;
    }
cout<<"\nThe smallest number is "<<small;
}
```

6. Write a program to sum the digits of an entered number.

```
#include <iostream.h>
```

```
#include <conio.h>
```

```
void main()
```

```
{
```

```
int num,rdigit,sum=0;
```

```
cout<<"\n Enter a number";
```

```
cin>>num;
```

```
while(num>0)
```

```
{
```

```
rdigit=num%10;
```

```
sum +=rdigit*rdigit;
```

```
num=num/10;
```

```
}
```

```
cout<<"\n The sum of squares of the number is "<< sum;
```

```
}
```

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## 3.2 APPLIED MECHANICS

### DETAILED CONTENTS

L T P

3 – 2

#### 1. Introduction (04 hrs)

- 1.1 Concept of engineering mechanics definition of mechanics, statics, dynamics, application of engineering mechanics in practical fields. Definition of Applied Mechanics.
- 1.2 Definition, basic quantities and derived quantities of basic units and derived units
- 1.3 Different systems of units (FPS, CGS, MKS and SI) and their conversion from one to another for density, force, pressure, work, power, velocity, acceleration
- 1.4 Concept of rigid body, scalar and vector quantities

#### 2. Laws of forces (09 hrs)

- 2.1 Definition of force, measurement of force in SI units, its representation, types of force: Point force/concentrated force & Uniformly distributed force, effects of force, characteristics of a force
- 2.2 Different force systems (coplanar and non-coplanar), principle of transmissibility of forces, law of super-position
- 2.3 Composition and resolution of coplanar concurrent forces, resultant force, method of composition of forces, laws of forces, triangle law of forces, polygon law of forces - graphically, analytically, resolution of forces, resolving a force into two rectangular components
- 2.4 Free body diagram
- 2.5 Equilibrant force and its determination
- 2.6 Lami's theorem (concept only)

*[Simple problems on above topics]*

#### 3. Moment (09 hrs)

- 3.1 Concept of moment
  - 3.2 Moment of a force and units of moment
  - 3.3 Varignon's theorem (definition only)
  - 3.4 Principle of moment and its applications (Levers – simple and compound, steel yard, safety valve, reaction at support)
  - 3.5 Parallel forces (like and unlike parallel force), calculating their resultant
  - 3.6 Concept of couple, its properties and effects
  - 3.7 General conditions of equilibrium of bodies under coplanar forces
  - 3.8 Position of resultant force by moment
- [Simple problems on the above topics]*

#### 4. Friction (09 hrs)

- 4.1 Definition and concept of friction, types of friction, force of friction
- 4.2 Laws of static friction, coefficient of friction, angle of friction, angle of repose, cone of friction

- 4.3 Equilibrium of a body lying on a horizontal plane, equilibrium of a body lying on a rough inclined plane.
- 4.4 Calculation of least force required to maintain equilibrium of a body on a rough inclined plane subjected to a force:
- Acting along the inclined plane Horizontally
  - At some angle with the inclined plane

## **5. Centre of Gravity (08 hrs)**

- 5.1 Concept, definition of centroid of plain figures and centre of gravity of symmetrical solid bodies
- 5.2 Determination of centroid of plain and composite lamina using moment method only, centroid of bodies with removed portion
- 5.3 Determination of center of gravity of solid bodies - cone, cylinder, hemisphere and sphere; composite bodies and bodies with portion removed

*[Simple problems on the above topics]*

## **6. Simple Machines (09 hrs)**

- 6.1. Definition of effort, velocity ratio, mechanical advantage and efficiency of - a machine and their relationship, law of machines
- 6.2. Simple and compound machine (Examples)
- 6.3. Definition of ideal machine, reversible and self locking machine
- 6.4. Effort lost in friction, Load lost in friction, determination of maximum mechanical advantage and maximum efficiency
- 6.5. System of pulleys (first, second, third system of pulleys), determination of velocity ratio, mechanical advantage and efficiency
- 6.6. Working principle and application of wheel and axle, Weston's Differential Pulley Block, simple screw jack, worm and worm wheel, single and double winch crab. Expression for their velocity ratio and field of their application

*[Simple problems on the above topics]*

## **LIST OF PRACTICALS**

- Verification of the polygon law of forces using grave sand apparatus.
- To verify the forces in different members of jib crane.
- To verify the reaction at the supports of a simply supported beam.
- To find the mechanical advantage, velocity ratio and efficiency in case of an inclined plane.
- To find the mechanical advantage, velocity ratio and efficiency of a screw jack.
- To find the mechanical advantage, velocity ratio and efficiency of worm and worm wheel.
- To find mechanical advantage, velocity ratio and efficiency of single purchase crab.
- To find out center of gravity of regular lamina.
- To find out center of gravity of irregular lamina.
- To determine coefficient of friction between three pairs of given surface.

### **Assignment No. 1**

- Q.-1 Define mechanics and applied mechanics.
- Q.-2 Differentiate between mass and weight.
- Q.-3 Write a short note on Vector Quantities.
- Q.-4 Discuss Lami's Theorem.
- Q.-5 Explain the concept of "Free Body Diagram".
- Q.-6 Find the components of a force of 500 N into two directions inclined at an angle of  $45^\circ$  &  $30^\circ$  with the force.

### **Assignment No. 2**

- Q.-1 State the laws of Moments.
- Q.-2 What is Couple? Mention important properties of couple.
- Q.-3 What are the units of moment? Definition of Varignon's theorem.
- Q.-4 A uniform rod 1 meter long is supported on two pegs, so that the right side of the rod overhangs by 200mm. Find out the reaction at the pegs, if weight of rod is 4 N/cm length of rod.
- Q.-5 Find out the resultant of parallelogram Law of forces methods.

### **Assignment No. 3**

- Q.-1 Define Friction, Co-efficient of Friction and limiting friction
- Q.-2 State the 'Laws of Solid Friction'
- Q.-3 Explain the methods to reduce friction.
- Q.-4 Discuss the advantages and disadvantages of friction
- Q.-5 A pull of 50 N inclined at  $30^\circ$  to the horizontal is necessary to just move a block placed on a horizontal table. If coefficient of friction is 0.2; Find out the weight of the block

### **Assignment No. 4**

- Q.-1 Define centroid and centroidal axes.
- Q.-2 Define
- a.) Axis of symmetry
  - b.) Axis of reference
- Q.-3 Find the C.G. of thin uniform triangular lamina.
- Q.-4 Find the C.G. of thin uniform in shape of trapezium.

## Assignment No. 5

- Q.-1 Definition of mechanical advantage and velocity ratio.  
Q.-2 Definition of ideal machine, reversible and self-locking machine  
Q.-3 Define First System of pulley  
Q.-4 Write working principle and application of worm and worm wheel

## Experiment No. 1

### Object

To verify the law of polygon of forces.

### Apparatus

Wooden board, Pulleys with clamps, threads, paper sheet, drawing pins, weights with pan, mirror strips etc.

### Theory

The law of polygon of forces states that "if a number of coplanar concurrent forces acting on a particle be represented in magnitude and direction by the sides of a polygon, taken in order, then their resultant is represented in magnitude and direction by the closing side of the polygon taken in opposite order."

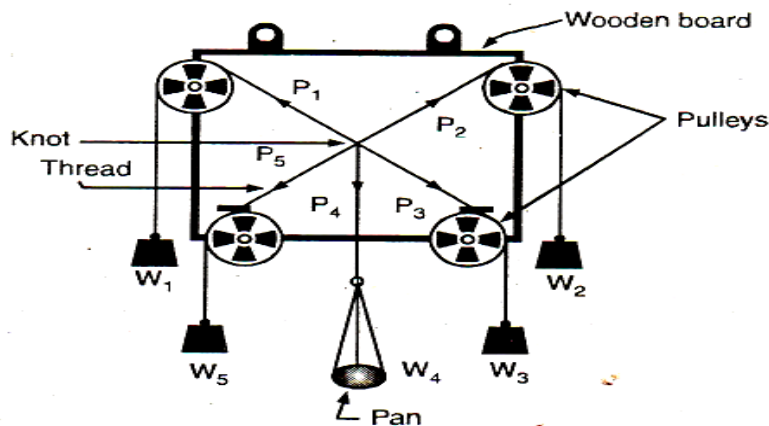


Fig 1.1. Force polygon apparatus

### Procedure

1. Fix the paper sheet on the wooden board with the help of drawing pin.
2. Fix the pulley in the wooden board with the help of the clamps as shown in fig 1.1.
3. Take a thread and pass over two pulleys.
4. Take another thread and tie the middle of this thread to the middle of the first thread and pass the ends of the second thread over another two pulleys.
5. Take the third thread and tie with the other two threads as shown in the fig 1.1.
6. Attach pan to the free end of the third thread and put weights to the free end of other threads.

7. Place the weight in the pan and adjust them in such a way that the knot comes at the centre of the paper and allow the system to come to rest.
8. Place the mirror strip under the threads one by one and mark the point of the thread on the paper.
9. Write down the magnitude of weights near the corresponding thread point on the paper and remove the paper.
10. Produce the lines of forces to meet at o.

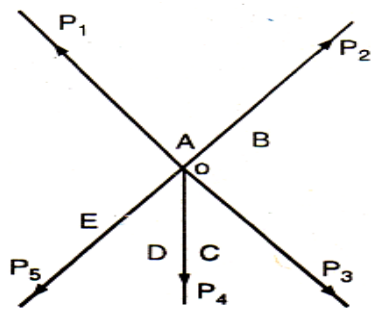


Fig 1.2 Space diagram

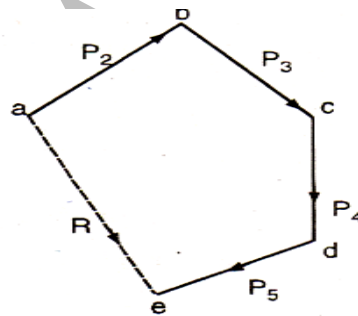


Fig 1.3 Force Polygon

11. Draw ab parallel to AB & cut it equal to force  $P_2$ . Similarly draw lines parallel to BC, CD, DE and lengths equal to  $P_3, P_4, P_5$ .
12. Join ae and measure the length of ae.
13. Convert the length into the force (R) and check whether it is equal to  $P_1$  or not.
14. If R is not equal to  $P_1$  then calculate the error.
15. Repeat the experiment at least three times.

### OBSERVATIONS

Scale..

Sl. No.	Weight suspended (in Kg) or Forces					Calculated Resultant (R)	%Error in 'R' $\frac{R - P_1}{R} \times 100$
	$P_1 = W_1$	$P_2 = W_2$	$P_3 = W_3$	$P_4 = W_4$	$P_5 = W_5$		

### Precautions

1. Pulleys should be lubricated properly to minimise friction.
2. Weights or Pans should not touch the wooden board.
3. Making the lines should be done accurately.

## Experiment No-2

### Object

To verify the forces in the different members of a Jib crane.

### Apparatus

Jib crane apparatus, Spring balance, Weights, metre scale.

### Theory

This experiment is based on the triangle law of forces which states that "if two forces acting simultaneously on a body are represented in magnitude and directions by the two sides of a triangle, taken order, then the third side of the triangle will represent the resultant of the forces in magnitude and directions taken in opposite order."

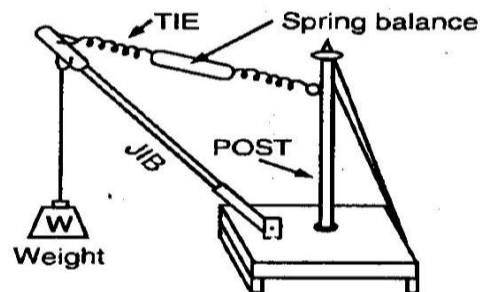


Fig 2.1. Jib crane apparatus

### Procedure

1. Note down the initial readings of the spring balance in the tie member and compression spring of Jib member.
2. Place a weight 'W' in the hook.
3. Note down the final readings of the springs in the Jib and tie member.
4. Subtract the initial readings from the final readings to get the observed values of the forces (say  $F_1$  &  $F_2$ ).
5. Measure the length of the Jib, tie and post after placing the weight 'W'.
6. Draw the space diagram to some convenient scale by using the measured lengths of Jib, tie and post. The diagram represents the three members i.e. Jib, tie and post and also the weight 'W' as shown in the Fig 2.2. Name the members by using Bow's notation as shown in the fig 2.2.
7. Draw the vector diagram to some scale. For this draw a vertical line  $ab =$  weight 'W' (by choosing the scale like  $1\text{kg} = 1\text{cm}$ ). From point 'a' draw a line  $ac$  parallel to  $PR$  and from point 'b' draw a line  $bc$  parallel to  $QR$  of the space diagram.
8. Measure line  $ac$  and  $bc$  and convert into weight scale-(by using the same scale i.e  $1\text{kg} = 1\text{cm}$ ). Thus the line  $ac$  and  $bc$  so measured will represent the forces in the Tie and Jib members respectively. This gives the calculated values of forces in the Tie and Jib member.
9. Repeat the experiment at least three times by using different weights.

### Observations

SI. No.	Weight 'W' in Kg	Length			Initial readings (1)		Final readings (2)		Observed forces (2)-(1)		Calculated Forces (graphically)		% Error	Remarks
		Tie	Jib	Post	Tie	Jib	Tie	Jib	Tie	Jib	Tie	Jib		
					(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	

### Calculation

$$\% \text{ Error in Tie member} = \frac{F_t - F_{tc}}{F_t} \times 100$$

$$\% \text{ Error in Jib member} = \frac{F_j - F_{jc}}{F_j} \times 100$$

### Result

Mean % error in Tie member =

Mean % error in Jib member =

### Precautions

1. The initial & final readings of the Tie and Jib member should be taken carefully.
2. The length of Jib, tie and post should be measured accurately.
3. The space and vector diagram should be drawn correctly and accurately.
4. The proper functioning of the spring balance in tie and compression spring in Jib is to be checked before the start of the experiment.

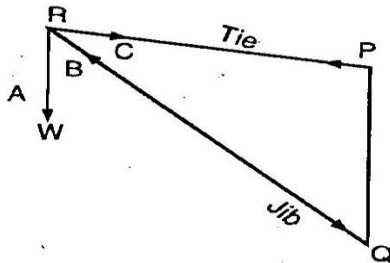


Fig. 2.2 Space diagram

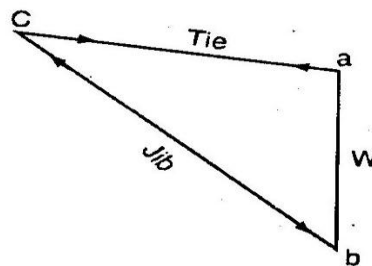


Fig. 2.3 Vector diagram

### QUESTIONS FOR VIVA

1. State the principle on which the experiment of Jib crane is based.
2. What is the practical significance of this experiment?
3. Which member is in tension and which is in compression?
4. What can be the sources of error in this experiment?

# Experiment No-3

## Object

To determine the reactions at the supports of a simply supported beam.

## Apparatus

Simply supported beam, sliding hooks, weights, metre scale.

## Theory

This experiment is based on the 'Principle of moments' which states that if a body is in static equilibrium under the action of coplanar forces, the algebraic sum of moments of all the forces about a point in their plane is zero.

Taking moment of all the forces about A

$$\Sigma M_A = 0$$

$$\therefore R_B \times l = W_1 X_1 + W_2 X_2$$

[Where  $R_A$  &  $R_B$  be the reactions at the supports]

$$\text{or, } R_B = \frac{W_1 X_1 + W_2 X_2}{l}$$

$$\text{Again } R_A + R_B = W_1 + W_2$$

$$\therefore R_A = (W_1 + W_2) - R_B$$

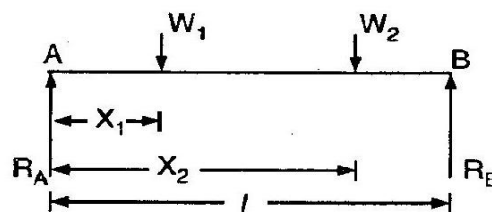


Fig. 3.1 Line diagram of the apparatus

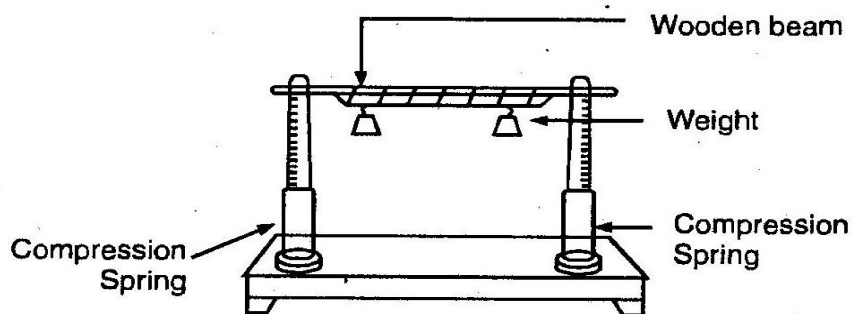


Fig 3.2 Simply supported beam apparatus

### Procedure

1. First measure the length of the beam 'l'.
2. Note down the initial readings of the compression springs fitted at the support A and B.
3. Place the loads,  $W_1$  &  $W_2$  on the sliding hook and measure the distance of  $W_1$  and  $W_2$  from A i.e., measure  $x_1$  &  $x_2$ .
4. Note down the final readings of the compression springs at A and B.
5. The difference of final reading and initial reading of the compression springs at A and B will give the practical value of  $R_A$  and  $R_B$ .
6. Repeat the experiments at least three times by using different loads at different points.

### Observations

Sl. No.	Length of the beam (l)	Distance of Load from A		Initial reading of the springs at		Final reading of the springs at		Practical values of reactions		Theoretical values of reactions		% Error in	Remarks (if any)
		$X_1$ (kg)	$X_2$ (kg)	A (kg)	B (kg)	A (kg)	B (kg)	$R_A$ (kg)	$R_B$ (kg)	$R_{A1}$	$R_{B1}$		
1.													
2.													
3.													

### Calculations

Theoretical values of reactions

$$R_{B1} = \frac{W_1 X_1 + W_2 X_2}{l}$$

$$\& R_{A1} = (W_1 + W_2) - R_{B1}$$

$$\% \text{ Error in } R_A = \frac{R_A - R_{A1}}{R_A} \times 100$$

$$\text{and } \% \text{ Error in } R_B = \frac{R_B - R_{B1}}{R_B} \times 100$$

### Result

Mean Percentage error in  $R_A$  ...

Mean percentage error in  $R_B$  ...

### Precautions

1. Readings of the compression spring at A & B should be noted accurately.
2. The length of beam (l) should be measured accurately.
3. The distance  $X_1$  and  $X_2$  should be measured accurately.

### QUESTIONS FOR VIVA

1. What is moment?
2. State the principle of moment.
3. What do you mean by a simply supported beam?
4. What do you mean by parallel forces and coplanar forces?
5. What can be the source of error in the experiment?

## Experiment No-4

### Object

To find the mechanical advantage, Velocity ratio and efficiency in the case of inclined plane.

### Apparatus

Inclined plane apparatus, wooden block, weight box, pan, thread and metre scale.

### Theory

Consider a block of weight ' $W$ ' resting on the rough inclined plane at an angle  $\theta$  with the horizontal. Let  $P$  be the effort required to move the block up the inclined plane. If  $P$  moves a vertical distance ' $y$ ', the block moves a distance ' $y$ ' along the inclined plane. But the vertical distance moved by the block is only  $x$  as shown in fig. 4.1.

$$\therefore x = y \sin \theta$$

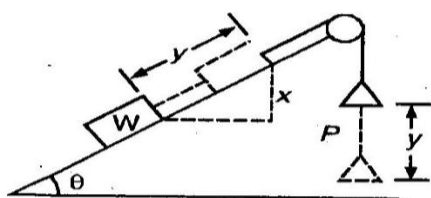


Fig 4.1 line diagram

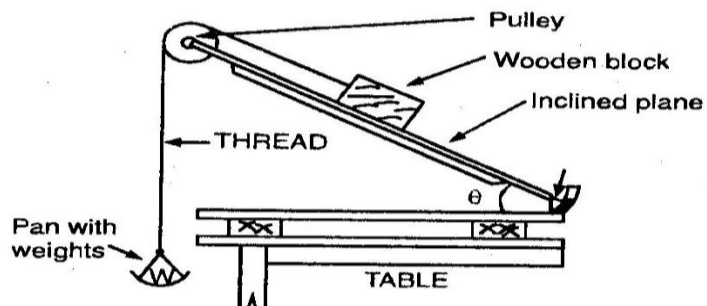


Fig 4.2 Inclined plane apparatus

$\therefore$  Mechanical advantage

$$= \frac{\text{load}}{\text{Effort}} = \frac{W}{P}$$

$$\text{Velocity ratio} = \frac{\text{Distance moved by effort}}{\text{Vertical Distance by load}} = \frac{y}{y \sin \theta}$$

$$\therefore \text{V.R} = \frac{1}{\sin \theta}$$

$$\therefore \text{Efficiency} = \frac{M.A}{V.R}$$

$$\therefore \eta = \frac{W/P}{1/\sin \theta} = \frac{W \sin \theta}{P}$$

### Procedure

1. Set the plane to the desired inclination and note down the angle ( $\theta$ ).
2. Connect the wooden block and pan with a thread.
3. Note down the weight ( $W$ ) of the block and that of the pan ( $W_1$ ).
4. Place the wooden block on the inclined plane and allow the pan to hang freely by passing the thread over the pulley.
5. Now put extra weight on the pan gradually till the block just start moving on the inclined plane.
6. Note down the weights ( $W_2$ ) put on the pan and add it with the weight of the pan ( $W_1$ ) to get the effort ( $P$ ) required to move the block.
7. Calculate the M.A, V.R and efficiency.
8. Repeat the experiment at least three times by varying the angle of inclination ( $\theta$ ).

### Observations

Sl. No.	Weight of block 'w' in Kg	Weight of Pan 'w <sub>1</sub> ' in Kg	Weight added to the pan (w <sub>2</sub> ) (in Kg)	Effort P=(w <sub>1</sub> +w <sub>2</sub> )	Angle of inclination (indegree)	M.A = W/P	V.R.= 1/sin $\theta$	% $\eta$	Remarks

### Calculation

$$M.A = \frac{W}{P}$$

$$V.R = \frac{1}{\sin \theta}$$

### Precautions

1. Lubricate the apparatus before use.
2. Inclined plane should be clean and smooth.
3. The thread should be free from knots.
4. Pulley of the apparatus should move freely.
5. Weight should be put gently on the pan.

### QUESTIONS FOR VIVA

1. Define M.A, V.R and efficiency.
2. What type of machine is the inclined plane?
3. How the angles of inclination is changed in the inclined plane?
4. From where you note down the angle of inclination?

## **Experiment No-5**

---

### **Object**

To determine the mechanical advantage, velocity ratio and efficiency of a Screw jack.

### **Apparatus**

Screw jack, weights, vernier calliper, metre scale, string.

### **Theory**

Screw jack is a simple machine, works on the principle of screw and nut. It is used to lift heavy loads by applying small efforts.

In this apparatus, load is kept on the double flanged or single flanged head and effort is applied by hanging weights in the hooks fitted with the threads. The thread passes over the pulley as shown in fig 5.1.

Let  $W$  = Load to be lifted  
 $P$  = Effort required to lift the load  
 $p$  = Pitch of the screw  
(Pitch is the vertical distance between two consecutive threads of the screw).  
 $D$  = Diameter of the head

In one revolution of the screw,  
the distance moved by effort =  $\pi D$   
and the distance moved by load =  $p$

$$\therefore \text{Mechanical advantage} = \frac{\text{load}}{\text{Effort}} = \frac{W}{P}$$

$$\begin{aligned} \text{Velocity ratio} &= \frac{\text{Distance moved by effort}}{\text{Distance moved by load}} \\ &= \frac{\pi D}{p} \end{aligned}$$

$$\% \text{ Efficiency} = \frac{\text{M.A}}{\text{V.R}} \times 100$$

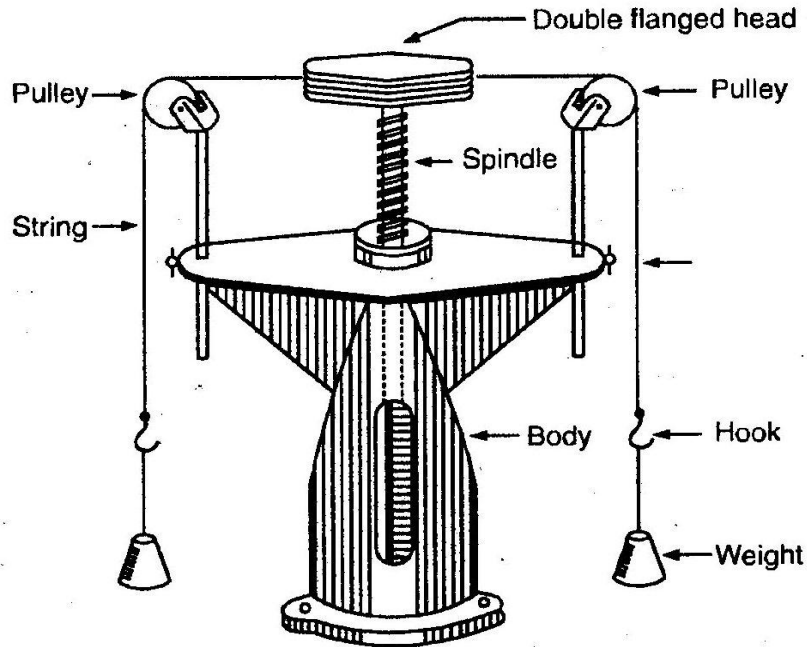


Fig 5.1 Screw Jack

### Procedure

1. Measure the pitch of the screw by using vernier calliper.
2. Measure the diameter of the head by metre scale.
3. Wrap the thread around the flanged head passing over the guide pulleys and put hooks at the ends of the threads.
4. Place a known weight on the head and start hanging weights with the hooks gradually till the load starts lifting.
5. Repeat the experiment at least three times by using different weights (or load).
6. Calculate the M.A, V.R and % efficiency in each case.

### Calculation

Circumference of the head =  $\pi D = \dots\dots\dots$

$$M.A = \frac{W}{P} = \dots\dots\dots$$

$$V.R = \frac{\pi D}{p} = \dots\dots\dots$$

$$\% \eta = \frac{M.A}{V.R} \times 100 \dots\dots\dots$$

### Precautions

1. Lubricate the screw to minimize friction.
2. Wrapping of string on the flanged head should be done correctly.
3. The pitch of the screw and diameter of the head should be measured accurately.

### QUESTIONS FOR VIVA

1. What is the difference between simple and compound machine?
2. What is pitch?
3. State the principle on which screw jack works.
4. Define M.A, V.R and efficiency.
5. What is reversible and irreversible machine?

## Experiment No-6

### Object

To find out the coefficient of friction between two surfaces (wood and glass) in contact by using horizontal plane.

### Apparatus

Horizontal plane apparatus, weight box, pan, thread, wooden block, glass plate.

### Theory

The co-efficient of friction ( $\mu$ ) is the ratio of limiting force of friction to the normal reaction.

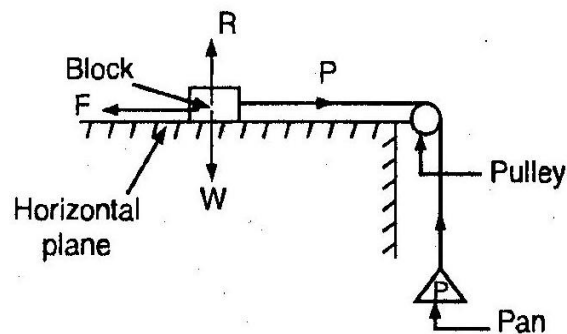


Fig 6.1 Line diagram of horizontal plane apparatus

Let a wooden block of weight 'W' be kept on a rough horizontal plane and this block is just allowed to move by applying a pull 'P'.

Let  $F$  be the limiting friction and  $R$  be the normal reaction.

Then for  $\Sigma H = 0$

$$F = p$$

and  $\Sigma V = 0$

$$R = W$$

$$\therefore \mu = \frac{F}{R} = \frac{P}{W}$$

### Procedure

- Note down the weight of the block and the pan.
- Place the glass plate on the horizontal plane.
- Mark a particular region on the horizontal plane.
- Place the block on this region. Thread is tied to the hook of the block passing over a smooth pulley fixed on the edge of the apparatus and tie the pan to the free end of the thread.
- Put some weights on the block and put weights into the pan also.
- Go on increasing the weights into the pan till the block just begins to move.
- Note down the weight of the block as well as the pan.
- Repeat the experiments at least three times by putting different weights in the block and find out the different values of weights in the pan.

If another pairs of surfaces (suppose steel and glass) is to be taken to know the coefficients of friction. Then use block with steel surface at the bottom and the horizontal plane with glass and repeat the procedure, 1 to 8 to find the value of co-efficient of friction.

### Observations

Sl. No.	Weight of block + Weight add in the block ( $w$ ) (in kg)	Weight of pan + Weights add in the pan ( $p$ ) in kg	$\mu$ (= $p/w$ )	Remarks

### Result

Co-efficient of friction between wood and glass . . . . .

### Precautions

- Lubricate the pulley to minimize the friction.
- The thread should be free from knots.
- The plane should be kept perfectly horizontal.
- The weights in the pan should be kept gently.

### QUESTIONS FOR VIVA

- Define friction and co-efficient of friction.
- What are the laws of fractions?
- What is limiting force of friction?

## Experiment No-7

### Object

To find the mechanical advantage, velocity ratio and efficiency in the case of worm and worm wheel.

### Apparatus

Worm and worm-wheel apparatus, weights, Strings, pan, metre scale.

### Theory

The apparatus consists of a toothed wheel (known as worm wheel) fixed with a load drum on it and, a spring screw (called worm). The worm meshes with the toothed wheel. The worm is fixed on a metallic spindle. This spindle carries a pulley from which a string hangs for application of effort. Another string is wound round the load drum carrying weight 'W' to be lifted.

Let  $r$  = Radius of load drum  
 $R$  = Radius of pulley.  
 $T$  = No of teeth of the worm wheel.  
 $P$  = Effort required.  
 $W$  = Load to be lifted.

$$\therefore M.A = \frac{W}{P}$$

In one revolution of the pulley, only one teeth of worm wheel moves if the worm threads are of single start.

$$\therefore \text{Distance moved by effort (pulley)} = 2\pi R$$

$$\text{and, Distance moved by load (drum)} = \frac{2\pi r}{T}$$

$$\therefore V.R = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$$

$$= \frac{2\pi R}{\frac{2\pi r}{T}} = \frac{R \times T}{r}$$

SI No.	Load Lifted $w$ (in Kg)	Effort applied (wt of pan + wt in pan $P$ (in Kg)	M.A $\left( = \frac{W}{P} \right)$	V.R $\left( = \frac{RT}{r} \right)$	% $\eta = \frac{wr}{PRT}$	Remarks
						$\times 100$

### Calculation

Calculate  $R$  and  $r$  from the measured circumference and

$$\text{M.A} = \frac{W}{P}$$
$$\text{V.R} = \frac{RT}{r}$$
$$\% \eta = \frac{Wr}{PRT} \times 100$$

### Result

$$\text{M.A} = \dots\dots\dots$$
$$\text{V.R} = \dots\dots\dots$$
$$\% \eta = \dots\dots\dots$$

### Precaution

1. Lubricate the different parts of the apparatus to minimise the friction.
2. The string should not overlap on the pulley or on the drum.
3. Weights should be kept gently on the pan.
4. The load 'W' to be lifted and the pan should not touch the wall.
5. The load 'W' should move slowly.

### QUESTIONS FOR VIVA

1. Differentiate between ideal machine and practical machine.
2. How do you determine the V.R in this experiment?
3. How will you increase the M.A of the moment?

## Experiment No-8

### Object

To find the mechanical advantage, velocity ratio and efficiency of a single purchase crab.

### Apparatus

Single purchase which crab, weights, pan, metre scale etc.

### Theory

This machine consists of two geared wheel, smaller is called pinion and the bigger one is called 'spur-wheel'.

These two wheels are mounted on two parallel spindles shown in fig 8.1. The spindle B carries a load drum, round which the string is wrapped and carries the load 'W'. The pulley which is fitted with the spindle A carries the effort 'P'.

Let  $T_1$  = No. of teeth of the pinion.  
 $T_2$  = No. of teeth of the spur-wheel.  
 $R$  = Radius of the pulley.  
 $r$  = Radius of the load drum.

$$\therefore M.A = \frac{W}{P}$$

For one revolution of the effort pulley.  
 Distance moved by effort =  $2\pi R$

$$\text{Distance moved by load} = \frac{T_1}{T_2} \times 2\pi r$$

$$\begin{aligned} V.R &= \frac{\text{Distance moved by effort}}{\text{Distance moved by load}} \\ &= \frac{2\pi R}{\frac{T_1}{T_2} \times 2\pi r} = \frac{T_2 \times R}{T_1 \times r} \end{aligned}$$

$$\therefore \% \eta = \frac{M.A}{V.R} \times 100 = \frac{W/P}{\frac{T_2 \times R}{T_1 \times r}} \times 100$$

$$= \frac{W \times r \times T_1}{P \times R \times T_2} \times 100$$

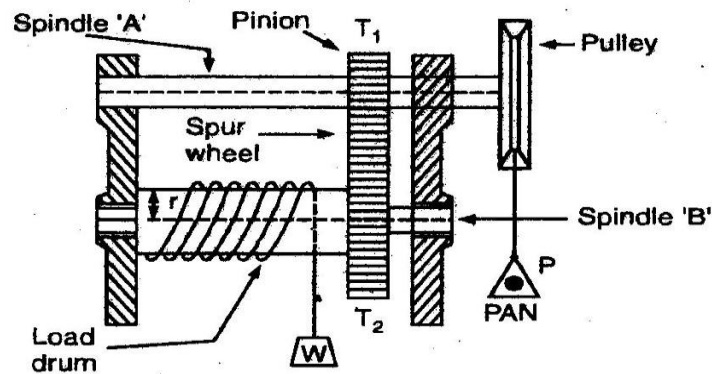


Fig 8.1 Single Purchase crab

### Procedure

1. Measure the circumference of the load drum and the pulley.
2. Count the number of teeth of pinion and spur wheel.
3. Wrap a string round the effort pulley and attach a pan to its free end.
4. Wrap a string round the load drum in such a manner that when effort is applied, the load gets lifted.
5. Suspend the load 'W' to the free end of the string passing round the load drum.

6. Now place the weights in the pan and go on increasing the weights till the load just starts moving.
7. Note down the weights in the pan.
8. By adding weight of the pan with the weights in the pan we get the value of effort 'P'.
9. Calculate the M.A, V.R and  $\eta$ .
10. Repeat the experiment at least three times by using different loads.

### Observations

No. of teeth of the pinion ( $T_1$ ) =

No. of teeth of Spur wheel ( $T_2$ ) =

Sl. No.	Load 'W' in Kg	Effort 'P' in Kg	M.A	V.R	% $\eta$	Remarks

Radius of the pulley ( $R$ ) =

Radius of the load drum ( $r$ ) =

wt. of the pan =

### Calculations

$$M.A = \frac{W}{P}$$

$$V.R = \frac{R \times T_2}{r \times T_1}$$

$$\% \eta = \frac{W \times r \times T_1}{P \times R \times T_2} \times 100$$

### Result

M.A = .....

V.R = .....

%  $\eta$  = .....

### Precautions

1. Lubricate the apparatus properly to minimise friction.
2. The strings on the pulley and load drum should not overlap.
3. Weights should be gently put in the effort pan.
4. The string should be free from any knot.

### QUESTIONS FOR VIVA

1. What is a single purchase winch crab?
2. How will you find the efficiency of the machine?
3. Explain 'ideal effort' and 'ideal load'.
4. What can be the sources of errors in this experiment?

## Experiment No-9

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### Object

To determine the personal horse power by using manual horse power apparatus.

### Apparatus

Personal horse power apparatus, weights, rope, revolution counter, stop-watch, meter scale etc.

### Theory

The power of a person is defined as workdone by him in one second. Generally the power of an average person is one-eighth of a horse power. Power is the amount of workdone per second.

One Horse Power is equal to 75 kg-m/sec.

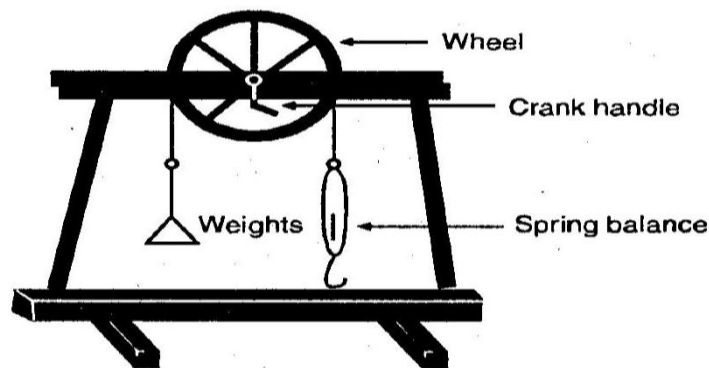


Fig 9.1. Personal Horse Power Apparatus

### Procedure

1. Measure the circumference of the wheel and then calculate the diameter of the wheel
2. Pass the rope on the wheel. Attach spring balance to one end of the rope and load 'W' to the other end of the rope as shown in fig. 9.1.
3. Rotate the wheel from load side to the spring balance side at uniform speed and count the number of revolutions ' $n$ ' with the help of revolution counter.
4. Note also the time taken ' $t$ ' for ' $n$ ' revolutions.
5. Note down the spring balance reading ' $S$ ' and suspended load ' $W$ '.
6. Time ' $t$ ' and number of revolution ' $n$ ' should be noted down at least thrice for one revolution to minimise the error.
7. Repeat the experiment at least three times.

### Observations

Dia of the wheel ( $D$ ) =

Sl. No.	Load 'W' in Kg	Spring balance recording 'S' in Kg.	Frictional force (W-S)	No. of revolution 'n'	Time taken in 'n' revolution			Mean time taken for 'n' revolution	Personal H.P = $\frac{(W - S) \pi D n}{t \times 75}$
					$t_1$	$t_2$	$t_3$		

### Calculation

$$\text{Personal H.P} = \frac{(W - S) \pi D n}{t \times 75}$$

### Result

Mean personal H.P = . . . . .

### Precautions

1. The no. of revolution and time should be noted carefully.
2. The speed of the wheel should be uniform.
3. The weight of the hook should be added with W.
4. The apparatus should be rigidly fixed to the base.

### QUESTIONS FOR VIVA

1. Define power and horse power.
2. What is personal horse power?
3. What is the unit of power?

## Experiment No-10

### Object

To find out the centre of gravity of a irregular lamina.

### Apparatus

Irregular lamina (piece of thin cardboard), stand, metre rod, in extensible string chalk or pencil for marking.

### Theory

A body which does not have mass is called lamina. The C.G of a lamina is the point at which the whole area of the lamina is supposed to be concentrated.

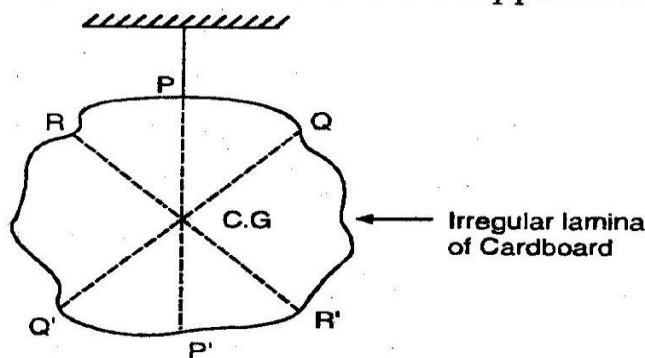


Fig 10.1 C.G of irregular lamina

1. Take the irregular lamina and suspend it from point  $P$  with the help of a string.
2. Draw the line  $PP'$  by chalk or pencil on the lamina.  $PP'$  is the extension of string line from  $P$ .
3. Similarly hang the lamina from point  $Q$  and draw line  $QQ'$  on the lamina. The  $QQ'$  is the extension of string line from  $Q$ .
4. The same produce may be repeated by hanging the lamina from point  $R$ .
5. The point at which the line  $PP'$ ,  $QQ'$  and  $RR'$  cut gives the C.G of the lamina.
6. Measure the distance of the C.G from any of the points  $P$ ,  $Q$  and  $R$ . This length gives the distance of C.G from that point.

### Observation

Distance of C.G from point ..... =

### Precautions

1. The lines  $PP'$  and  $RR'$  should be marked accurately.
2. The intersection point of the line should be accurately located.

### 3.3 ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING

#### DETAILED CONTENTS

L T P

3 - 2

#### 1. Application and Advantage of Electricity (03 hrs)

Difference between ac and dc, various applications of electricity, advantages of electrical energy over other types of energy

#### 2. Basic Electrical Quantities (04 hrs)

Definition of voltage, current, power and energy with their units, name of instruments used for measuring above quantities, connection of these instruments in an electric circuit

#### 3. AC Fundamentals (04 hrs)

Electromagnetic induction-Faraday's Laws, Lenz's Law; Fleming's rules, Principles of a.c. Circuits; Alternating emf, Definition of cycle, frequency, amplitude and time period. Instantaneous, average, r.m.s and maximum value of sinusoidal wave; form factor and Peak Factor. Concept of phase and phase difference. Concept of resistance, inductance and capacitance in simple a.c. circuit. Power factor and improvement of power factor by use of capacitors. Concept of three phase system; star and delta connections; voltage and current relationship (no derivation)

#### 4. Transformers (06 hrs)

Working principle and construction of single phase transformer, transformer ratio, emf equation, losses and efficiency, cooling of transformers, isolation transformer, CVT, auto transformer (brief idea), applications.

#### 5. Distribution System (06 hrs)

Difference between high and low voltage distribution system, identification of three-phase wires, neutral wire and earth wire in a low voltage distribution system. Identification of voltages between phases and between one phase and neutral. Difference between three-phase and single-phase supply

#### 6. Electric Motor (08 hrs)

Description and applications of single-phase and three-phase motors. Connection and starting of three-phase induction motors by star-delta starter. Changing direction of rotation of a given 3 phase induction motor. Motors used for driving pumps, compressors, centrifuge, dyers etc. Totally enclosed submersible and flame proof motors

#### 7. Domestic Installation (06 hrs)

Distinction between light-fan circuit and single phase power circuit, sub-circuits, various accessories and parts of domestic electrical installation. Identification of wiring systems. Common safety measures and earthing

#### 8. Electrical Safety (04hrs)

Electrical shock and precautions against shock, treatment of electric shock, concept of fuses and their classification, selection and application, concept of earthing and various types of earthing, applications of MCBs and ELCBs

### **9. Batteries (02 hrs)**

Construction, charging and maintenance of lead acid batteries, maintenance free batteries

### **10. Basic Electronics (05 hrs)**

Basic idea of semiconductors – P and N type; diodes, zener diode and their applications, transistor – PNP and NPN, their characteristics and uses. Characteristics and applications of a thyristor, characteristics and applications of stepper motors and servo motors in process control.

### **LIST OF PRACTICALS**

1. Connection of a three-phase motor and starter with fuses and reversing of direction of rotation
2. Connection of a single-phase induction motor with supply and reversing of its direction of rotation
3. Charging and testing of a lead – acid battery
4. Troubleshooting in domestic wiring system, including distribution board
5. Connection and reading of an electric energy meter
6. Use of ammeter, voltmeter, wattmeter, and multi-meter
7. Measurement of power and power factor in a given single phase ac circuit
8. Study of different types of fuses, MCBs and ELCBs
9. Study of zener as a constant voltage source and to draw its V-I characteristics
10. Study of earthing practices
11. To draw V-I characteristics of a (i) NPN transistor (ii) thyristor (SCR)
12. Study of construction and working of a (i) stepper motor and (ii) servo motor

#### **Assignment No. 1**

1. Mention five applications of electricity.
2. What do you mean by electromotive force?
3. What is the difference b/w pulsating and steady current?

#### **Assignment No. 2**

1. A coil of resistance 100 ohms is connected across a 250V supply. Calculate current flowing and power rating of coil.
2. Two lamps rated 250 V, 100W are connected in parallel across 250 V calculate total current taken from the supply mains.
3. What is the difference b/w emf and potential difference?

### Assignment No. 3

1. How you define the resistance of a conductor? What are the factors upon which it depends?
2. A coil of resistance 100 ohm is placed in a magnetic field of 1mWb. The coil has 500 turns and a galvanometer of 900 ohms resistance is connected in series with it. Find the average e. m. f. and the current, if the coil is moved in  $1/10^{\text{th}}$  of a second from the given field to a field strength of 0.2 mWb.
3. State and explain Fleming's right hand rule and Lenz's law.

### Assignment No. 4

1. Define electromagnetic induction and explain the laws of electromagnetic induction.
2. Explain the comparison b/w magnetic & electric circuit.
3. Compare three phase star and delta connected systems.

### Assignment No. 5

1. What do you mean by transformer? Give its classification.
2. Explain the construction and principle of Transformer.
3. Explain the different types of cooling of transformer

### EXPERIMENT NO. 1

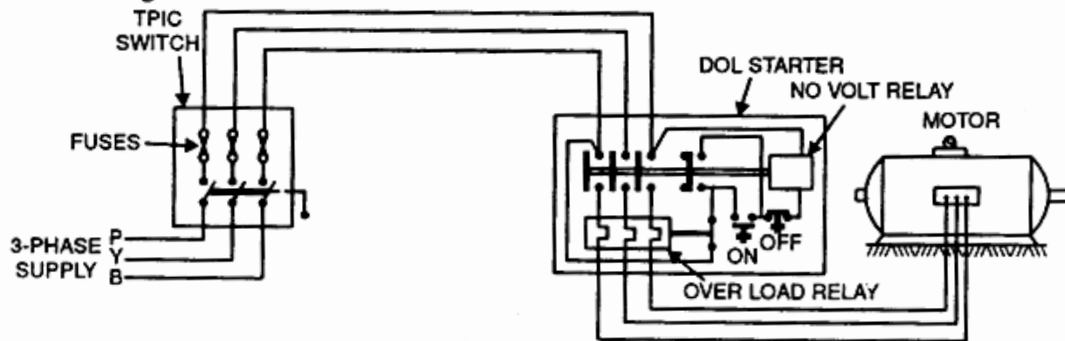
**Experiment :** *Connections of three phase motor and starter with fuses and reversing of direction of rotation.*

**Objective :** After performing this experiment, students shall be in position to install, connect, start and reverse the direction of rotation of a 3-phase induction motor if required.

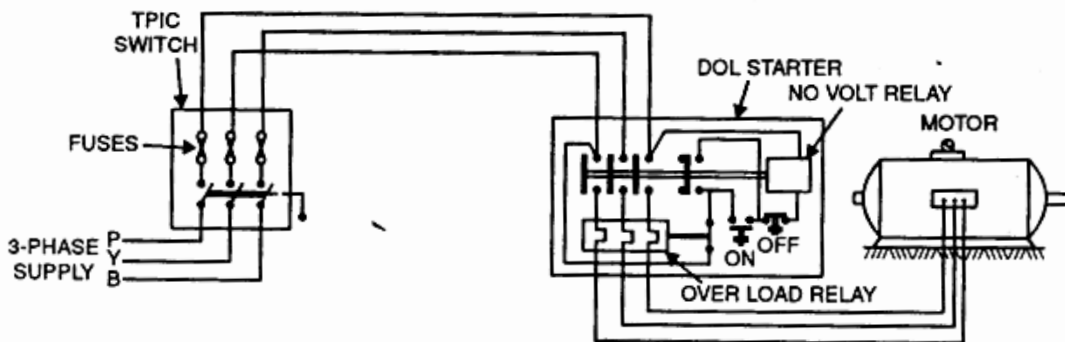
**Apparatus/Instruments/Components required :**

1. Three-phase ac supply.
2. Three-phase induction motor.
3. One starter (DOL starter)
4. Reversing Switch (change over switch)
5. Tools as mentioned in the beginning (*i.e.* plier, screw driver, test pin etc.)
6. Connecting leads etc.

**Circuit diagram :**



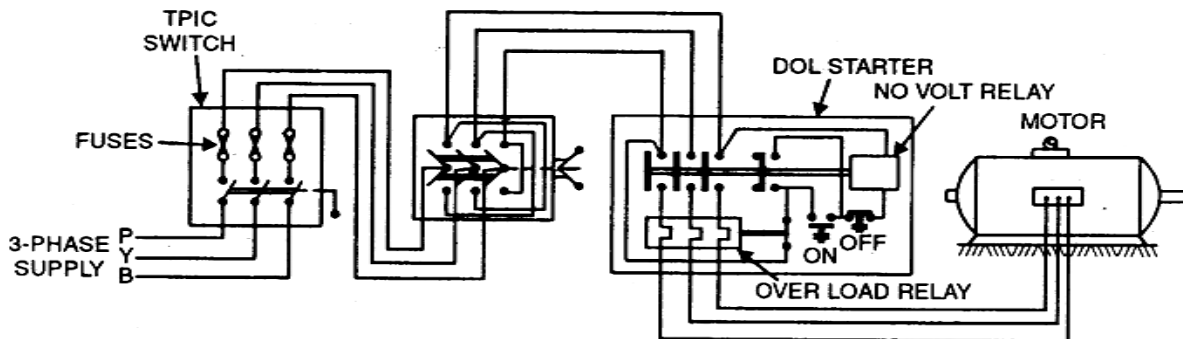
**Fig. 1(a)**



**Fig. 1(b)**

**Theory :** Motor is connected to the mains through a triple pole iron clad (TPIC) with fuses and a starter. A reversing switch may be connected in between.

The direction of rotation of the motor can be reversed by changing the position of reversing switch or by interchanging any two terminals at the TPIC switch.



**Fig. 1(c)**

**Procedure :**

1. Make the connections to the motor through TPIC switch and a starter as shown in fig. 1.
2. Get the connections checked by the teacher incharge.
3. Start the motor by pushing the green push button.
4. Observe the direction of rotation of the motor.
5. Stop the motor by pushing stop button at the starter and switch off the TPIC switch.
6. To reverse the direction of rotation of the motor interchange the leads of motor at any two terminals of the TPIC switch or by changing the position of change over switch.
7. Switch-ON the TPIC switch and start the motor again. Observe the direction of rotation of the motor.

8. Switch-off the motor and supply.

**Observations :** Direction of rotation of motor in first case — clock wise/counter clockwise.

Direction of rotation of motor after interchanging the connections — clockwise/counter clockwise.

**Results :** The direction of rotation of the motor is reversed when connections at any two terminals are interchanged.

## EXPERIMENT NO. 2

**Experiment :** Connections of a single-phase induction motor with supply and reversing of its direction of rotation.

**Objective :** To make the students familiar with the connections of single-phase motor and to tell them how to reverse the direction of rotation of the motor.

**Apparatus/Instruments/Components required :**

1. Single-phase ac supply.
2. Single-phase ac motor
3. Double Pole Iron Clad (DPIC) switch
4. Various tools
5. Connecting leads etc.

**Circuit diagram :**

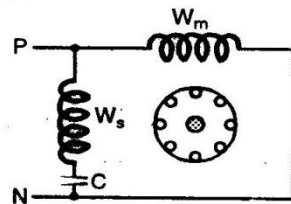


Fig. 2(b)

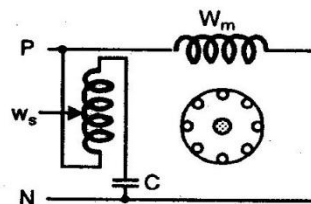


Fig. 2(c)

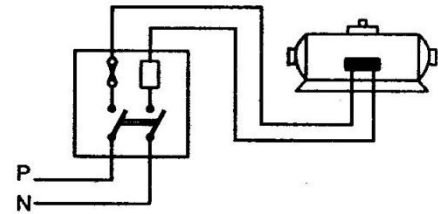


Fig. 2(a)

**Theory :** A single-phase induction motor may be a split-phase, capacitor start, capacitor run or capacitor start-capacitor run induction motor. Usually, capacitor run motor is used in number of electrical appliances.

**Procedure :**

1. Make the connections to the motor through DPIC switch as shown in circuit diagram.
2. Get the connections checked by the teacher incharge.
3. Switch ON the supply to the motor through DPIC switch.
4. Note down the direction of rotation of the induction motor.
5. Switch OFF the supply to the motor through DPIC switch.
6. Interchange the connections of starting winding of the motor as shown in the figure.
7. Switch ON the supply to the motor through DPIC switch and note down the direction of rotation of the motor.

**Observation :**

1. Direction of rotation of the induction motor in first case : ..... (Clockwise or anticlockwise)
2. Direction of rotation of the motor when the connections of starting winding are interchanged : ..... (clockwise or anticlockwise)

**Result :** The direction of rotation of the motor is reversed when the connections of starting winding of the motor are reversed.

## EXPERIMENT NO. 3

**Experiment :** Charging and testing of a Lead-acid battery.

**Objective :** 1. To check the condition of the battery (whether charged or discharged).  
2. If discharged, how to charge it.

**Apparatus/Instruments/Component required**

1. Lead-acid battery for testing (say 6V battery or 12 V battery )
2. Hydrometer for checking the condition of the battery.
3. Battery charger or dc source having voltage more than 7.5 for 6V battery and 15 V for 12 V battery.
4. One dc voltmeter (V) of range .....
5. One dc ammeter (A) of range .....
6. One rheostat.
7. One double pole single throw (DPST) switch.
8. Cell tester.
9. Connecting leads etc.

**Circuit diagram :**

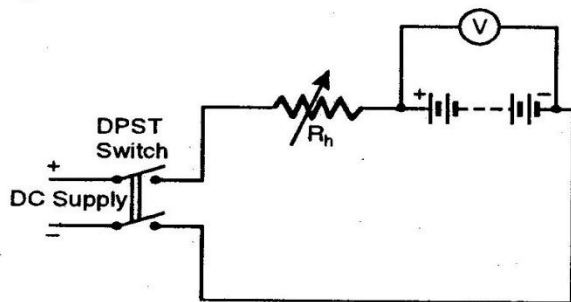


Fig. 3(b)

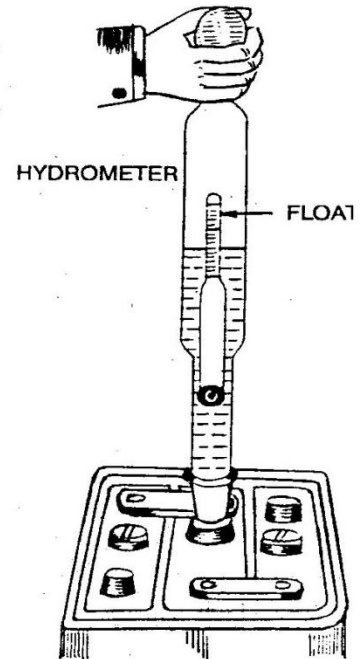


Fig. 3(a)

**Theory :** The condition of the battery is checked by checking the specific gravity of the electrolyte of each cell one by one with the help of a hydrometer after removing the vent caps as shown in Fig. 3(a). The chart given below tells the condition of each cell :

Specific gravity	Condition
1280 to 1290	100% charged
1230 to 1250	75% charged
1190 to 1200	50% charged
1150 to 1160	25% charged
below 1130	fully discharged

Some times, scale of the hydrometer is formed on the coloured paper having colours green, yellow and red. Reading on green position shows fully charged cell, reading on yellow shows cell has already been used and reading on red portion shows that the cell is fully discharged and needs charging.

**Procedure :**

1. Check the condition of the battery (*i.e.* of each cell) with the help of hydrometer as per the table given above.
2. If the battery is in discharged condition and needs charging, make the connections as per the circuit diagram shown in Fig. 3(b) (for 12V battery).
3. Get your connections checked by the teacher incharge. Be sure that +ve terminal of source is connected to the +ve terminal of the battery.
4. Before switching on the supply remove the vent caps of the battery.
5. Switch ON the supply and adjust the value of rheostat so that voltage across the battery should not be more than 15 V.
6. Keep the battery under charging for 8 to 10 hours.

7. Test the battery condition (or cells condition) with the help of hydrometer. The cell condition can also be checked by the cell tester. In that case, the e.m.f. of each cell should be 2.2 to 2.5 V when the cell is fully charged.

**Observation table :**

S. No.	Particulars of Checking	Before charging	After charging
1.	Sp. gravity of electrolyte		
2.	EMF of each cell		

**Result :** It is observed that in the beginning when the e.m.f. of each cell is tested by the cell tester the voltage comes out to be nearly 2 V but the hydrometer shows that the cell is only 25% charged. Hence, exact condition of the cell or battery is checked by the hydrometer.

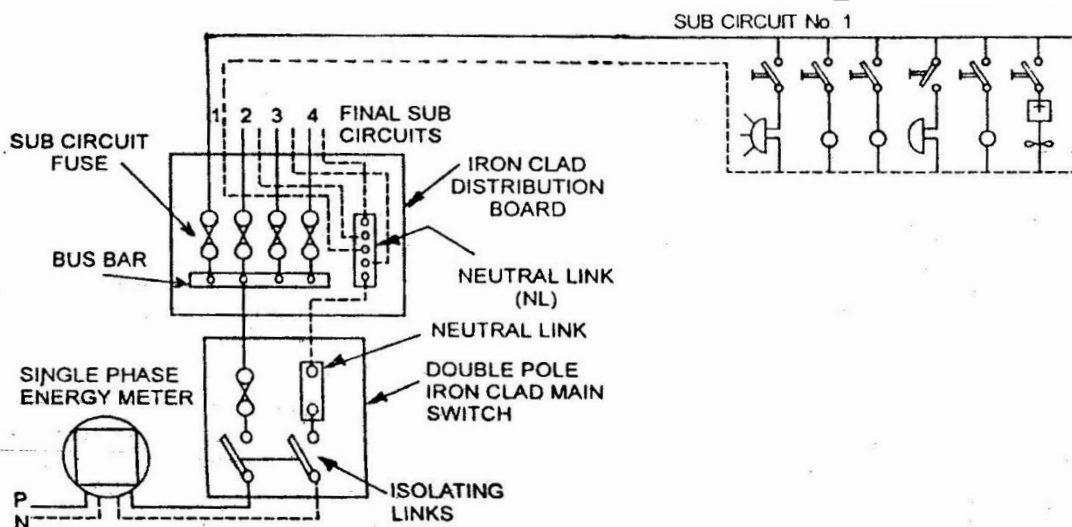
### EXPERIMENT NO. 4

**Experiment :** Troubleshooting in domestic wiring system.

**Objective :** To familiarise the students, how to locate fault in domestic wiring.

**Apparatus/Instruments/Components required :**

1. Test lamp holder
2. Neon tester
3. Meggar
4. Leads etc.



**Fig. 4**

**Theory :** The following faults may occur in a domestic wiring system :

1. **Over load :** When load on a sub-circuit increases more than the designed value, the fuse of the sub-circuit melts and disconnects the sub-circuit. Usually, it happens when heavy load like heater, room heater, electric iron etc. are connected in a 5A socket.
2. **Earth fault :** When insulation of the phase wiring cable fails and touches the earthed conduit, it leads to earth fault. This fault occurs usually, when an appliance having earth fault is connected in the circuit.
3. **Short circuit :** When insulation of a phase wire and neutral fails, thus phase conductor comes in contact with neutral conductor, it leads to short circuit fault.
4. **Open circuit fault :** This fault occurs when a terminal is disconnected due to any reason.

5. **Loose connection** : Sometimes, in wiring system, screw at the terminals may get loosened. This causes sparking and burning of contacts which leads to open circuit fault.

**Procedure :**

Whenever fault occurs in a domestic wiring we proceed as follows :

1. Check the supply at the main-switch (DPST switch) with the help of test lamp.
2. Check the fuse (or MCB) of the sub circuit.
3. Check the circuit for open circuit fault with the help of test lamp.
4. When there is disturbance in the load due to voltage variation, there is every possibility of sparking at the loose connection. Check it and remove it.

**EXPERIMENT NO. 5**

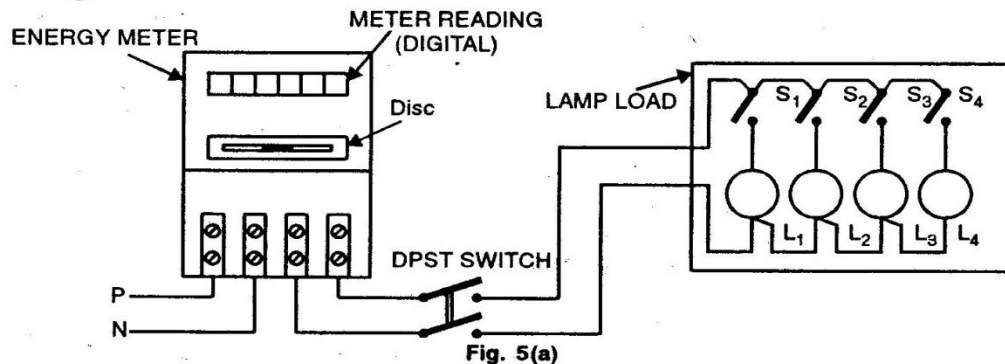
**Experiment :** Connection and reading of an electrical energymeter including distribution board.

**Objective :** By performing this experiment, the students shall be in position to connect an energy meter in the circuit and shall be in position to read it.

**Apparatus/Instruments/Components required :**

1. Single phase ac supply.
2. Double pole iron clad (DPIC) switch.
3. Single-phase energy meter of rating .....
4. Distribution board (for sub circuits)
5. Lamp load
6. Connecting leads etc.

**Circuit diagram :**

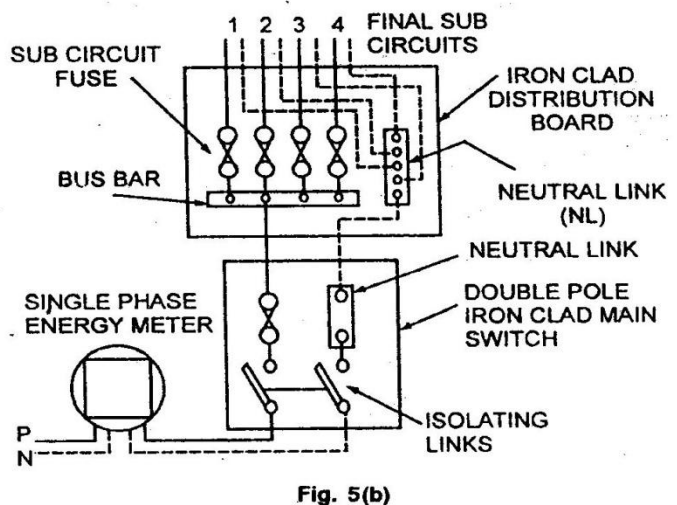


**Theory :** Energy meter is an integrating instrument which measures electrical energy in kWh. One kWh energy is called one unit of energy.

Name plate of the energy meter contains of the following data :

- No. of phases and voltage  
— 1 × 240 V or 3 × 240 V
- Frequency — 50 Hz
- Current rating — 5 to 10 A or 10 to 40A
- Energy meter constant  
— 300 rev/kWh or 150 rev/kWh

Readings are tabulated directly on the scale. There are two types of scales given below :



10000	1000	100	10	1.0	0.1
0	4	2	5	6	0

For small rating energy-meter  
Table-1

10000	1000	100	10	1
1	6	7	2	5

For larger rating energy meter  
Table-2

**Procedure :**

1. Study the distribution board carefully as shown in fig. 5(b)
2. For doing experiment connect energy meter to the supply and load to the energy meter as shown in fig. 5(a).
3. Read the energy meter reading (say for Table-1 = 4256.0 kWh)
4. Put load on the energy meter by switching-ON various number of lamps through DPST switch and switches  $S_1, S_3, \dots$  (about 1kW)
5. After about 15 minutes, switch OFF the DPST.
6. Record the readings of energymeter in the observation table.
7. Repeat the experiment 2 or 3 times.
8. Make the calculations as given in the observation table.

**Observation Table :**

No.	Previous Energymeter Reading $E_1$	Final Energymeter Reading $E_2$	Energy consumed $E = E_2 - E_1$
1.			
2.			
3.			

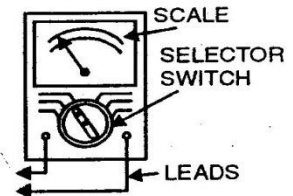
**EXPERIMENT NO. 6**

**Experiment :** Use of ammeter, voltmeter, wattmeter, energymeter and multi-meter.

**Objective :** To familiarise the students with the said electrical measuring instrument and how to use them for measuring various electrical quantities.

**Apparatus/Instruments/Components required :**

1. Single phase ac supply.
2. Double Pole Single Through (DPST) switch
3. Variac (i.e. 1-phase auto-transformer)
4. Heater load
5. Ammeter of range .....
6. Voltmeter of range .....
7. Wattmeter of range .....
8. Energymeter of rating .....
9. Multimeter
10. Connecting leads etc.



MULTIMETER  
Fig. 6(a)

**Circuit diagram :**

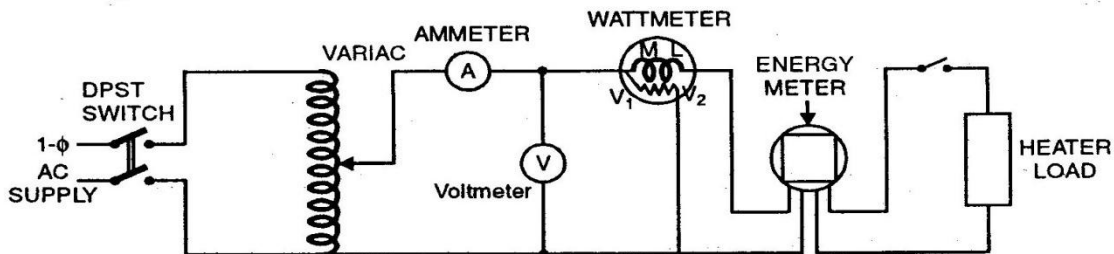


Fig. 6(b)

### Theory :

**Ammeter** : It is an instrument which is used to measure electric current in the circuit. It is always connected in series, as shown in the circuit diagram.

**Voltmeter** : It is an instrument which is used to measure electric potential difference across the circuit. It is always connected in parallel, as shown in the circuit diagram.

**Wattmeter**. It is an instrument which is used to measure electric power of the circuit. It contains two coils *i.e.* current coil (*CC*) connected in series and potential coil (*PC*) connected across the load.

**Energymeter** : It is an instrument which is used to measure electrical energy consumed by the load in a given period. It has four terminal (for 1-phase energymeter), on the left, the two terminals are incoming terminals whereas on the right two terminal are the outgoing terminals.

**Multimeter** : It is an instrument which is used to measure, ac/dc voltage, ac/dc current and resistance. For the measurement of a particular quantity, the position of the relector switch is adjusted. Moreover, we can also select the desired range.

### Procedure :

To measure various electrical quantities proceed as follows :

1. Connect all the instruments/equipment as shown in the circuit diagram.
2. Get the connections checked by the teacher incharge before energising the circuit.
3. Note down the reading of energymeter.
4. Switch ON the DPST switch and adjust the variac to read 230 V at the output (*i.e.* voltmeter reading).
5. Measure voltage, current and power by recording the readings of voltmeter, ammeter and wattmeter in the observation table and check the speed of rotation of the disc of energymeter.
6. After 10 to 15 minutes, change the output voltage to lower value (say 190V) with help of variac.
7. Again record the readings of all the measuring instruments. Check the speed of rotating disc of energymeter also.
8. Use multimeter to measure voltage across the load and compare it with the voltmeter reading.

### Observation Table

Position of Variac	Energymeter Reading	Voltmeter Reading (V)	Ammeter Reading (I)
First position	Before experiment		
Second position	After experiment		

**Result** : When the voltage applied to the circuit is decreased, the voltage, current and power decreases. Moreover, the speed of the rotating disc of the energymeter also slows down.

## EXPERIMENT 7

**Experiment** : Measurement of power and power factor in a given single-phase ac circuit.

**Objective** : The students will be made familiar with measuring of power and power factor in ac circuit.

**Apparatus/Instruments/Components required** :

1. Single phase ac supply.
2. Variac or 1-phase auto-transformer
3. One inductive load (may be 1-phase induction motor ; a desert cooler pump motor *i.e.* shaded pole motor ; a lamp in series with choke coil etc.)

- One wattmeter of range .....
  - One ac voltmeter of range .....
  - One ac ammeter of range .....
  - One single-phase power factor meter.
8. One double pole single throw (DPST) switch.
  9. Connecting leads etc.

Circuit diagram :

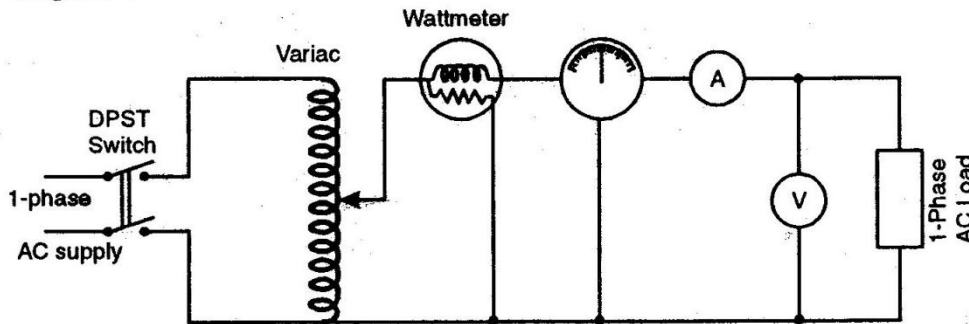


Fig. 7

**Theory :** Wattmeter reading =  $W$  ; Voltmeter reading =  $V$   
 Ammeter reading =  $I$  ; Power factor meter reading =  $K$   
 Calculated p.f. =  $\frac{W}{VI}$  ; If  $K = \frac{W}{VI}$  then p.f. is verified.

**Procedure :**

1. Make the connections as shown in fig. 7.
2. Get the connections checked by the teacher incharge.
3. Switch ON the DPST switch and increase the voltage.
4. Take the readings of wattmeter, p.f. meter, voltmeter and ammeter at different setting and fill the observation table.
5. Switch off the DPST switch and dismantal the circuit.

**Observation Table :**

Observations				Calculations	
Wattmeter Reading ( $W$ ) in watts	Voltmeter Reading ( $V$ ) in volts	Ammeter Reading ( $I$ ) in amperes	p.f. meter Reading ( $K$ )	$p.f. = \frac{W}{VI}$	Compare $K$ and $p.f.$
1					
2					
3					

**Results :**

1. Power factor meter reading and the calculated p.f. is the same, hence, p.f. is verified.

### EXPERIMENT NO. 8

**Experiment :** Study of different types of fuses, MCBs and ELCBs

**Objective :** To make the students familiar about the protective devices such as fuses, *MCBs* and *ELCBs*.

**Apparatus/Instruments/Components required.**

1. Rewirable fuses, High Breaking Capacity (*HBC*) or High Rupturing Capacity (*HRC*) fuses, Miniature Circuit Breakers (*MCBs*) Single-Pole (*SP*), Double-Pole (*DP*) and Tripple-Pole (*TP*) etc.

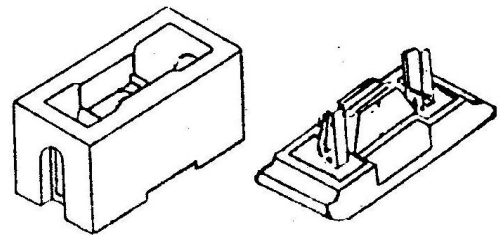
Earth Leakage Circuit Breakers (*ELCBs*) or Residual Current Circuit Breakers (*RCCBs*) – single-Pole (*SP*) and Triple-Pole (*TP*) etc.

**Theory/Study :**

**Fuse, MCB or ELCB :** These are the protective devices connected in the phase wire in series with the load. Whenever overload, short circuit or earth fault occurs, these devices (any one of these) protect the system by disconnecting the system from supply.

1. **Study of fuses :** In domestic, commercial and industrial wiring installations, generally rewirable fuses or *HBC* (High Breaking capacity also called High Rupturing Capacity *HRC*) fuses are used for protection.

- (i) **Rewirable fuse :** It consists of two parts *i.e.* base and carrier as shown in fig. 8(a). Both the parts may be made of porcelain or bakelite. The base contains two fixed contacts. The incoming phase wire is connected to one of the contacts and the circuit to be protected is connected to the other contact. The fuse carrier hold the fuse element connected between two fixed terminals. The fuse carries can be inserted in the base and taken out from it without any risk.



**Fig. 8(a) Rewirable Fuse**

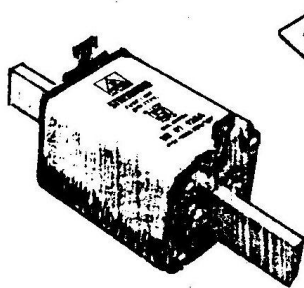
- (ii) **High Breaking Capacity (*HBC*) fuses :** Different types of *HBC* fuses, such as Unit (*DIN*) types, Bolted type and cylindrical type, are available in the market.

*Current rating of DIN type HBC fuses :* 6, 10, 16, 20, 25, 32, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 425, 500, 630

*Current rating of Bolted type HBC fuses :* 2, 4, 6, 10, 16, 20, 25, 32, 50, 63, 80, 100, 125, 160, 200, 250, 300, 315, 400, 500, 630

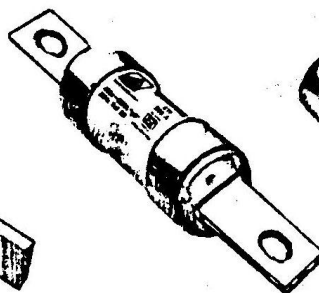
*Current rating of Cylindrical type HBC fuses :* 4, 6, 10, 16, 20, 32, 40, 50, 63

These fuses are shown in fig. 8. (b, c, d).



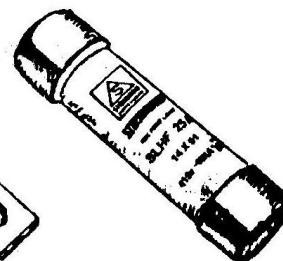
**DIN Type HBC Fuse**

**Fig. 8(b)**



**Bolted Type HBC Fuse**

**Fig. 8(c)**



**Cylindrical Type HBC Fuse**

**Fig. 8(d)**

These are preferred over rewirable fuses because of the following reasons.

**Range :**

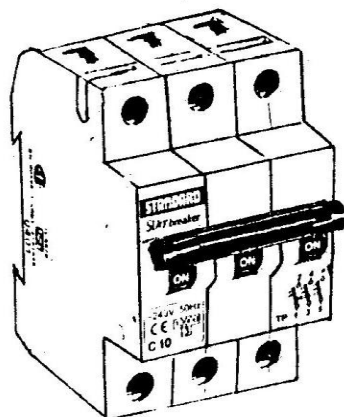
2A-800A in Bolted Type.

6A-630A in DIN Type.

4A-63A in Cylindrical Type.

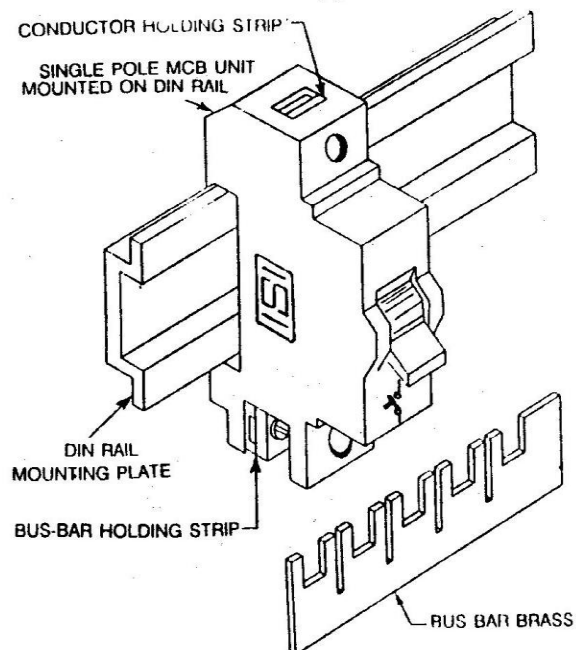
- Rated Breaking Capacity 80 KA of the fuse links at 415V.
- Rated Braking Capacity 80 kA of the fuse links at 415V.
- Raduced electromagnetic stress as a result of low cut off current to protect device adequately.
- Reduced thermal stress because of llower let through fault energy to eliminate mechanical damages.
- Reduced power consumption because of low watt losses.
- Suitable for motor starting and switching ON power transformer due to superior surge withstand capability.
- Tamper proof characterstic.
- Good discrimination between major and minor fuse rating.
- There is no emission of gas or flames in operation.
- Very economical protection device.
- Breaking range & Utilization category-gG.
- Interchangeability with all the compatible brands.

2. **Study of MCBs :** Miniature Circuit Breaker (MCB) is a device which ensures definite protection of wiring system and sophisticated equipment against over current and short circuit faults. The MCBs may be Single pole, Single pole Neutral, Double Pole, Triple Pole, Triple Pole Neutral and Four Pole. A Triple Pole MCB is shown in fig. 8(e). Whereas a single pole MCB mounted on a DIN Rail is shown in fig. 8(f). These are employed in the wiring installation as per the need.



**Triple Pole MCB**

**Fig. 8(e)**



**Single Pole MCB mounted on DIN Rail**

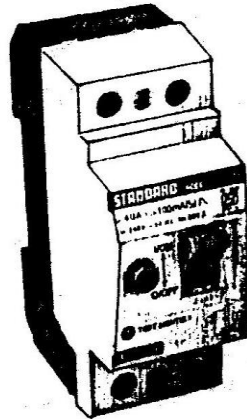
**Fig. 8(f)**

The current rating of *MCBs*, in ampere, may be :

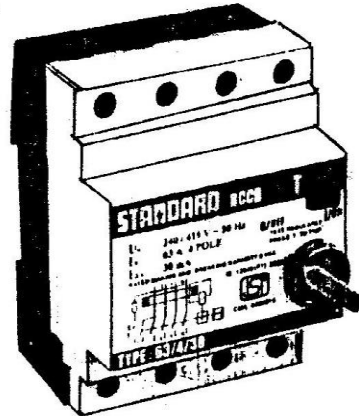
0.5, 1, 2, 2.5, 3, 5, 6, 10, 16, 20, 25, 32, 40, 63

3. **RCCB or ELCB** : Earth Leakage is an electrical hazard, which is responsible for electric shock and fire risk. Earth leakage and its associated hazard can be prevented by the use of Residual Current Circuit Breaker (*RCCB*). It is also popularly known as Earth Leakage Circuit Breaker (*ELCB*). These devices are ideally suited for providing earth leakage protection in domestic and commercial complexes. These can also be used on individual appliances like Geysers, Ovens, Water Coolers, Air Conditioners etc.

In fig. 8(g) & (h), 2 Module and 4 Module *RCCB* are shown respectively.



2-Module *RCCB*  
Fig. 8(g)



4-Module *RCCB*  
Fig. 8(h)

Every *RCCB* has a residual operated electro-mechanical release which operates without any auxiliary source of supply to open a circuit automatically whenever an earth leakage fault between phase and earth is greater than or equal to a threshold current of 30,100 or 300 mA. They are set to trip at maximum leakage current value called a threshold or sensitivity level which is measured in mA. The maximum value coincide with the safety limits for human body or for preventing fire.

## EXPERIMENT NO. 9

**Experiment** : To plot  $V - I$  characteristics of a Zener diode and finding its reverse breakdown voltage.

**Objective** : (i) To make the students familiar with different zener diodes.

(ii) To show that zener diode is a special diode which conducts in reversed biased condition after a particular voltage for which it is designed without damaging itself.

**Equipment/Apparatus/Instruments/Components Required**

1. Regulated power supply ; 0-50 V
2. Meter to read d.c. voltage ; 0-50 V
3. Meter to read d.c. current ; 0-100 mA
4. Zener diode ; (i) BZ 148 (ii) ..... (iii) .....
5. Series resistor ; 200  $\Omega$ , 1/2 W
6. Connecting leads etc.

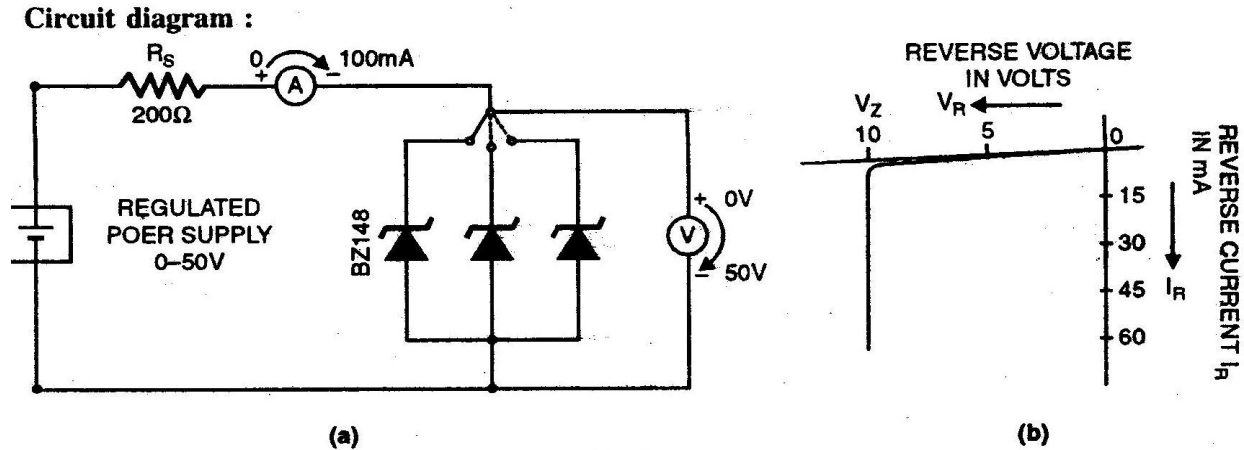


Fig. 9

**Theory :** A specially designed silicon diode which is optimised to operate in the breakdown region (reverse biased) is known as *zener diode*. It is generally operated in the breakdown region. Ordinary diodes are operated in this region, i.e. when they are applied reverse voltage more than their *PIN*, they are damaged.

The forward characteristics of a zener diode are the same as that of an ordinary diode. Therefore, when we talk about  $V - I$  characteristics of a zener diode, we basically talk about its reverse characteristics.

Once a zener diode starts conducting in reverse bias condition, the voltage across it becomes constant i.e.  $V_z$  for which it is designed. It will be damaged only when it carries current more than its rated value.

The probable reverse characteristics of a zener diode are shown in fig. 10(b).

**Procedure :**

To perform the experiment proceed as under :

1. Make the connections as shown in the circuit diagram.
2. Get the connections checked from the teacher incharge before giving supply.
3. Note down the number of the zener diode connected in the circuit. Check and note down the important data regarding each zener from the data book so that diodes may be operated within the safe limits.
4. Set the meters (voltmeter and ammeter) to their proper range and select the zener for experiment through selector switch.
5. Bring the knob of the power supply to zero and switch- ON the supply to the DC power supply.
6. Increase the d.c. voltage supplied to the circuit by rotating the knob of the power supply in clockwise direction in small steps having a close watch on the ammeter.
7. Record the voltmeter and ammeter reading in the observation table.
8. Plot reverse  $V - I$  characteristics of the zener diode choosing suitable scale as shown in Fig. 9.3.
9. Note the voltage at which zener starts conducting heavily. This is called breakdown voltage ( $V_z$ ) of the zener.
10. Switch-OFF the supply given to the power supply, bring the knob to zero position, change the zener diode with selector switch and repeat the experiment.

## OBSERVATIONS

Zener in circuit .....			Zener in circuit .....		
S. No.	Voltmeter reading	Ammeter reading	S. No.	Voltmeter reading	Ammeter reading
1.			1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		

Breakdown voltage of zener .....,  $V_z =$  ..... volts.

Breakdown voltage of zener .....,  $V_z =$  ..... volts.

## EXPERIMENT NO. 10

**Experiment :** Study of earthing practices

**Objective :** To make the students familiar with earthing procedure.

**Apparatus/Instruments/Components required :**

1. Boring machine
2. Material required for pipe earthing such as GI pipe of different sizes, charcoal, common salt, cement/sand/crushed stone etc.

3. Various tools.

**Procedure for pipe earthing :**

The pipe used as earth electrode is galvanised and perforated. Its diameter is 38.1 mm and length is 2 meters. The length may be increased to 2.75 meters in case of dry soil. The diameter of pipe has very little effect on the resistance of the earth connection. To facilitate the driving in of the pipe into ground, it is provided with the tapered casting at the lower end. Another pipe of 19.05 mm diameter and of length 2.45 metre is connected at the top of the above said pipe. The connection between these pipes is made through a reducing socket, as shown in fig. 10.

The earthing lead should be soldered and connected to the pipe. Alternate layers of charcoal and salt are provided around the G.I. pipe to keep the surroundings moist

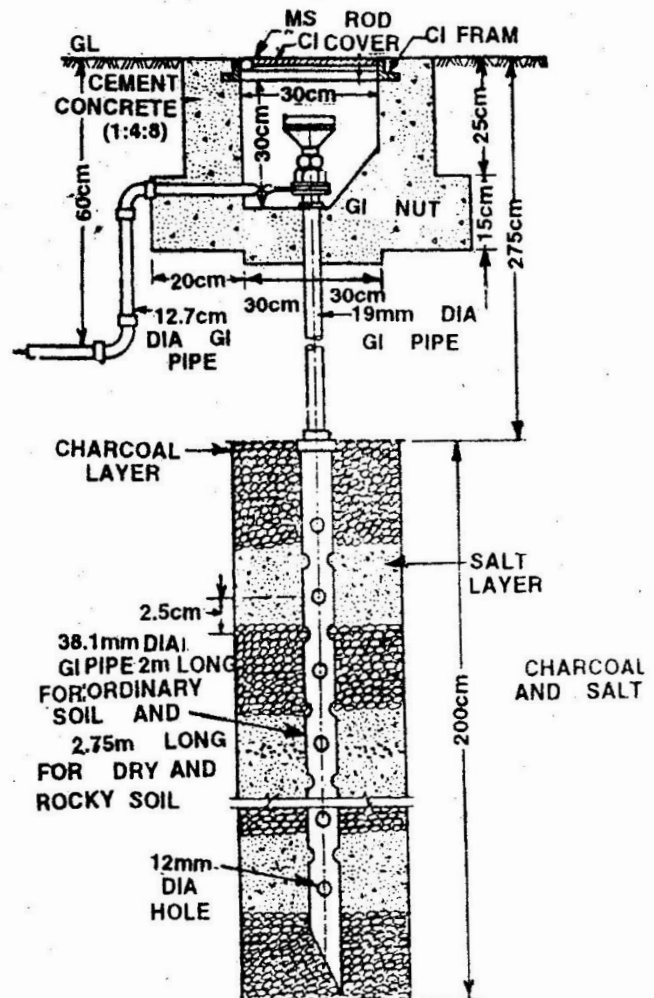


Fig. 10

enough. The salt is poured at the bottom and thereafter alternate layers of salt and charcoal are arranged.

## EXPERIMENT 11

**Experiment :** To plot input and output characteristics of a NPN transistor in CB configuration.

**Objective :**

- (i) To make the students familiar with (i) the transistor terminals and its connections where base is made common.
- (ii) Input and output characteristics of a transistor in CB configuration.
- (iii) Utility of the transistor in electronic circuits.

**Equipment/Apparatus/Instruments/Components required :**

1. Bread board or experiment board containing
  - (i) Transistor : BC 147 (or any other)
  - (ii) Resistor : 100, 1/2 W
2. DC Regulated power supplies : 2 No.
3. Electronic voltmeters : 2 No.
4. Ammeters : ( 0H-50 mA) – 2 No.

**Circuit diagram :**

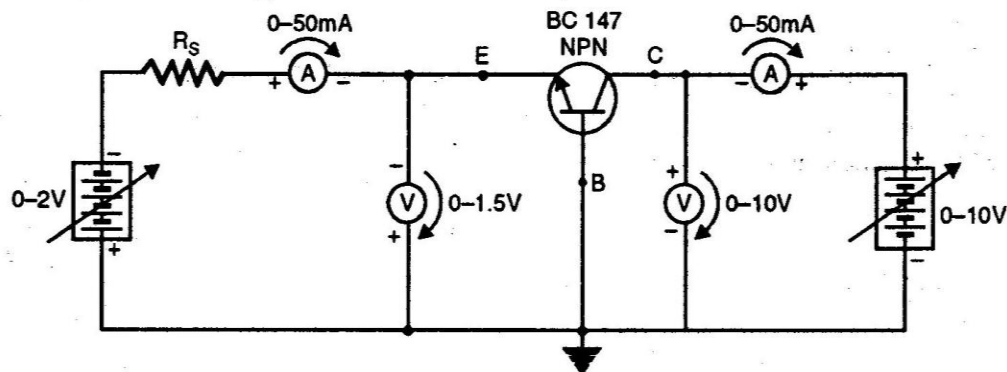


Fig. 11

**Theory :**

**Input Characteristics :** In CB configuration, the curve plotted between emitter current  $I_E$  and the emitter-base voltage  $V_{EB}$  at constant collector-base voltage  $V_{CB}$  is called input characteristics.

These characteristics are just like diode  $V - I$  characteristics. These characteristics are used to determine input dynamic resistance, i.e.

$$r_i = \frac{\Delta V_{EB}}{\Delta I_E} \text{ at constant } V_{CB}$$

**Output Characteristics :** In CB configuration, the curve plotted between collector current  $I_C$  and the collector-base voltage  $V_{CB}$  at constant emitter current  $I_E$  is called output characteristics.

These characteristics are used to determine output dynamic resistance, i.e.

$$r_{o0} = \frac{\Delta V_{CB}}{\Delta I_C} \text{ at constant } I_E$$

From both the characteristics, we may determine d.c. and a.c. current amplification factor ;

$$\alpha_{dc} = \frac{I_C}{I_E}$$

and  $\alpha_{ac} = \frac{\Delta I_C}{\Delta I_E}$  at constant  $V_{CB}$

**Procedure :**

To perform the experiment proceed as under :

1. Make the connections as shown in the circuit diagram.
2. Get the connections checked from the teacher incharge.
3. Set both the power supplies at zero. Switch ON the a.c. input to both the power supplies.
4. For input characteristics, fix and voltage  $V_{CB} = 5$  V. Now increase the  $V_{EB}$  voltage in step of 0.05 V and note down the corresponding value of emitter current  $I_E$  and record them in the observation table.
5. Draw the input characteristics taking  $V_{EB}$  on x-axis and  $I_E$  on y-axis.
6. Repeat the step 4 and 5 for  $V_{CB} = 10$  V.
7. For output characteristics, fix  $I_E = 0$  mA i.e. keep the input circuit open. Change the collector-base voltage  $V_{CB}$  in steps and note down the corresponding values of  $I_C$ . Record the readings in the observation table.
8. Draw the output, characteristics taking  $V_{CB}$  on x-axis and  $I_C$  on y-axis.

**Observations :**

**For Input Characteristics**

S. No.	$V_{CB} = 5V$		$V_{CB} = 10 V$	
	$V_{EB}$ (in volts)	$I_E$ (in mA)	$V_{EB}$ (in volts)	$I_E$ (in mA)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

**For Output Characteristics**

S. No.	$I_E = 0 mA$		$I_E = 2 mA$		$I_E = 4 mA$	
	$V_{CB}(V)$	$I_C(mA)$	$V_{CB}(V)$	$I_C(mA)$	$V_{CB}(V)$	$I_C(mA)$
..						
..						

3.						
4.						
5.						
6.						
7.						

## EXPERIMENT 12

**Experiment :** To draw the  $V - I$  characteristics of an SCR.

**Objectives :**

- (i) To make the students familiar with the device called SCR.
- (ii) To make the students familiar with  $V - I$  characteristics of an SCR by taking various observations.
- (iii) To make the students familiar with breakover voltage of an SCR.

**Equipment/Apparatus/Instruments/Components required**

1. Experimental board containing various components as shown in circuit diagram.
2. Variable dc power supply
  - (i) 0 - 20 V, 500 mA - 1 No.
  - (ii) 0 - 200 V, 1A - 1 No.
3. Ammeters
  - (i) 0 - 10 mA - 1 No.
  - (ii) 0 - 20 A - 1 No.
4. Digital multimeters - 2 No.
5. Connecting leads etc.

**Circuit diagram :**

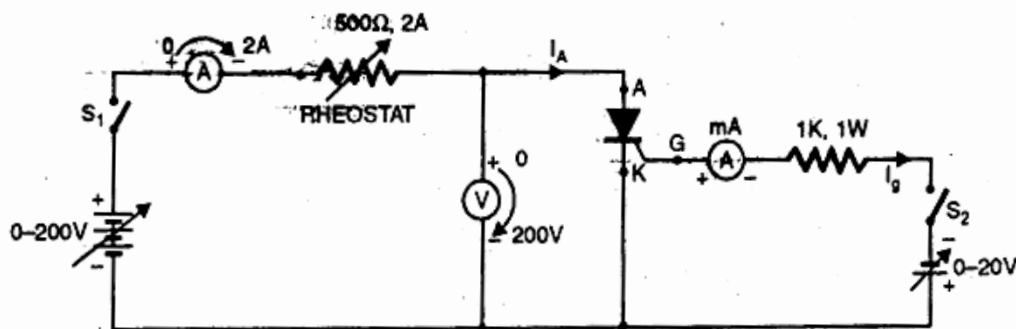


Fig. 12

**Theory :** An SCR is a four-layer (PNPN), three terminal device. The terminals are known as anode (A), cathode (K) and gate (G). It is a unidirectional device which can handle heavy power. It conducts only when it is forward biased *i.e.* when anode is kept at higher potential to that of cathode. The anode voltage at which it starts conducting is called *breakover voltage*. The breakover voltage of the device can be reduced by applying positive potential to its gate.

Thus, the breakover voltage of the device can be regulated by regulating the gate current.

**Procedure :**

To perform the experiment proceed as follows :

1. Make the connections as shown in circuit diagram and get them checked from the teacher incharge.
2. Keep the switch  $S_2$  open which is placed in the gate circuit. So that  $I_g = 0$ .
3. Bring the anode voltage to zero and close the switch  $S_1$  placed in the anode circuit.
4. Increase the anode voltage gradually and record the voltmeter ( $V$ ) and ammeter ( $I_A$ ) reading, connected in the anode circuit, in the observation table.
5. Note down the breakover voltage, then decrease the anode voltage to zero and open switch  $S_1$ .
6. Close the switch  $S_2$  placed in the gate circuit and set the gate current  $I_g = 2$  mA.
7. Repeat the steps from 3 to 6.
8. Repeat the experiment for different settings of gate current.
9. Plot the curve between anode supply voltage  $V_{CC}$  and anode current  $I_A$ .

**Observations :**

S. No.	$V_{CC}$	$I_G = 0$		$I_G = 2mA$		$I_G = 3mA$		$I_G = \dots\dots mA$	
		$I_A$	$V_{AK}$	$I_A$	$V_{AK}$	$I_A$	$V_{AK}$	$I_A$	$V_{AK}$
1.	0	0	0						
2.	25	0	25						
3.	50	0	50						
4.	—	—							
5.	—	—	—						
6.	—	—	—						
7.	—	—	—						

**Result :**

1. The breakover voltage decreases, when gate current is increased.

### 3.4 WORKSHOP TECHNOLOGY-1

#### DETAILED CONTENTS

L T P  
3 - 2

#### 1. Welding

(22 hrs)

##### 1.1 Welding Process

Principle of welding, Classification of welding processes, Advantages and limitations of welding, Industrial applications of welding, Welding positions and techniques, symbols.

##### 1.2 Gas Welding

Principle of operation, Types of gas welding flames and their applications, Gas welding equipment - Gas welding torch, Oxy acetylene cutting torch, Blow pipe, Pressure regulators, Filler rods and fluxes

##### 1.3 Arc Welding

Principle of operation, Arc welding machines and equipment, A.C. and D.C. arc welding, Effect of polarity, current regulation and voltage regulation, Electrodes: Classification, B.I.S. specification and selection, Flux for arc welding

##### 1.4 Other Welding Processes

Resistance welding: Principle, advantages, limitations, working and applications of spot welding, seam welding, projection welding and percussion welding, Atomic hydrogen welding, Shielded metal arc welding, submerged arc welding, Welding distortion, welding defects, methods of controlling welding defects and inspection of welded joints.

##### 1.5 Modern Welding Methods

Methods, Principle of operation, advantages, disadvantages and applications of, Tungsten inert gas (TIG) welding, Metal inert gas (MIG) welding, Thermit welding, Electro slag welding, Electron beam welding, Ultrasonic welding, Laser beam welding, Robotic welding

#### 2. Pattern Making

(05 hrs)

Types of pattern, Pattern material, Pattern allowances, Pattern codes as per B.I.S., Introduction to cores, core boxes and core materials, Core making procedure, Core prints, positioning of cores

#### 3. Moulding and Casting

(22 hrs)

##### 3.1 Moulding Sand

Properties of moulding sand, their impact and control of properties viz. permeability, refractoriness, adhesiveness, cohesiveness, strength, flow ability, collapsibility, Various types of moulding sand, Testing of moulding sand.

##### 3.2 Mould Making

Types of moulds, Step involved in making a mould, Molding boxes, hand tools used for mould making, Molding processes: Bench molding, floor molding, pit molding and machine molding, Molding machines squeeze machine, jolt squeeze machine and sand slinger.

### 3.3 Casting Processes

Charging a furnace, melting and pouring both ferrous and non ferrous metals, cleaning of castings, Principle, working and applications of Die casting: hot chamber and cold chamber, Investment and lost wax process, Centrifugal casting

### 3.4 Gating and Riser System

Elements of gating system, Pouring basin, sprue, runner, gates, Types of risers, location of risers, Directional solidification

### 3.5 Melting Furnaces

Construction and working of Pit furnace, Cupola furnace, Crucible furnace – tilting type, Electric furnace

### 3.6 Casting Defects

Different types of casting defects, Testing of defects: radiography, magnetic particle inspection and ultrasonic inspection.

## 4. Metal Forming Processes

(10 hrs)

4.1 Press Working - Types of presses, type of dies, selection of press die, die material. Press Operations-Shearing, piercing, trimming, punching, notching, shaving, gearing, embossing, stamping

4.2 Forging - Open die forging, closed die forging, Press forging, upset forging, swaging, up setters, roll forging, Cold and hot forging

4.3 Rolling - Elementary theory of rolling, Types of rolling mills, Thread rolling, roll passes, Rolling defects and remedies

4.4 Extrusion and Drawing - Type of extrusion- Hot and Cold, Direct and indirect. Pipe drawing, tube drawing, wire drawing

## 5. Plastic Processing

(05 hrs)

5.1 Industrial use of plastics, situation where used.

5.2 Injection moulding-principle, working of injection moulding machine.

5.3 Compression moulding-principle, and working of compression moulding machine.

5.4 Potential and limitations in the use of plastics

## LIST OF PRACTICALS

General introduction to hand tools used in foundry, welding and pattern making and smithy shop.

### 1. Welding Shop

Job 1. Preparing gas welding joint in vertical position joining M.S. Plates

Job 2. Exercise on gas cutting of mild steel plate with oxy-acetylene gas torch.

Job 3. Exercise on gas welding of cast iron and brass part or component.

Job 4. Exercise on preparation of T Joint by arc welding

Job 5. Exercise on spot welding/seam welding

Job 6. Exercise on MIG and TIG welding

### 2. Pattern making

Job 1. Preparation of solid/single piece pattern.

Job 2. Preparation of two piece/split pattern

Job 3. Preparation of a pattern on wooden lathe

Job 4. Preparation of a self cored pattern

Job 5. Preparation of a core box.

### 3. Foundry Shop

Job 1. Preparation of mould with solid pattern on floor.

Job 2. Preparation of floor mould of solid pattern using cope.

Job 3. Preparation of floor mould of split pattern in cope and drag of moulding box.

Job 4. Moulding and casting of a solid pattern of aluminum

Job 5. Preparing a mould of step pulley and also preparing core for the same.

Job 6. A visit to cast iron foundry should be arranged to have first hand knowledge of cast iron melting pouring and casting.

Job 7. Testing of moisture contents and strength of moulding sand.

### 4. Forging Shop/Fitting Shop/Sheet Metal Shop

Job 1. Preparation of single ended spanner by hand/machine forging.

Job 2. Preparation of simple die

Job 3. Demonstration of spinning process on lathe and spinning a bowl on a lathe machine.

Job 4. Demonstration of grinding process on lathe machine and grinding a job on a lathe machine

Job 5. Preparation of utility item out of G.I. sheet.

Job 6. Preparation of drilling Jig.

## Practicals

### 1. WELDING SHOP

#### JOB-1

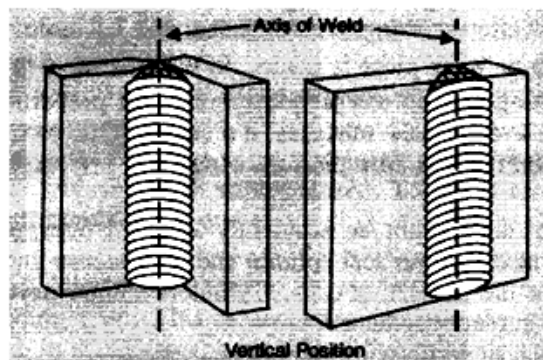
**Object :** Preparing gas welding joint in vertical position joining M.S. Plate.

**Tools Required :** Scale, scribe, try square, center punch, shearing machine, bench vice, hammer anvil, chipping hammer, wire brush, scale or foot rule, hacksaw, chisel and number punch.

**Material Required :** Mild steel Flat 50 mm × 8 mm & M.S. welding electrode 3.15 mm.

**Equipment Required :** High pressure gas cutting set with power supply, welding cables, electrode holder earth clamp, welding screen, hand gloves, leather apron & welding table.

**Method : Marking and Cutting :** Marking of M.S. flat as per given dimensions by scale, scribe, chalk & try square and after marking, cut M.S. flat with hacksaw or shearing machine.



**Setting and Tacking :** Job or work piece is placed on welding table in flat positions & tacked.

**Welding :** Mark parallel three lines on the work piece or job surface with the help of chalk. Before starting the M/C check all connections of power supply. Now welding M/C is started with the help of change over switch. M.S. electrode size 3.15 mm or 10 S.W.G. is held in electrode holder. Current is set by current regulator upto 80 amp – 120 amp or according to the diameter of the electrode. Wear the hand gloves & leather apron. Electrode holder is held in right side and welding screen in the left hand. Face & eyes are covered with welding screen before starting the arc. Welding is started from one corner of the work piece. Make beads between the parallel lines. Select proper gap and electrode positions. Continue practice to make beads until you can produce uniform beads. After completion of beads the M/C is switched off & tools are set on proper size.

**Finishing :**

1. Slag is cleaned from weld beads with the help of chipping hammer.
2. Spatter is cleaned with the help of chisel and chipping hammer.
3. Job or work piece surface is cleaned by wire brush.
4. Extra welding material is finished by flat file or grinder.
5. Job put on anvil by tong & write roll no. on surface of job by number punch.

**Precautions :**

1. Keep your mind on your job. Do not be careless.
2. Check the connections of power supply before starting the welding set.
3. During welding use a welding screen or face shield.
4. Always use hand gloves and leather apron for against heat and spatter.
5. Always wear goggles during chipping operations.
6. Hot work piece or job is held by tong.
7. Do not use expired date & wet electrode.

## **JOB-2**

**Object :** Exercise on gas cutting of mild steel plate with oxy acetylene gas torch.

**Tools Required :** Scale, scribe, try square, center punch, shearing machine, bench vice, hammer anvil, chipping hammer, wire brush, scale or foot rule, hacksaw, chisel and number punch.

**Material Required :** Mild steel Flat 50 mm × 8 mm & M.S. welding electrode 3.15 mm.

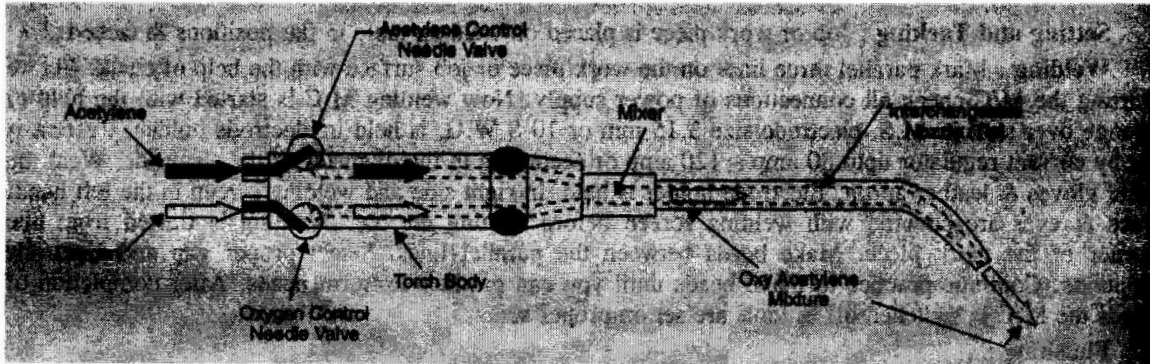
**Equipment Required :** High pressure gas cutting set with power supply, welding cables, electrode holder earth clamp, welding screen, hand gloves, leather apron & welding table.

**Method : Marking and Cutting :** Marking of M.S. flat as per given dimensions by scale, scribe, chalk & try square and after marking, cut M.S. flat with hacksaw or shearing machine.

**Setting and Tacking :** Job or work piece is placed on welding table in flat positions & tacked.

**Cutting Procedure :** Setting up the oxygas equipment and preparing for cutting must be done carefully and systematically to avoid costly mistakes. To ensure your own safety, as well as the safety of your coworkers and equipment, make sure the following steps are taken before any attempt is made to light the torch :

1. Secure the cylinders so they cannot be accidentally knocked over. A good way to do this is to either put them in a corner or next to a vertical column and then secure them with a piece of line. After securing the cylinders, remove the protective caps. Cylinders should never be secured to a structural member of a building that is a current conductor.



### Oxy - acetylene welding torch

2. Standing to one side, crack each cylinder valve slightly and then immediately close the valve again. This blows any dirt or other foreign matter out of the cylinder valve nozzle. Do not bleed fuel

gas into a confined area because it may ignite. Ensure the valves are closed and wipe the connections with a clean cloth.

3. Connect the fuel-gas regulator to the fuel-gas cylinder and the oxygen regulator to the oxygen cylinder. Using a gang wrench, snug the connection nuts sufficiently to avoid leaks.

4. Back off the regulator screws to prevent damage to the regulators and gauges and open the cylinder valves slowly. Open the fuel-gas valve only one-half turn and the oxygen valve all the way. Some fuel-gas cylinders have a handwheel for opening the fuel-gas valve while others require the use of a gang wrench or T-handle wrench. Leave the wrench in place while the cylinder is in use so the fuel-gas bottle can be turned off quickly in an emergency. Read the high-pressure gauge to check the contents in each cylinder.

5. Connect the RED hose to the fuel-gas regulator and the GREEN hose to the oxygen regulator. Notice the left-hand threads on the fuel-gas connection.

6. To blow out the oxygen hose, turn the regulator screw in (clockwise) and adjust the pressure between 2 and 5 psig. After the hose has been purged, turn the screw back out again (counterclockwise) to shutoff the oxygen. Do the same for the fuel-gas hose, but do it **ONLY** in a well-ventilated place that is free from sparks, flames, or other possible sources of ignition.

7. Connect the hoses to the torch. The RED (fuel-gas) hose is connected to the connection gland with the needle valve marked "FUEL." The GREEN (oxygen) hose is connected to the connection gland with the needle valve marked "OXY."

8. With the torch valves closed, turn both regulator screws clockwise to test the hose connections for leaks. If none are found, turn the regulator screws counterclockwise and drain the hose by opening the torch valves.

9. Select the correct cutting tip and install it in the cutting torch head. Tighten the assembly by hand, and then tighten with your gang wrench.

10. Adjust the working pressures. The fuel-gas pressure is adjusted by opening the torch needle valve and turning the fuel-gas regulator screw clockwise. Adjust the regulator to the working pressure needed for the particular tip size, and then close the torch needle valve. To adjust MAPP gas, you should set the gauge pressure with the torch valves closed. To adjust the oxygen working pressure, you should open the oxygen torch needle valve and proceed in the same manner as in adjusting the fuel-gas pressure.

In lighting the torch and adjusting the flame, always follow the manufacturer's directions for the particular model of torch being used. This is necessary because the procedure varies somewhat with different types of torches and, in some cases, even with different models made by the same manufacturer.

In general, the procedure used for lighting a torch is to first open the torch oxygen needle valve a small amount and the torch fuel-gas needle valve slightly more, depending upon the type of torch. The mixture of oxygen and fuel gas coming from the torch tip is then lighted by means of a spark igniter or stationary pilot flame.

**Precautions :**

1. Keep your mind on your job. Do not be careless.
2. Check the connections of power supply before starting the welding set.
3. During welding use a welding screen or face shield.
4. Always use hand gloves and leather apron for against heat and spatter.
5. Always wear goggles during chipping operations.
6. Hot work piece or job is held by tong.
7. Do not use expired date & wet electrode.

**JOB-3**

**Object :** Exercise on gas welding of cast iron and brass part or component.

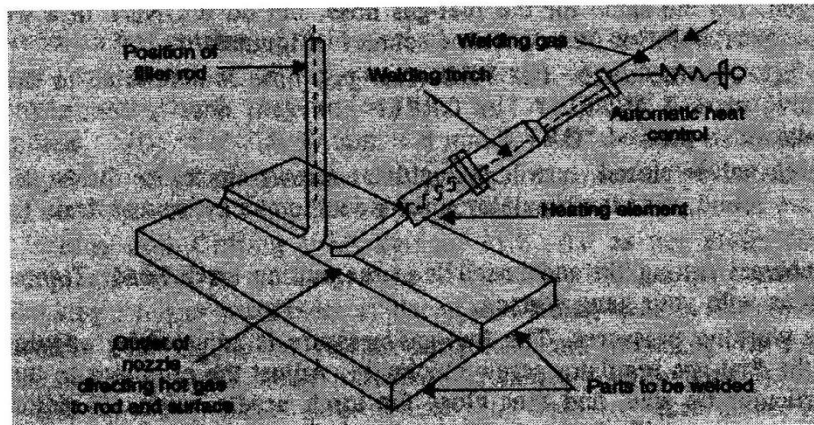
**Tools Required :** Scale, scribe, try square, center punch, shearing machine, bench vice, hammer anvil, chipping hammer, wire brush, scale or foot rule, hacksaw, chisel and number punch.

**Material Required :** Cast iron or brass part size 2 x 20 S.W.G. & cast iron welding electrode 3.15 mm.

**Equipment Required :** Arc welding transformer set with power supply, welding cables, electrode holder earth clamp, welding screen, hand gloves, leather apron & welding table.

**Method : Marking and Cutting :** Marking of Cast Iron and Brass Part as per given dimensions by scale, scribe, chalk & try square and after marking, cut cast iron and brass part with hacksaw or shearing machine.

**Setting and Tacking :** Job or work piece is placed on welding table in flat positions & tacked.



**Schematic of hot gas welding showing correct position of torch and filter rod**

**Welding :** Before starting the M/C check all connections of power supply. Now welding M/C is started with the help of change over switch. M.S. electrode size 3.15 mm or 10 S.W.G. is held in electrode holder. Current is set by current regulator upto 80 amp – 120 amp or according to the diameter of the electrode. Wear the hand gloves & leather apron. Electrode holder is held in right side and welding screen in the left hand. Face & eyes are covered with welding screen before starting the arc. Welding is started from the edge of the joints of the work pieces. During welding a circular motion is given to electrode. During welding, adjust the electrode at an angle of 65° to 75° with the base of work piece. Select proper air gap & welding speed. After having one run of welding, if required another can be taken. After completion of job welding M/C is switched off . The work piece or weld is later chipped off & cleaned with chipping hammer & wire brush.

### Finishing :

1. Slag is cleaned from weld beads with the help of chipping hammer.
2. Spatter is cleaned with the help of chisel and chipping hammer.
3. Job or work piece surface is cleaned by wire brush.
4. Extra welding material is finished by flat file or grinder.
5. Job put on anvil by tong & write roll no. on surface of job by number punch.

### Precautions :

8. Keep your mind on your job. Do not be careless.
9. Check the connections of power supply before starting the welding set.
10. During welding use a welding screen or face shield.
11. Always use hand gloves and leather apron for against heat and spatter.
12. Always wear goggles during chipping operations.
13. Hot work piece or job is held by tong.
14. Do not use expired date & wet electrode.

## JOB-4

### Object : Preparation of T Joint by Arc welding.

**Tools Required :** Scale, scribe, try square, center punch, shearing machine, bench vice, hammer anvil, chipping hammer, wire brush, scale or foot rule, hacksaw, chisel and number punch.

**Material Required :** Mild steel Flat 50 mm × 8 mm & M.S. welding electrode 3.15 mm.

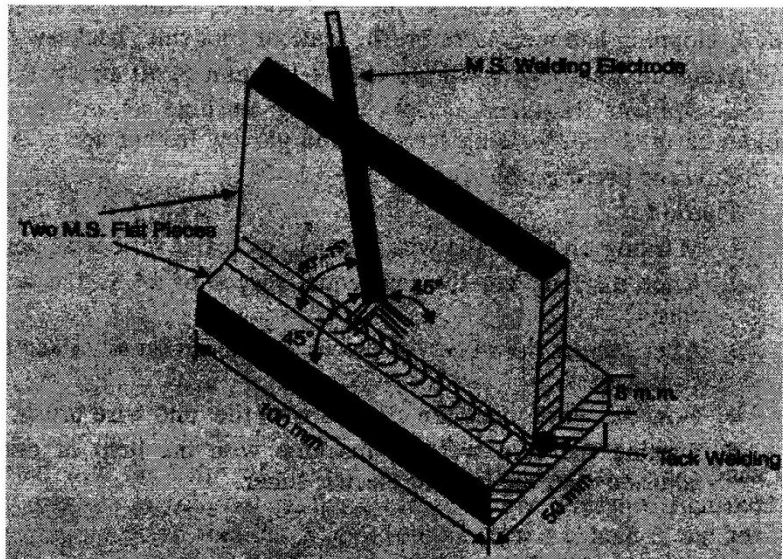
**Equipment Required :** Arc welding transformer set with power supply, welding cables, electrode holder earth clamp, welding screen, hand gloves, leather apron & welding table.

**Method : Marking and Cutting :** Marking of M.S. Flat as per given dimensions by scale, scribe, chalk & try square and after marking, cut M.S. flat with hacksaw or shearing machine.

**Setting and Tacking :** One M.S. piece is set on the welding table in flat position & mark one line in the center of work piece which is placed on the table & second M.S. piece is set or adjust on the center line at right angle & thus making a T-shape and tacked.

**Welding :** Before starting the M/C check all connections of power supply. Now welding M/C is started with the help of change over switch. M.S. electrode size 3.15 mm or 10 S.W.G. is held in electrode holder. Current is set by current regulator up to 80 amp – 120 amp or according to the diameter of the electrode. Wear the hand gloves & leather apron.

Electrode holder is held in right side and welding screen in the left hand. Face & eyes are covered with welding screen before starting the arc. Welding is started from the edge of the joints of the work pieces. During welding a circular motion is given to electrode. During welding, adjust the electrode at an angle of 65° to 75° with the base of work piece and left and right side angle of electrode is selected at 45° with the base of job. Select proper air gap & welding speed. After having one run of welding, if required another can be taken. After completion of job welding M/C is switched off. The work piece or weld is later chipped off & cleaned with chipping hammer & wire brush. All the tools and equipments are set on proper places.



**Finishing :**

1. Slag is cleaned from weld beads with the help of chipping hammer.
2. Spatter is cleaned with the help of chisel and chipping hammer.
3. Job or work piece surface is cleaned by wire brush.
4. Extra welding material is finished by flat file or grinder.
- 5 Job put on anvil by tong & write roll no. on surface of job by number punch.

**Precautions :**

1. Keep your mind on your job. Do not be careless.
2. Check the connections of power supply before starting the welding set.
3. During welding use a welding screen or face shield.
4. Always use hand gloves and leather apron for against heat and spatter.
5. Always wear goggles during chipping operations.
6. Hot work piece or job is held by tong.
7. Do not use expired date & wet electrode.
8. Earthing of the machine should be proper.
9. Do not walk bare footed in the workshop. Always use rubber sole shoes.

**JOB-5**

**Object :** Exercise on spot/seam welding.

**Tools Required :** Scale, scribe, try square, center punch, shearing machine, bench vice, hammer anvil, chipping hammer, wire brush, scale or foot rule, hacksaw, chisel and number punch.

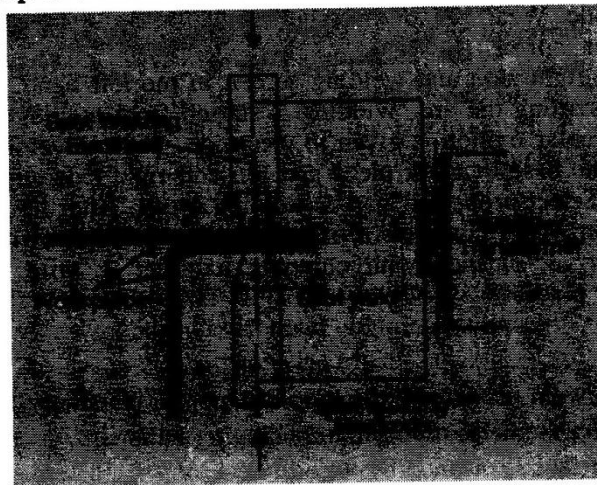
**Material Required :** Mild steel Flat 100 mm × 50 mm × 4 mm = Two pieces

**Equipment Required :** Spot welding machine set with power supply, welding cables, electrode holder earth clamp, welding screen, hand gloves, leather apron & welding table.

**Current Setting :** 65 Amps

**Method :**

1. Marking on M.S. flat with the help of scale, scribe as per given dimension.
2. After marking cut the two equal pieces of M.S. flat according to drawing with the help of chisel.
3. After cutting the M.S. flat pieces are placed on anvil and hammering of work pieces is done for straightness.
4. Now the work piece are cleaned with tile and wire brush.
5. Starting the spot welding machine with the help of change over switch and time is set or adjusted with the help of electric timer.



**Precautions :**

1. Keep your mind on your job. Do not be careless.
2. Check the connections of power supply before starting the welding set.
3. During welding use a welding screen or face shield.
4. Always use hand gloves and leather apron for against heat and spatter.
5. Always wear goggles during chipping operations.
6. Hot work piece or job is held by tong.
7. Do not use expired date & wet electrode.

**JOB-6****Object : Exercise on TIG welding**

**Tools Required :** Scale, scribe, try square, center punch, shearing machine, bench vice, hammer anvil, chipping hammer, wire brush, scale or foot rule, hacksaw, chisel and number punch.

**Material Required :** Mild steel Flat 50 mm × 8 mm & M.S. welding electrode 3.15 mm.

**Equipment Required :** D.C. welding machine with power supply, CO<sub>2</sub> cylinder with pressure regulators and flow meter, welding cables, electrode holder earth clamp, welding screen, hand gloves, leather apron & welding table.

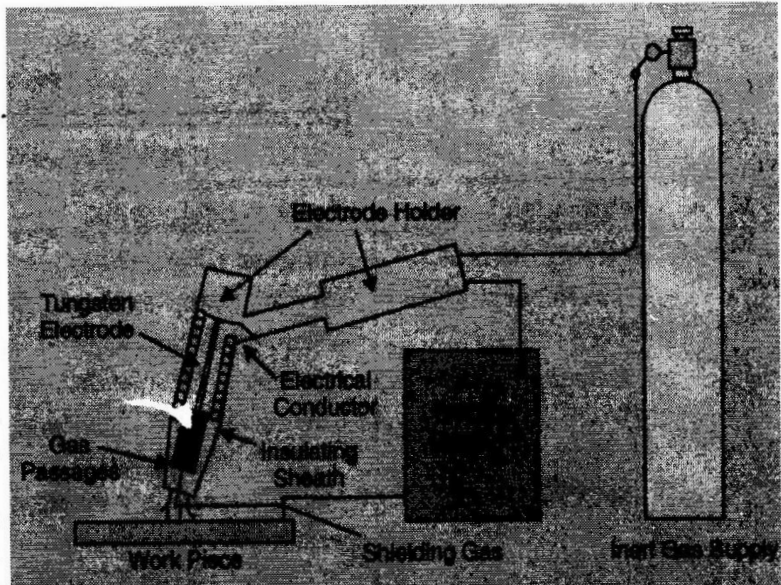
**Method : Setting and Tacking :**  
Job or work piece is placed on welding table in flat positions & tacked.

**Procedure :** First the -ve pole of the power supply is clamped with the welding table by welding cables and then +ve pole is attached with central unit metal electrode in the whole unit.

Now D.C. welding machine is started with the help of change over switch. Now open CO<sub>2</sub> gas cylinder with cylinder key. Now further pressure is adjusted on the pressure screw. Pressure adjusted on flow meter is 15-20 spn. The welding gun is held in right hand and welding screen is held in the left hand. When welding electrode is pressed against the work piece welding starts. The inert gas with standard value is opened and starts the water jet coming and also the feed mechanism. After completion of job welding switch is turned off and CO<sub>2</sub> cylinder is locked with cylinder key.

**Precautions :**

1. Keep your mind on your job. Do not be careless.
2. Check the connections of power supply before starting the welding set.
3. During welding use a welding screen or face shield.
4. Always use hand gloves and leather apron for against heat and spatter.
5. Always wear goggles during chipping operations.
6. Hot work piece or job is held by tong.
7. Do not use expired date & wet electrode.



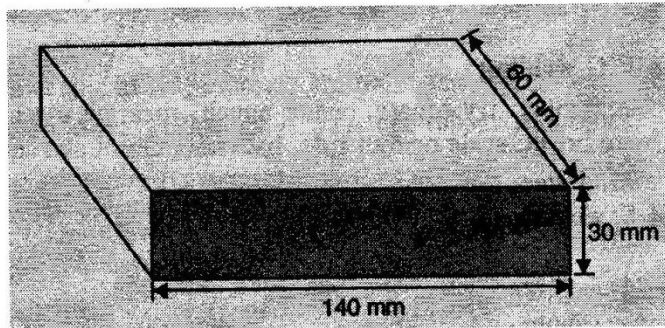
## 2. PATTERN MAKING

### JOB-1

**Object :** Preparation of solid/single piece pattern.

**Material of Job :** Softwood (Kail)

**Procedure :**



S.No.	Operation	Tools & Equipments	Method
1.	Cutting the raw material or wooden piece	Carpentary Vice, rip saw, marking gauge, steel rule, pencil, try square	Cut the wooden pieces according to the size of the job
2.	Planing the job	Jack plane, try square, bench hook	Sides & Upper & lower surface of job or work piece is to be smooth
3.	Marking the job	Marking gauge, try square, pencil, steel rule.	Mark the job according to the drawings
4.	Extensive planing	Smooth planer	After smooth planing the job is smooth
5.	Finishing the job	Sand paper rush file	After extensive planing is done on the pattern.

**Precautions :**

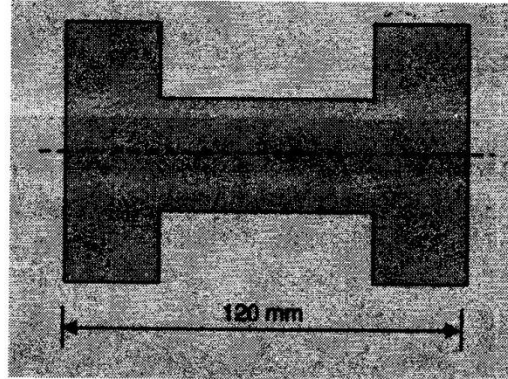
1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.
7. Never walk bare footed in the workshop.
8. Do not carry tools in your pockets.
9. Loose clothing should always be avoided.

## JOB-2

**Object :** Preparation of two piece/ split pattern.

**Material of Job :** Softwood (Kail)

**Procedure :**



S.No.	Operation	Tools & Equipments	Method
1.	Cutting the raw material or wooden piece	Carpentary Vice, rip saw, marking gauge, steel rule, pencil, try square	Cut the wooden pieces according to the size of the job
2.	Planing the job	Jack plane, try square, bench hook	Sides & Upper & lower surface of job or work piece is to be smooth
3.	Marking the job	Marking gauge, try square, pencil, steel rule.	Mark the job according to the drawings
4.	Extensive planing	Smooth planer	After smooth planing the job is smooth
5.	Finishing the job	Sand paper rush file	Finishing both the part or piece

**Precautions :**

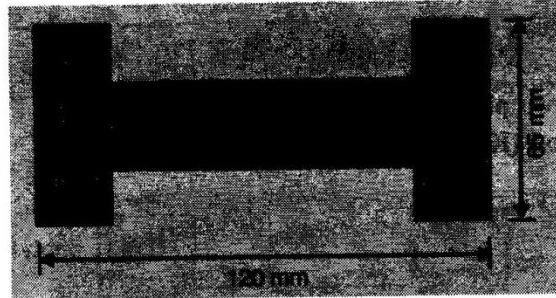
1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

## JOB-3

**Object :** Preparation of pattern on wooden lathe.

**Material of Job :** Softwood (Kail)

**Procedure :**



S.No.	Operation	Tools & Equipments	Method
1.	Cutting the raw material or wooden piece	Carpentary vice, rip saw, marking gauge, steel rule, pencil, try square	Cut the wooden pieces according to the size of the job
2.	Marking the job	Jack plane, try square, bench hook	Sides & Upper & lower surface of job or work piece is to be smooth
3.	Turning the job	Marking gauge, try square, pencil, steel rule	The job is held between the center of head stock & tail stock center is turned

**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

**JOB-4**

**Object : Preparation of self cored pattern.**

**Material of Job : Softwood (Kail)**

**Procedure :**

S.No.	Operation	Tools & Equipments	Method
1.	Cutting the raw material or wooden piece	Carpentary vice, rip saw, marking gauge, steel rule, pencil, try square	Cut the wooden pieces according to the size of the job
2.	Planing the job	Jack plane, try square, bench hook	Sides & Upper & lower surface of job or work piece is to be smooth
3.	Marking the job	Marking gauge, try square, pencil, steel rule. Sand paper rush file	Mark the job according to the drawings. After drilling finishing of the part or piece is done

**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

**JOB-5**

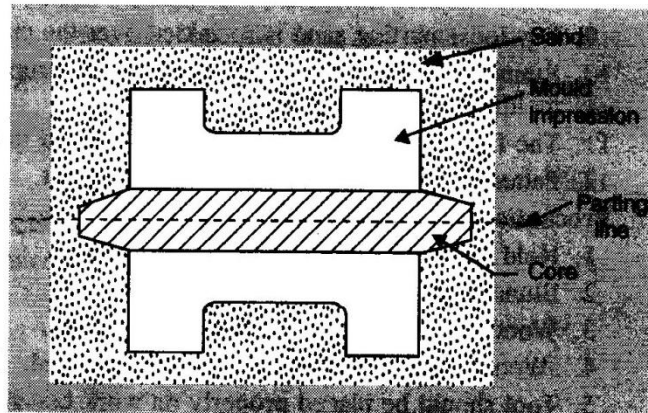
**Object : Preparation of a core box**

**Material of Job : Softwood (Kail)**

**Procedure :**

There are six steps in this process :

1. Place a pattern in sand to create a mold.
2. Incorporate the pattern and sand in a gating system.
3. Remove the pattern.
4. Fill the mold cavity with molten metal.
5. Allow the metal to cool.
6. Break away the sand mold and remove the casting.



**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

**3. FOUNDRY SHOP**

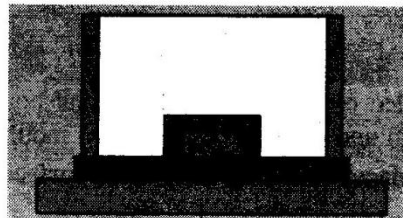
**JOB-1**

**Object : Preparation of mould with solid pattern on floor**

**Tools & Equipments :** Green Sand, Solid Pattern, Molasses, core sand, mixture of graphite dust and clay water and parting sand.

**Procedure :**

1. First of all, a suitable flask is selected, which is large enough to accommodate the pattern and have some space for ramming of sand.



2. The drag part is placed on molding board and the pattern is placed on the board inside the flask. If the pattern is in two parts, then lower half pattern has to be placed in the drag.
3. A parting material is sprinkled over pattern and molding board to facilitate both, the removal of the pattern from the mould and the separation of two mould halves.
4. If facing sand is used, it is placed all along the pattern surface to a suitable depth.
5. The drag is filled with molding sand and it is packed and rammed around the pattern. After the ramming, the excess sand is cut-off with a straight bar called strike rod.
6. Vent holes are pierced in the sand within 15 to 20 mm of pattern surface with vent wire to permit the escape of gases.
7. A small amount of dry sand is sprinkled over the top surface.
8. The cope is placed over the drag and upper half of pattern is properly positioned over the pattern with the help of dowel pins.
9. Dry loose parting sand is sprinkled over the entire surface of pattern.
10. Runner and riser are put in position and supported vertically by tucking a small amount of molding sand around them.
11. The facing sand, if used is again put around the pattern surface upto the desired depth.
12. Pattern is loosened and pattern is drawn out.

**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

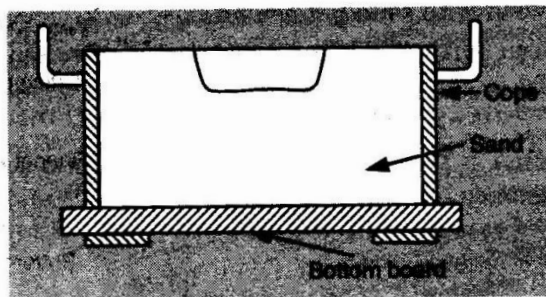
**JOB-2**

**Object :** Preparation of mould with solid pattern using cope.

**Tools & Equipments :** Green Sand, Solid Pattern, Molasses, cope, core sand, mixture of graphite dust and clay water and parting sand.

**Procedure :**

1. First of all, a suitable flask is selected, which is large enough to accommodate the pattern and have some space for ramming of sand.
2. The drag part is placed on molding board and the pattern is placed on the board inside the flask. If the pattern is in two parts, then lower half pattern has to be placed in the drag.



3. A parting material is sprinkled over pattern and molding board to facilitate both, the removal of the pattern from the mould and the separation of two mould halves.
4. If facing sand is used, it is placed all along the pattern surface to a suitable depth.

5. The drag is filled with molding sand and it is packed and rammed around the pattern. After the ramming, the excess sand is cut-off with a straight bar called strike rod.
6. Vent holes are pierced in the sand within 15 to 20 mm of pattern surface with vent wire to permit the escape of gases.
7. A small amount of dry sand is sprinkled over the top surface.
8. The cope is placed over the drag and upper half of pattern is properly positioned over the pattern with the help of dowel pins.
9. Dry loose parting sand is sprinkled over the entire surface of pattern.
10. Runner and riser are put in position and supported vertically by tucking a small amount of molding sand around them.
11. The facing sand, if used is again put around the pattern surface upto the desired depth.
12. The cope is filled with ordinary sand. The sand is rammed and excess sand is removed.
13. A pouring basis is cut adjacent to the sprue and then the sprue and riser pins are withdrawn.
14. The cope is carefully lifted off, temporarily separated from the drag and placed on one side.
15. Pattern is loosened and pattern is drawn out.

**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

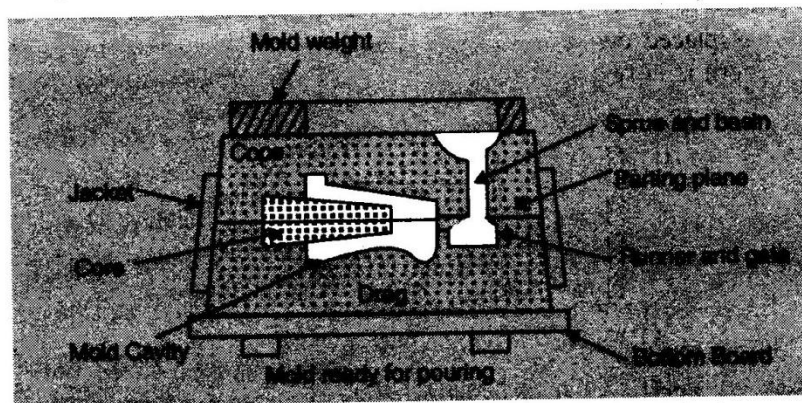
**JOB-3**

**Object :** Preparation of mould with split pattern using cope & drag of moulding box.

**Tools & Equipments :** Green Sand, Split Pattern, Molasses, Cope & Drag core sand, mixture of graphite dust and clay water and parting sand.

**Procedure :**

1. First of all, a suitable flask is selected, which is large enough to accommodate the pattern and have some space for ramming of sand.
2. The drag part is placed on molding board and the pattern is placed on the board inside the flask. If the pattern is in two parts, then lower half pattern has to be placed in the drag.



3. A parting material is sprinkled over pattern and molding board to facilitate both, the removal of the pattern from the mould and the separation of two mould halves.

4. If facing sand is used, it is placed all along the pattern surface to a suitable depth.
5. The drag is filled with molding sand and it is packed and rammed around the pattern. After the ramming, the excess sand is cut-off with a straight bar called strike rod.
6. Vent holes are pierced in the sand within 15 to 20 mm of pattern surface with vent wire to permit the escape of gases.
7. A small amount of dry sand is sprinkled over the top surface.
8. The cope is placed over the drag and upper half of pattern is properly positioned over the pattern with the help of dowel pins.
9. Dry loose parting sand is sprinkled over the entire surface of pattern.
10. Runner and riser are put in position and supported vertically by tucking a small amount of molding sand around them.
11. The facing sand, if used is again put around the pattern surface upto the desired depth.
12. The cope is filled with ordinary sand. The sand is rammed and excess sand is removed.
13. A pouring basin is cut adjacent to the sprue and then the sprue and riser pins are withdrawn.
14. The cope is carefully lifted off, temporarily separated from the drag and placed on one side.
15. Pattern is loosened and pattern is drawn out.

**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

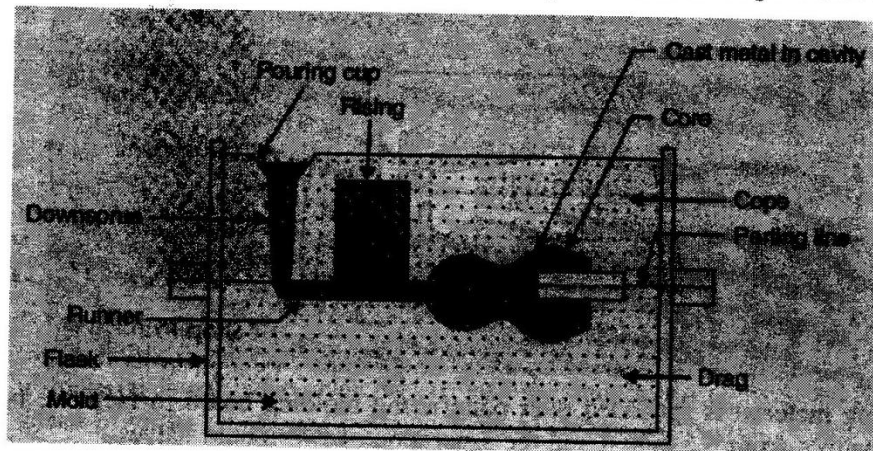
**JOB-4**

**Object : Moulding and Casting of a solid pattern of aluminium**

**Tools & Equipments :** Green Sand, Solid Pattern, Molasses, core sand, mixture of graphite dust and clay water and parting sand, pouring basin, ladle, molten aluminium.

**Procedure :**

1. First of all, a suitable flask is selected, which is large enough to accommodate the pattern and have some space for ramming of sand.
2. The drag part is placed on molding board and the pattern is placed on the board inside the flask. If the pattern is in two parts, then lower half pattern has to be placed in the drag.



3. A parting material is sprinkled over pattern and molding board to facilitate both, the removal of the pattern from the mould and the separation of two mould halves.
4. If facing sand is used, it is placed all along the pattern surface to a suitable depth.
5. The drag is filled with molding sand and it is packed and rammed around the pattern. After the ramming, the excess sand is cut-off with a straight bar called strike rod.
6. Vent holes are pierced in the sand within 15 to 20 mm of pattern surface with vent wire to permit the escape of gases.
7. A small amount of dry sand is sprinkled over the top surface.
8. The cope is placed over the drag and upper half of pattern is properly positioned over the pattern with the help of dowel pins.
9. Dry loose parting sand is sprinkled over the entire surface of pattern.
10. Runner and riser are put in position and supported vertically by tucking a small amount of molding sand around them.
11. The facing sand, if used is again put around the pattern surface up to the desired depth.
12. Now pouring of hot molten aluminium metal is done through the pouring cup.
13. Slowly and steadily the molten aluminium reaches the core & casting chamber.
14. Finally the molding box is left for some desired time duration.
15. After this whole process the solid pattern of aluminium is ready for use.

**Precautions :**

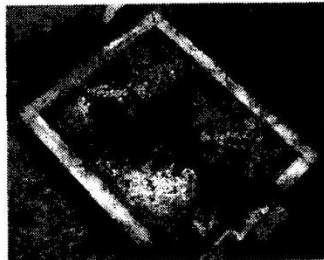
1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

**JOB-5**

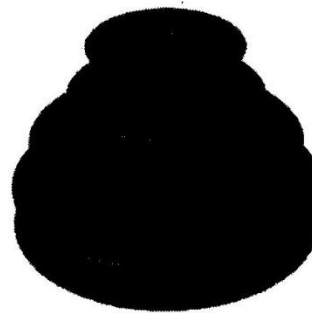
**Object :** Preparing a mould of step pulley and also preparing the core for the same.

**Tools & Equipments :** Green Sand, Solid Pattern, Molasses, core sand, mixture of graphite dust and clay water and parting sand.

**Procedure :**



**Half Mould of Step Pulley**



**Step Pulley**

1. First of all, a suitable flask is selected, which is large enough to accommodate the pattern and have some space for ramming of sand.

2. The drag part is placed on molding board and the pattern is placed on the board inside the flask. If the pattern is in two parts, then lower half pattern has to be placed in the drag.
3. A parting material is sprinkled over pattern and molding board to facilitate both, the removal of the pattern from the mould and the separation of two mould halves.
4. If facing sand is used, it is placed all along the pattern surface to a suitable depth.
5. The drag is filled with molding sand and it is packed and rammed around the pattern. After the ramming, the excess sand is cut-off with a straight bar called strike rod.
6. Vent holes are pierced in the sand within 15 to 20 mm of pattern surface with vent wire to permit the escape of gases.
7. A small amount of dry sand is sprinkled over the top surface.
8. The cope is placed over the drag and upper half of pattern is properly positioned over the pattern with the help of dowel pins.
9. Dry loose parting sand is sprinkled over the entire surface of pattern.
10. Runner and riser are put in position and supported vertically by tucking a small amount of molding sand around them.
11. The facing sand, if used is again put around the pattern surface upto the desired depth.
12. The cope is filled with ordinary sand. The sand is rammed and excess sand is removed.
13. A pouring basis is cut adjacent to the sprue and then the sprue and riser pins are withdrawn.
14. The cope is carefully lifted off, temporarily separated from the drag and placed on one side.
15. Pattern is loosened and pattern is drawn out.

**Precautions :**

1. Hold the work piece or job in vice firmly.
2. Blunt tools should not be used.
3. Wooden piece should be free from defects.
4. Wooden piece should be properly seasoned.
5. Tool should be placed properly on work bench.
6. Always keep your mind on the job.

**JOB-6**

**Object :** A visit to the cast iron foundry should be arranged to have first hand knowledge of cast iron melting and pouring.

**JOB-7**

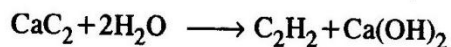
**Object :** Testing of moisture contents and strength of moulding sand.

**Tools & Equipments :** Strength Testing Equipment and Specimen mould.

**Procedure :**

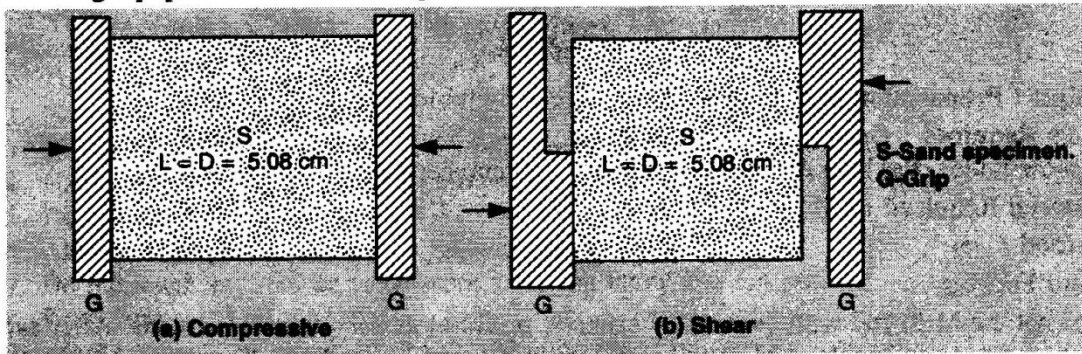
**Moisture content Test :** Moisture present in moulding sand affects many properties of moulding sands. To test the moisture content in sand, the weighted test sample of 50 grams is dried at a temperature of 105 to 110°C for 2 hours. All the moisture present in sand will be evaporated. The sample is then heated. The difference in weight shows the moisture content.

Another method of moisture content test is use of moisture teller. Moisture teller uses calcium carbide. Calcium carbide reacts with the moisture content of the moulding sand and generates acetylene gas.



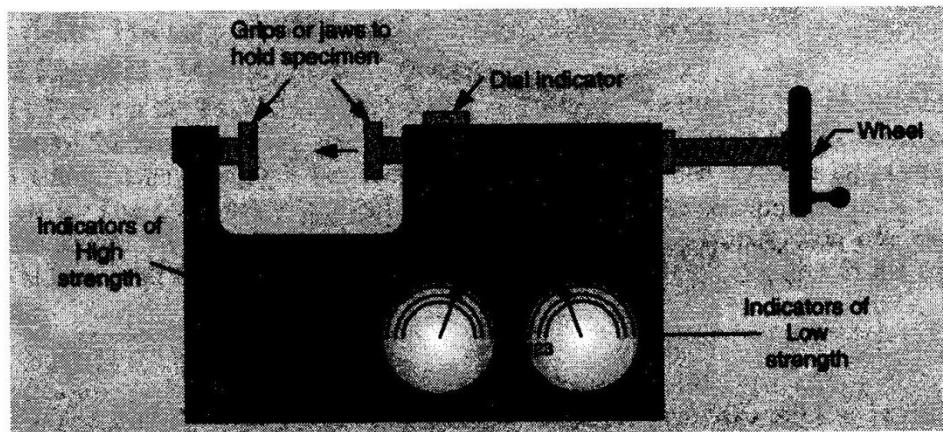
The acetylene coming out is collected in the space above the sand raising the pressure. The pressure of acetylene provides the direct reading of moisture content.

**Strength Test** : The most commonly used strength test is compressive test. It is conducted on strength testing equipment as shown in fig.



**Fig. Strength test**

The specimen is held between the grips as shown in fig. When hand wheel is rotated, it actuates a mechanism which builds up hydraulic pressure on the specimen. There are two manometer indicators. One is used while testing low strength and another is used for relatively high strength core sand. Each indicator has three scales, one for compressive strength, second for tensile strength and third for shear strength.



**Fig. Strength testing equipment**

The green compressive strength refers to the stress required to rupture sand specimen under the compressive loading. The green strength of sand ranges from 30 to 160 kPa.

The green shear strength is the stress required to shear the specimen along the axis. The green strength vary from 10 to 50 kPa.

The dry strength is calculated by using standard specimen dried between 105 and 110°C for 2 hrs. The range of dry compression strength is from 140 to 180 kPa.

The hot strength test is conducted in an equipment known as **Dilatometer**.

**Precautions :**

1. Blunt tools should not be used.
2. Wooden piece should be free from defects.
3. Equipment used must be properly calibrated.
4. Tool should be placed properly on desired location.
5. Always keep your mind on the job.

## 4. FORGING SHOP/FITTING SHOP/ SHEET METAL SHOP

### JOB-1

**Object :** Preparation of a single ended spanner by hand/machine forging.

**Tools Required :** Open hearth furnace, anvil, sledge hammer, scale or foot rule, hacksaw, chisel, poker, show flatter, flat tong & round mouth tong and number punch.

**Material Required :** Mild steel rod

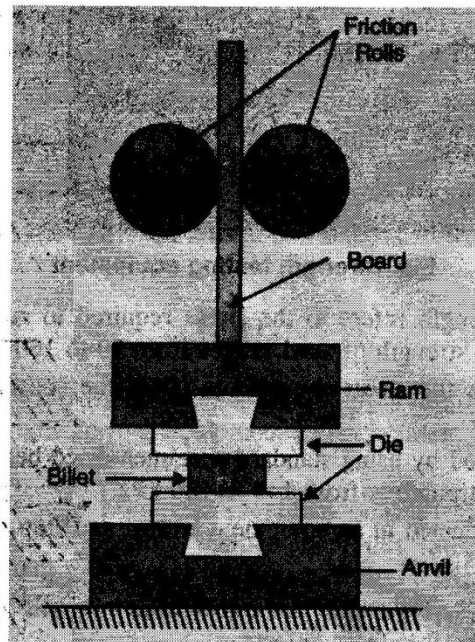
**Method :**

#### Hand Forging

First cut the M.S. rod with the help of hacksaw or chisel as per given dimensions. After sawing or cutting the work piece of job or M.S. rod is heated in an open hearth furnace upto material looks red in color. After heating, hot metal piece is placed on the anvil in horizontal position and hammering on it. The hot work piece is held in a tong. This process repeats until the M.S. rod is converted into thick rectangle. When complete M.S. rod is converted into rectangle and then one end of the work piece or job is removed with the help of hammer and chisel placed on the anvil. Now the spanner in the form of desired shape is ready to use.



#### Machine Forging



**Forging Hammer**

The electric motor supplies the energy to the flywheel. The flywheel stores the energy and delivers it (*the energy*) to the ram. The crank shaft changes the rotary motion of motor into reciprocating motion of the ram. As the punch is fitted with ram, so there is up and down movement of punch. The

energy is supplied continuously at a relatively constant rate to the crankshaft, but it is consumed periodically at each stroke of the ram. The clutch is used to connect the flywheel to the crankshaft whenever desired. Hence for the design of spanner the desired metal is placed in the die and with the immediate force the dies are released causing the metal to be shaped into desired dimensions of a single ended spanner

**Precautions :**

1. The fire should be lightened in the furnace very carefully.
2. Hammering should not be done in lazy mood.
3. Heavy blows should not be given on the tail of anvil.
4. Hammer should have proper handle length.
5. Do not use defective tools.
6. Always wear proper uniform in the workshop.
7. Do not touch any tool or metal piece until you know it is not hot.
8. Keep your mind on the job
9. All the exhaust gases and smoke should go to the chimney.
10. Do not keep the tool in your pocket.

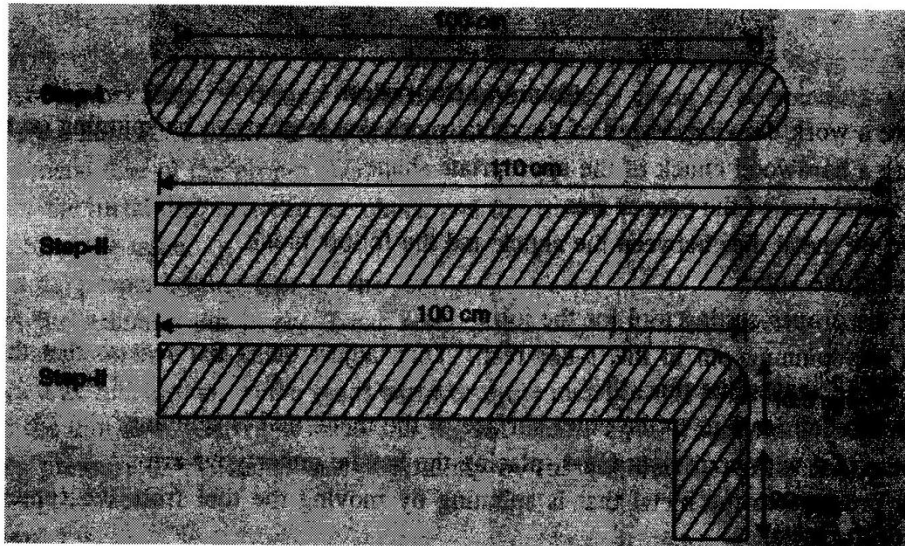
**JOB-2**

**Object : Preparation of a simple die.**

**Tool Required :** Open hearth furnace, nvil, sledge hammer, scale or foot rule, hacksaw, chisel, poker, show flatter, Flat tong & round mouth tong and number punch.

**Material Required :** Mild steel rod

**Method :** First cut the M.S. rod with the help of hacksaw or chisel as per given dimensions. After sawing or cutting the work piece of job or M.S. rod is heated in a open hearth furnace upto material looks red in color. After heating , hot metal piece is placed on the anvil in horizontal position and hammering on it. The hot work piece is held in a tong. This process repeats until the M.S. rod is converted into square. When complete M.S. rod is converted into square then one end of the work piece or job is bent with the help of hammer placed on the anvil. Now the dies in the form of L shape is ready to use.



**Precautions :**

11. The fire should be lightened in the furnace very carefully.

12. Hammering should not be done in lazy mood.
13. Heavy blows should not be given on the tail of anvil.
14. Hammer should have proper handle length.
15. Do not use defective tools.
16. Always wear proper uniform in the workshop.
17. Do not touch any tool or metal piece until you know it is not hot.
18. Keep your mind on the job
19. All the exhaust gasses and smoke should go to the chimney.
20. Do not keep the tool in your pocket.

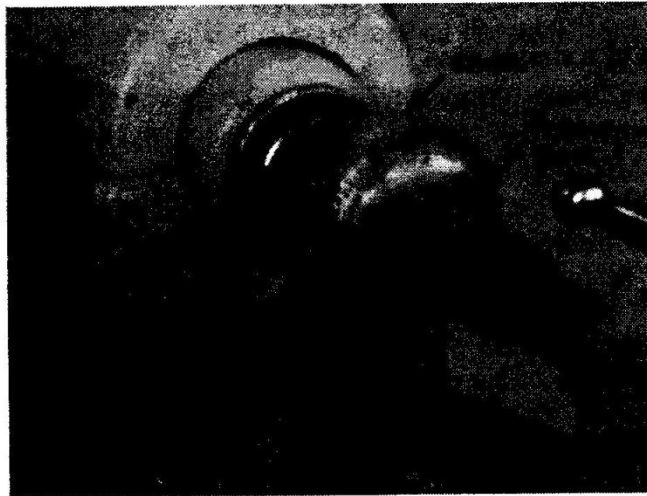
### **JOB-3**

**Object : Demonstration of spinning processing on Lathe machine**

**Equipments Required : Lathe Machine and forming tool**

**Material Required : Mild steel rod**

**Method :**



#### **Spinning Operation**

1. Prepare a work drawing design of the metal piece that is going to be spinning on the lathe.
2. Prepare a hardwood chuck of the appropriate shape.
3. Cut a metal disc of the proper size.
4. Center the metal disc between the chuck and the follow block.
5. Now start the lathe.
6. Select the proper cutting tool for the job.
7. Insert the spinning pin in the T-bar rest. Then adjust the T-bar rest so that the tool is at a slight angle against the pin.
8. Apply wax lubrication, to the outer surface of the metal that is spinning.
9. Hold the tool with your right hand, placing the handle under your arm.
10. Apply pressure to the metal that is spinning by moving the tool from the center to the outer edge of the metal.

**Precautions :**

1. Never stand directly in line with the disc.

2. Be sure that the metal disc does not have any defects that could cause the metal to break when spinning.
3. Always wear safety glasses and leather gloves during spinning operations..
4. Make sure that the metal piece is securely clamped between the chuck and follow block.
5. Be sure that the tail stock is locked.
6. Never insert the metal disc, while the lathe is running.
7. Wear the appropriate safety equipment.
8. The operating controls must be in proper working condition.
9. The lathe must be kept clean at all times.
10. When not in use, unplug the electrical cord.
11. Use the safety guard if possible.

### **JOB-4**

**Object : Demonstration of grinding processing on Lathe machine**

**Equipments Required : Lathe Machine and forming tool**

**Material Required : Mild steel rod**

**Method : Same as in Job 3.**



#### **Grinding Operation**

1. Prepare a work drawing design of the metal piece that is going to be spinning on the lathe.
2. Prepare a hardwood chuck of the appropriate shape.
3. Cut a metal disc of the proper size.
4. Center the metal disc between the chuck and the follow block.
5. Now Start the lathe.
6. Select the proper cutting tool for the job.
7. Insert the spinning pin in the T-bar rest. Then adjust the T-bar rest so that the tool is at a slight angle against the pin.
8. Apply wax lubrication, to the outer surface of the metal that is spinning.
9. Hold the tool with your right hand, placing the handle under your arm.
10. Apply pressure to the metal that is grinding by moving the tool from the center to the outer edge of the metal.

**Precautions :**

1. Never stand directly in line with the disc.
2. Be sure that the metal disc does not have any defects that could cause the metal to break when spinning.

3. Always wear safety glasses and leather gloves during spinning operations..
4. Make sure that the metal piece is securely clamped between the chuck and follow block.
5. Be sure that the tail stock is locked.
6. Never insert the metal disc, while the lathe is running.
7. Wear the appropriate safety equipment.
8. The operating controls must be in proper working condition.
9. The lathe must be kept clean at all times.
10. When not in use, unplug the electrical cord.
11. Use the safety guard if possible.

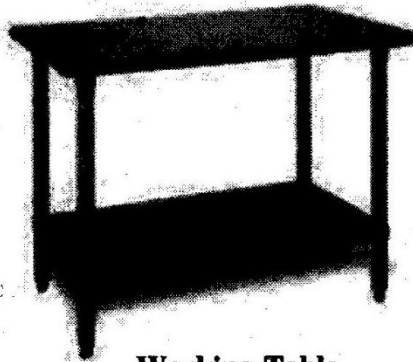
### **JOB-5**

**Object : Preparation of utility item out of G.I. sheet**

**Equipments Required : Hammer, Drill, Rivets, Shearing tool, Measure & Marking tool etc.**

**Material Required : Galvanized Iron (G.I.) sheet**

**Method : Same as in job 3.**



**Working Table**

1. Prepare a work drawing design of the metal sheet.
2. Cut a metal sheet of the proper size.
3. Mark the job according to given dimensions and punching on it.
4. Check the sides of the job with the help of try square & make perpendicular to each other.
5. Check the flatness of the surface with the help of try square.
6. Fix up the four legs of the table with the flat top and bottom with the help of rivets.
7. Finish the whole job with the help of smooth file or fine file.
8. Finally the working table is ready to use.

**Precautions :**

1. Right type of tool should be used.
2. Right size of rivets should be used.
3. Work carefully.
4. The hammer should have proper length.
5. Do not use tools with mushrooms.
6. Put tools at proper place after use.

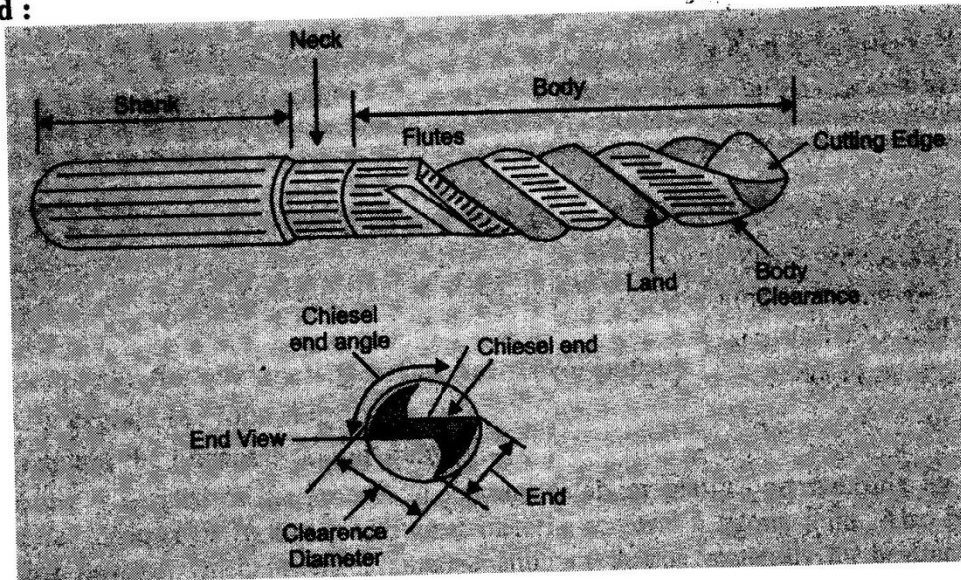
## JOB-6

**Object : Preparation of Drilling Jig.**

**Equipments Required : Milling Machine**

**Material Required : Mild steel rod**

**Method :**



**Parts of Drilling Jig**

1. Select the proper cutting bit.
2. Place the bit in the spindle and make sure that the bit is at a right angle to the table.
3. Tighten the spindle using the nut on the top of the milling machine.
4. Place the stock in the vise and lock it in place.
5. Make sure that the vise is tight and holding the material securely by hitting the handle with a rubber mallet.
6. Position the cutter at the starting point.
7. Place a spot of cutting oil on the spot that is to be cut.
8. Select the right cutting speed, rpm, and rate of feed for the job.
9. Cut the stock using the cross feed or longitudinal feed controls.
10. Turn off the machine before removing the stock.

**Precautions :**

1. Never stand directly in line with the disc.
2. Be sure that the metal disc does not have any defects that could cause the metal to break when spinning.
3. Always wear safety glasses and leather gloves during spinning operations..
4. Make sure that the metal piece is securely clamped between the chuck and follow block.
5. Be sure that the tail stock is locked.
6. Never insert the metal disc, while machine is running.
7. Wear the appropriate safety equipment.
8. The operating controls must be in proper working condition.

# MECHANICAL ENGINEERING DRAWING-I

## DETAILED CONTENTS

L T P  
- - 7

### 1. Limits and fits (03 sheets)

Maximum limit of size, minimum limit of size, tolerance, allowance, deviation, upper deviation, lower deviation, fundamental deviation, clearance, maximum clearance, minimum clearance. Fits – clearance fit, interference fit, transition fit. Hole basis system, shaft basis system, tolerance grades, calculating values of clearance, interference, hole tolerance, shaft tolerance with given basic size for common assemblies like H7/g6, H7/m6, H8/p6

### 2. Intersection of following solids:- (02 sheets)

- (a) Cylinder with cylinder (equal and different diameters; axis at right angles)
- (b) Cylinder with cylinder (axis inclined)

### 3. Drawing of the following with complete dimensions, tolerances, materials and surface finish marks.

- 3.1 Universal coupling (Assembly) (01 Sheets)
- 3.2 Bearings (05 sheets)
  - 3.2.1 Bushed Bearing (Assembled Drawing)
  - 3.2.2 Ball Bearing and Roller Bearing (Assembled Drawing)
  - 3.2.3 Plummer Block (Detailed Drawing)
  - 3.2.4 Plummer Block ( Assembled Drawing)
  - 3.2.5 Foot step Bearing (Assembled Drawing)
- 3.3 Bracket (01 sheets)
  - 3.3.1 Wall bracket (orthographic views)
- 3.4 Pulleys (03 sheets)
  - 3.4.1 Stepped Pulley
  - 3.4.2 V. Belt Pulley
  - 3.4.3 Fast and loose pulley (Assembled Drawing)
- 3.5 Pipe Joints (02 sheets)
  - 3.5.1 Expansion pipe joint (Assembly drawing)
  - 3.5.2 Flanged pipe and right angled bend joint (Assembly Drawing)
- 3.6 Lathe Tool Holder (Assembly Drawing) (01 sheets)
- 3.7 Reading of mechanical component drawing (01 sheets)
- 3.8 Sketching practice of bearings, bracket and pulleys. (02 sheets)

### 4. Electrical Circuit Diagram (01 sheet)

- 4.1 Electrical circuit diagrams for house hold appliances (bulb, fan, tube, provision for plug and switch with voltmeter and energy meter connected in the circuit.
- 4.2 Electrical connections for lathe machine

**Note:-** (1) First angle projection should be followed, 20% of drawings may be prepared in third angle projection.  
(2) SP-46-1988 should be followed  
(3) The drawing should include discussion with tolerances, whenever necessary and material list as per BIS / ISO specifications.

## 3.6. MATERIAL SCIENCE

### DETAILED CONTENTS

L T P  
3 - 2

- 1. Introduction (07 hrs)**  
Material, History of Material Origin, Scope of Material Science, Overview of different engineering materials and applications, Classification of materials, Thermal, Chemical, Electrical, Mechanical properties of various materials, Present and future needs of materials, Overview of Biomaterials and semiconducting materials, various issues of Material Usage-Economical, Environment and Social.
- 2. Crystallography (07 hrs)**  
Fundamentals: Crystal, Unit Cell, Space Lattice, Arrangement of atoms in Simple Cubic Crystals, BCC, FCC and HCP Crystals, Number of atoms per unit Cell, Atomic Packing Factor.  
Deformation: Overview of deformation behaviour and its mechanisms, behavior of material under load and stress-strain. Failure Mechanisms: Overview of failure modes, fracture, fatigue and creep.
- 3. Metals and Alloys (14 hrs)**  
Introduction: History and development of iron and steel, Different iron ores, Raw Materials in Production of Iron and Steel, Basic Process of iron-making and steel-making, Classification of iron and steel, Cast Iron: Different types of Cast Iron, manufacture and their usage. Steels: Steels and alloy steel, Classification of plain carbon steels, Availability, Properties and usage of different types of Plain Carbon Steels, Effect of various alloys on properties of steel, Uses of alloy steels (high speed steel, stainless steel, spring steel, silicon steel) Non Ferrous Materials: Properties and uses of Light Metals and their alloys, properties and uses of White Metals and their alloys.
- 4. Theory of Heat Treatment (08 hrs)**  
Purpose of heat treatment, Solid solutions and its types, Formation and decomposition of Austenite, Martensitic Transformation – Simplified Transformation Cooling Curves various heat treatment processes- hardening, tempering, annealing, normalizing, Case hardening and surface hardening, Types of heat treatment furnaces required for above operations (only basic idea)
- 5. Engineering Plastics (03 hrs)**  
Important sources of plastics, Classification-thermoplastic and thermo set and their uses, Various Trade names of engg. Plastics, Plastic Coatings.
- 6. Advanced Materials (03 hrs)**  
Composites-Classification, properties, applications Ceramics-Classification, properties, applications

## 7. Miscellaneous Materials

(06 hrs)

Overview of -Tool and Die materials, Materials for bearing metals, Spring materials, Materials for Nuclear Energy, Refractory materials.

### LIST OF PRACTICALS

1. Classification of about 25 specimens of materials/machine parts into
  - (i) Metals and non metals
  - (ii) Metals and alloys
  - (iii) Ferrous and non ferrous metals
  - (iv) Ferrous and non ferrous alloys
2. Given a set of specimen of metals and alloys (copper, brass, aluminium, cast iron, HSS, Gun metal); identify and indicate the various properties possessed by them.
3.
  - a) Study of heat treatment furnace.
  - b) Study of a thermocouple/pyrometer.
4. Study of a metallurgical microscope and a specimen polishing machine.
5. To prepare specimens of following materials for microscopic examination and to Examine the microstructure of the specimens of following materials:
  - i) Brass ii)Copper iii)Grey iv)Malleable v)Low carbon steel vi)High carbon steel vii) HSS
6. To anneal a given specimen and find out difference in hardness as a result of annealing.
7. To normalize a given specimen and to find out the difference in hardness as a result of normalizing.
8. To harden and temper a specimen and to find out the difference in hardness due to tempering.

### Assignment # 1

1. Explain different engineering materials and applications
2. Explain electrical and mechanical properties of material
3. Explain thermal and chemical properties of material
4. Explain Present and future needs of materials,

### Assignment # 2

1. Explain Crystal, Unit Cell, Space Lattice
2. Explain arrangement of atoms in Simple Cubic Crystals, BCC, FCC and HCP Crystals.
3. Explain overview of deformation behavior and its mechanisms.
4. Explain failure mechanism

### Assignment # 3

1. Explain metals and non metals.
2. Briefly explain the process of iron and steel making.

3. What is cast iron, explain its types?
4. Explain effect of various alloying element

#### **Assignment # 4**

1. What is heat treatment explain its advantage?
2. Explain different heat treatment process.
3. What is case hardening and surface hardening?
4. Explain different type of furnace.

#### **Assignment # 5**

1. What is of thermoplastic and thermo set and their uses?
2. Explain composites materials.
3. What are ceramics?
4. Explain the materials for springs and dies.

#### **Experiment No-1**

##### **OBJECT :-**

To classify materials in to :-

- (i) Metals and non metals.
- (ii) Metals and alloys.
- (iii) Ferrous and non-ferrous metals and alloys.

##### **MATERIALS AND EQUIPMENT:-**

Material specimens, grinding wheel, magnet, hot surfaces etc.

##### **THEORY:-**

The given material specimens can be classified in various categories by studying properties of materials in laboratory. Properties are different for different materials. These properties assist in material identification. The various properties can be grouped as physical, mechanical and chemical properties. Physical properties are physically observable characteristics of materials as colour, luster, conductivity, density, magnetic properties, etc. Mechanical properties are the characteristics of a material that are displayed when a force is applied to the material. Hardness, ductility, wear, strength are the examples of mechanical properties, Chemical reactions of a material.

##### **PROCEDURE:-**

- (i) **Classification in to metals and non metals:-** For the classification of specimens into metals and non metals following tests are performed:

- Lustre** :-It is the shining appearance of the surface. Metals possess luster While non metals do not possess luster normally. The luster of freshly cut Surface of metals sometimes differs from the luster of old exposed surface due to oxidation of surface. So on the basis of luster, tentative results can be obtained.
- Colour** :-Metals can be distinguished from non metals by observing colour of materials. Copper is easily recognized by its yellow colour of. Following table gives colour and luster of different materials.

**Table:Colour and luster of common materials:**

Sr. No.	Material	Colour	Lustre
1.	Copper	Yellowish red	Bright metallic
2.	Gold	Yellow	Bright
3.	Silver	White	Bright
4.	Brass	Yellowish	Bright
5.	Aluminium	White	Bright
6.	Chromium	Silvery White	Shining lustre
7.	Grey cast iron	Greyish black	Dull lustre
8.	Stainless steel	Bright	Bright
9.	Polythene	Transparent	—
10.	P. V. C.	Transparent	—
		Snow white	—
11.	Thermocole	Deep Brown	—
12.	Bakelite	Black or brownish	—
13.	Rubber	Light brown	—
14.	Leather		—

### 3. Specific Gravity:-

Specific Gravity of a material is defined as the ratio of specific weight of the material to the specific weight of water. In this test, volume of specimen is calculated. The specific gravity of material is calculated by dividing weight of specimen by its volume. Out of metals aluminium is relatively lighter in weight and lead is heavier. Out of non-metals asbestos, wood, leather and cork are lighter in weight.

**Table:- Specific gravity of some common materials:**

Sr. No	Element	Specific gravity
1.	Aluminium	2.7
2.	Copper	8.9
3.	Silver	10.5
4.	Lead	11.3
5.	Tin	7.3
6.	Zinc	7.2
7.	Gold	19.3
8.	Nickel	8.9
9.	Iron	7.87
10.	Tungston	19.3
11.	Maganese	7.2

4. **Sound Test:**-This test is performed on a specimen of standard shape and size. The specimen, when struck with a hammer or dropped on ground, produces sound. The sound produced is different for different materials. Following types of sound are produced.

Sound Produced	Specimens
Dull Sound	Aluminium, lead, copper
Ringing sound	Gun metal
Slight Ringing sound	Brass , bronze, mild steel.
Very dull sound	Cast iron, non metals.

5. **Spark Test:** In spark test material to be tested is held against the rotating grinding wheel. Some materials produces sparks for some common materials. Spark pattern of specimen is compared with standard spark pattern and thus identification is done.

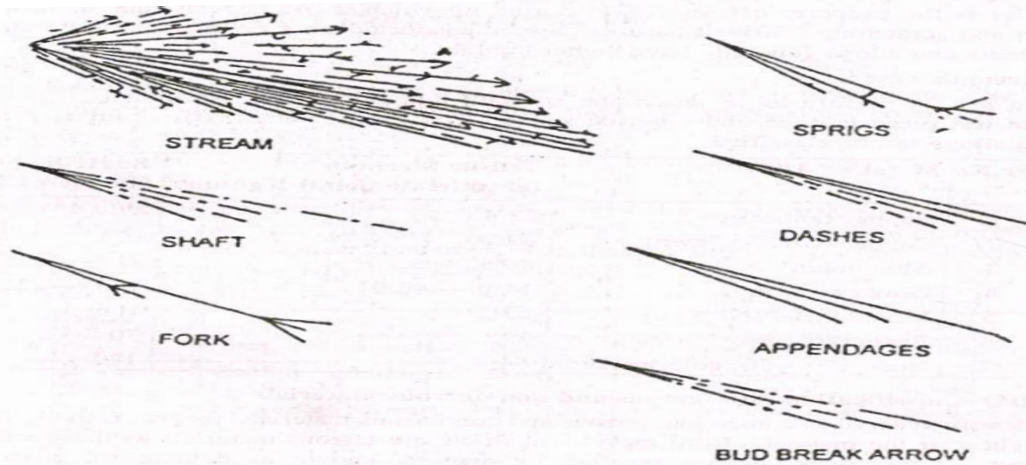


Fig. P.1. (a) Spark Pattern

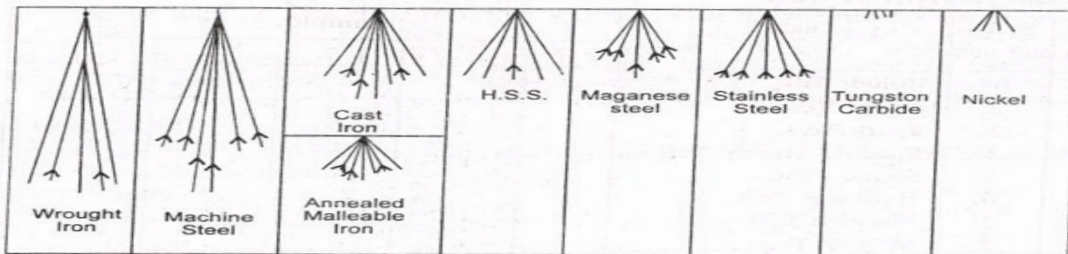


Fig. P.1. (b) Spark Chart

- (ii) **Classification in to metals and alloys:** For the classification of materials into metals and alloys following tests are conducted – colour test, specific gravity test, hardness test and strength test. Colour and specific gravity tests have to be conducted as explained earlier.
- (a) **Hardness Test:**-Hardness is the property of material by virtue of which it offers resistance to indentation, penetration and scratching. Brinell hardness test is conducted on specimens. Pure metals have lower hardness and alloys generally have higher hardness.
- (b) **Strength Test:**-Tensile test is performed to determine strength and ducility of specimens. In this test straining of test piece is under tensile stress, The results obtained are compared and thus metals and alloys can be classifind.

Sr. No	Metal or Alloy	Tensile Strength (at ultimate point) Kg/mm <sup>2</sup>	B. H. N.
1.	Copper (annealed)	22.40	47
2.	Copper (cold – brawn)	39.20	104

3.	Aluminium	8.75	21-24
4.	Gray cast iron	14.0-42.0	150-225
5.	Monel metal (Ni + cu)	63.0	166
6.	Brass (70 – 30, annealed)	32.2	70
7.	Brass(70 – 30, cold worked)	64.4	170

**(iii) Classification into ferrous and non-ferrous materials:-**

To classify material specimen into ferrous and ferrous materials, magnet is used. Specimens are brought near the magnet. Iron, nickel, cobalt etc are ferrous materials as these are attracted by magnet. Some materials are repelled

By magnet, known as diamagnetic materials e. g. bismuth, silver, copper and gold. Non magnetic materials by magnet.

**OBSERVATION TABLE:**

Sr. No	Tests	Samples				
		1	2	3	4	5
1.	Colour Test					
2.	Lustre Test.					
3.	Spark Test.					
4.	Specificgravity Test					
5.	Sound Test.					
6.	Hardness Test.					
7.	Strength Test.					
8.	Magnet Test.					

**CONCLUSION:-**

From the above tests material specimens can be classified in to metal – nonmetal, metal – alloy and ferrous-nonferrous materials

## Experiment No-2

### OBJECT:-

Given a set of specimen of metals and alloys (copper, brass, aluminum, cast iron, high speed steel and gun metal), identify and indicate the various properties by them.

### MATERIALS AND EQUIPMENT:-

Specimens of given metals and alloys, magnet, file, bench grinder .etc.

### PROCEDURE:

The given material specimens can be identified by studying properties of materials. Various tests as colour, luster, spark, specific gravity, sound test, magnet test etc. are performed on each specimen and with the help of these properties, identification of metal is done. The procedure of these tests have been explained in experiment number-1

Sr. No	Tests	Observations					
		Sample1	Sample2	Sample3	Sample4	Sample5	Sample6
1.	Colour Test	Reddish brown	Yellow	White	Grey	Medium grey	Reddish yellow
2.	Spark Test	No sparks	No sparks	No spark	As shown in spark chart	As shown in chart	No spark
3.	Magnet Test	Not attracts	Not attracts	Not attracts	Attracts	Attracts	Not attracts
4.	Sound Test	Dull ringing Red	Slight ring Easy to file,	Dull ringing	Very dull	Low ring	Ringing (Bell Like)

5.	Sound With	filings	yellow filings	Easy to file white filings	Black powder	Resistant to file, fine	Not very easy to file, reddish yellow filings
	Conclusion	Copper	Brass	Aluminium	Cast iron	H. S. S.	Gun metal.

**PROPERTIES:-**The properties of given material specimens are given in chapters Ferrous materials and Non-ferrous materials. They can be reproduced here.

**CONCLUSION:** The given set of specimens of metals and, is identified.

### Experiment No-3

**OBJECT:-**

- (a) Study of heat treatment furnace
- (b) Study of thermocouple/pyrometer

**EQUIPMENT:-**

Heat treatment furnace, thermocouple and pyrometers.

**(a) HEAT TREATMENT FURNACE:**

Heating of steel for the purpose of annealing, hardening and tempering is carried out in heat treatment furnaces. On the base of heat transfer media furnaces may be classified as-

1. Furnace, having liquid heat transfer media
2. Furnace, having gaseous heat transfer media
3. Electric furnace.

Salt bath and molten metal bath are the examples of furnace having liquid heat transfer media. These furnaces provide uniform temperature around specimen. Molten metal bath provides rapid heating rate. Furnaces having gaseous heat transfer media are useful for age hardening and tempering of steel nuts and bolts. Electrical furnaces are used for rapid heating. In these furnaces controlled atmosphere is maintained.

### **Constructional Features:-**

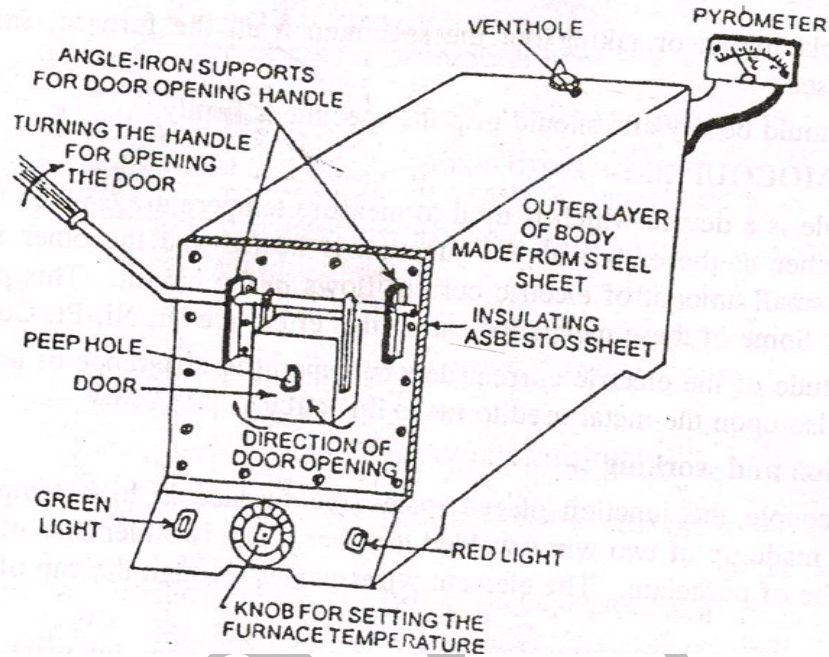
The heat treatment furnace available is suitable for small experiment jobs. A door is provided which can be operated by means of a steel handle. The door is provided with a peep hole. Colour of heat inside the furnace can be seen through this hole. Inside the furnace, insulator lining is provided. This prevents loss of heat.

Following types of furnaces are commonly used in jobs-

1. Box type furnace.
2. Pit type furnace.

### **1. Box type furnace.**

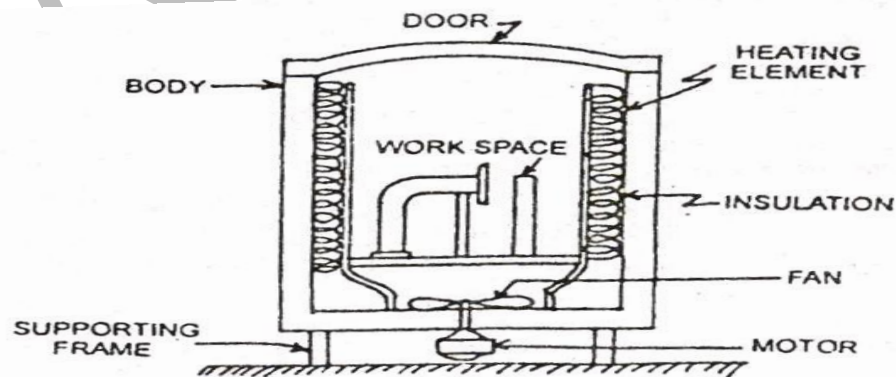
The shape of this type of furnace is like a box. Body is made of mild steel. These are electrically heated furnaces having heating element of chromium or nickel wire. Supply current, having 400V, 3 phase and 50Hz frequency, is used for these furnaces. In the interior of the furnace refractory bricks are fixed with the help of fire clay. The furnace is provided with an inspection hole in the door. A thermocouple is provided for temperature measurement. To regulate inside temperature a thermostat is provided. On one side of furnace body there is a cut out switch, which is operated by door handle. This is provided to ensure the safety of worker. On the control panel two are provided. Out of these two, one is movable and other idle. With the help of idle pointer required range of temperature is set. The movable pointer indicates the instantaneous temperature of the furnace.



**Fig.2. Box type furnace.**

## 2. Pit type furnace:

This is an electrical heating type furnace in which coiled wire is used as a heating element. Air circulation is provided to ensure uniform heating. The operating temperature of these furnaces varies from 100 to 700°C. These furnaces are used for heat treating, age hardening of alloys and for tempering steel specimens. In this furnace, the charge is kept inside the workspace. Heat is provided through the heating element. To deflect heat all around the charge, a centrifugal fan is provided.



**Fig.2. Pit type furnace.**

**Precautions:-**

1. While placing in or taking out specimen from the furnace, safety gloves and fire tongs must be used.

2. Tong should be dry and should grip the specimen firmly.

**(b) THERMOCOUPLE:-**

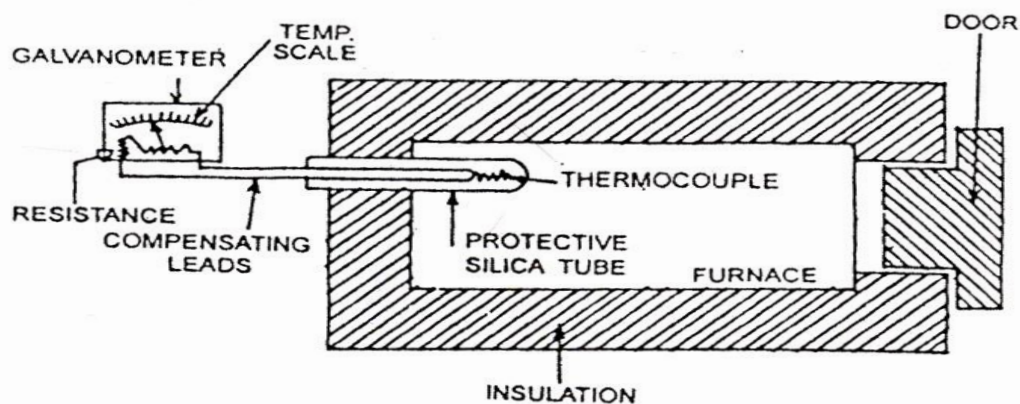
Thermocouple is a device which is used to measure temperature. When two dissimilar metals are joined together at the ends and one junction is heated and the other is kept at a constant temperature, a small amount of electric current flows in the circuit. This phenomenon is called seebeck effect. Some of these metals indicating this effect are Bi, Ni, Pt, Cu, Rh, Fe, Sb etc.

The magnitude of the electric current depends upon the difference of temperature of two junctions and also upon the metal used to make this circuit.

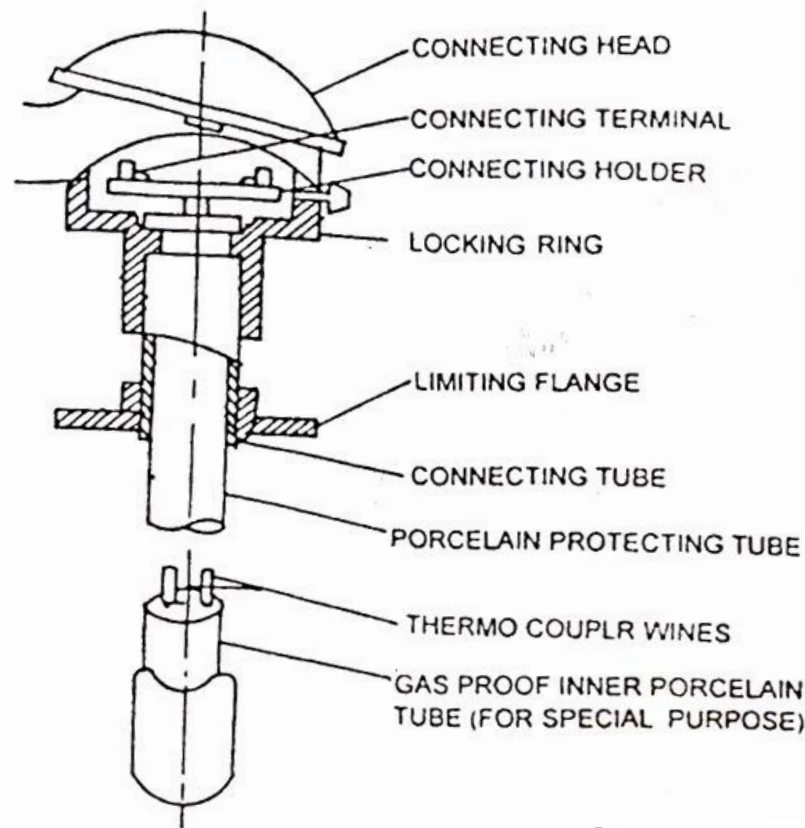
**Construction and working:-**

In thermocouple the junction placed inside the furnace at high temperature is called hot junction. It is made up of two wires welded together. The two elements of couple are put in a protective tube of porcelain. The element wires passes through the cap of the tube are matched to the terminal.

A sensitive galvanometer is connected to the hot junction, by means of lead wire. The galvanometer actually measures the current flowing through the circuit. There is a definite relationship between current flowing in circuit and temperature difference between hot junction and cold junction. Accordingly the scale of galvanometer is calibrated to give temperature in degrees.



**Fig. 4. Thermocouple.**



**Fig. 4. Thermocouple.**

**Precautions:-**

1. Cold junction should be kept away from furnace.
2. A thicker gauge wire should be used to reduce line resistance.
3. If thermocouple is inserted in the molten metal, the depth of immersion should be sufficient

**Pyrometer:-**

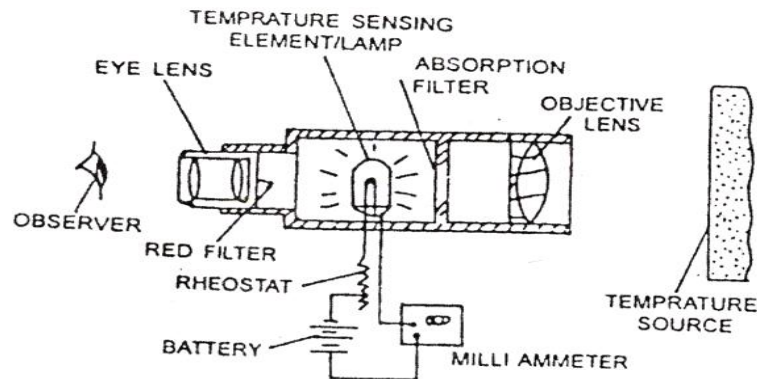
Pyrometer is an instrument, used to measure very high temperature. The pyrometers are of two type-

1. Total radiation pyrometer
2. Optical pyrometer

**1. Total Radiation Pyrometer:-**

In total radiation pyrometer the radiation from source are focussed on some sensing element. Lens is used for focusing radiations. The heat radiation from temperature source are

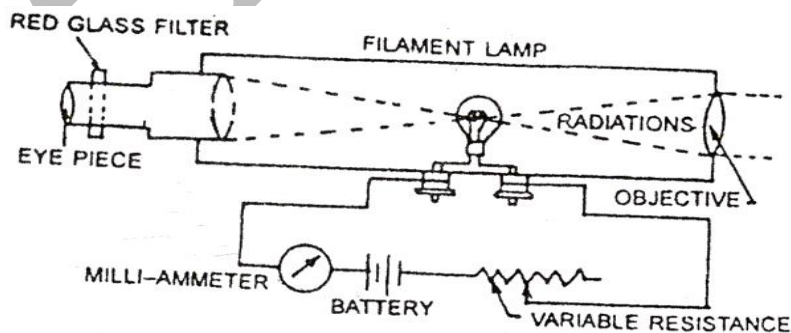
concentrated on the thermocouple after passing through the objective lens and the absorption filter. The objective lens is used to focuss the heat radiation. The e.m.f. thus produced is measured by milivoltmeter. The scale of milivoltmeter is calibrated to give readings in terms of temperature.



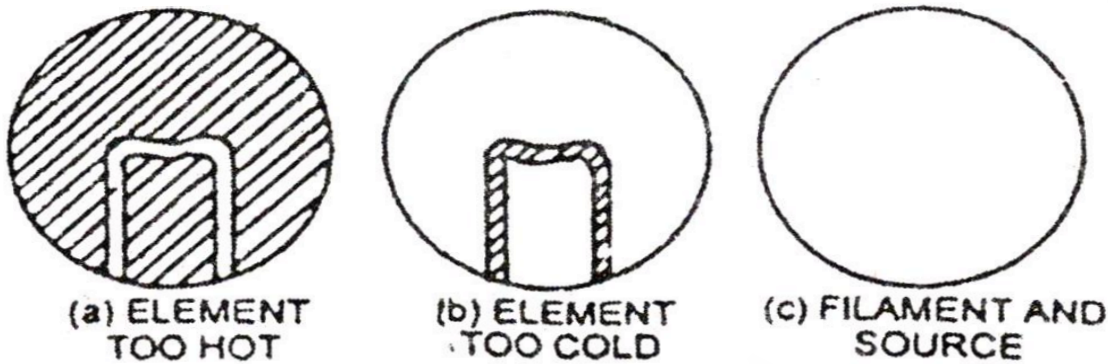
**Fig.5. Total Radiation Pyrometer.**

## 2. Optical Pyrometer:-

In optical pyrometer, the light emitted from a source is compared with the light inside the furnace. Light coming from furnace is matched with glow of standard filament lamp by varying the resistance provided in the circuit. When matching is completed the current flowing in the circuit can be read on the ammeter. The ammeter dial. In the beginning, filament will dark as compared to the background which is bright due to heat of furnace. By varying the resistance in filament circuit, more and more current is fed into it, till filament becomes equally bright as the back ground. Current flowing in the filament is measured with the help of ammeter which gives the value of temperature as it is calibrated for temperature.



**Fig. 6. Optical Pyrometer.**



**Fig.7. Appearance of filament at various temperatures.**

Some of the colours are given in table with their temperature.

**Table: Temperature-colour table.**

Sr.no.	Colour	Temperature( <sup>0</sup> C)
1.	Dark blue	299
2.	Very dark blue	316
3.	Deep blue	400
4.	Dark red	700
5.	Dull cherry red	800
6.	Bright cherry red	900
7.	Orange cherry red	1000
8.	Orange red	1100
9.	Orange yellow	1200
10.	Yellow	1300
11.	White	1400
12.	Brilliant white	1500

### **Experiment No-4**

#### **OBJECT:**

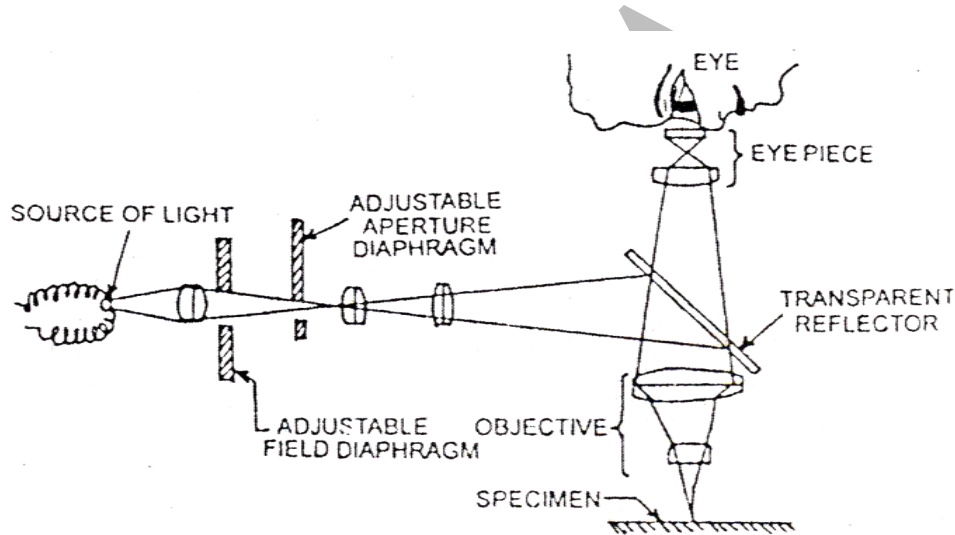
**Study of metallurgical microscope and diamond polishing machine.**

#### **EQUIPMENT:-**

Metallurgical microscope is the equipment which is used for observing the microstructures of properly prepared metallic specimens. The study of metals at high magnification is carried out with the help of metallurgical microscope. Grain size, segregation, distribution and mode of occurrence of phases and non metallic inclusions-such as slags, sulphides etc. are the structural characteristics which are studied in microstructures.

### Principle:-

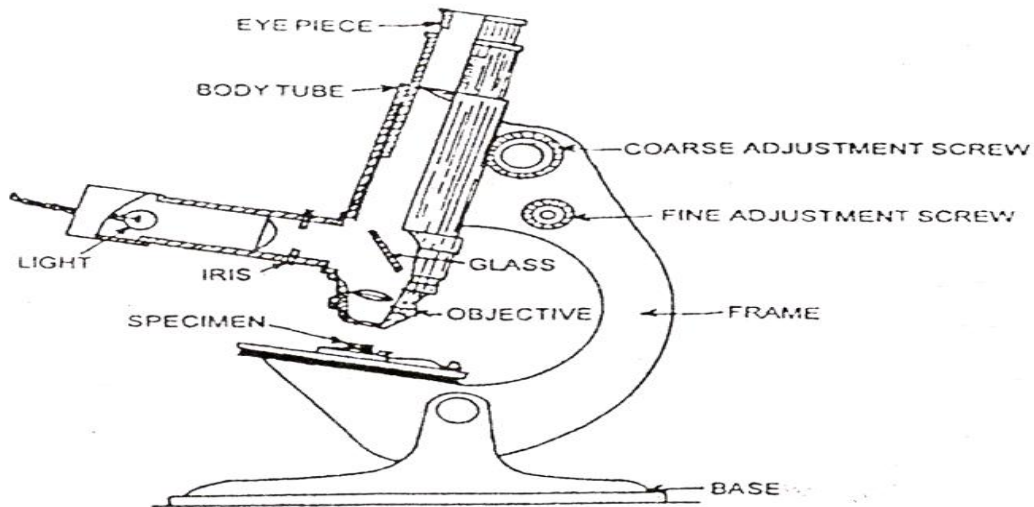
The metallurgical microscope differs from the biological microscope. Biological microscopes are used for viewing transparent objects while the metallurgical microscope is used for viewing opaque specimens. In this microscope, light from a lamp is through on the specimen, through the objective. The light is reflected from various grains and grain boundaries of the metallic specimen. The microstructure of the grains and their boundaries is viewed through the metallic piece, after proper magnification. This magnification depends upon the various combinations of lenses used



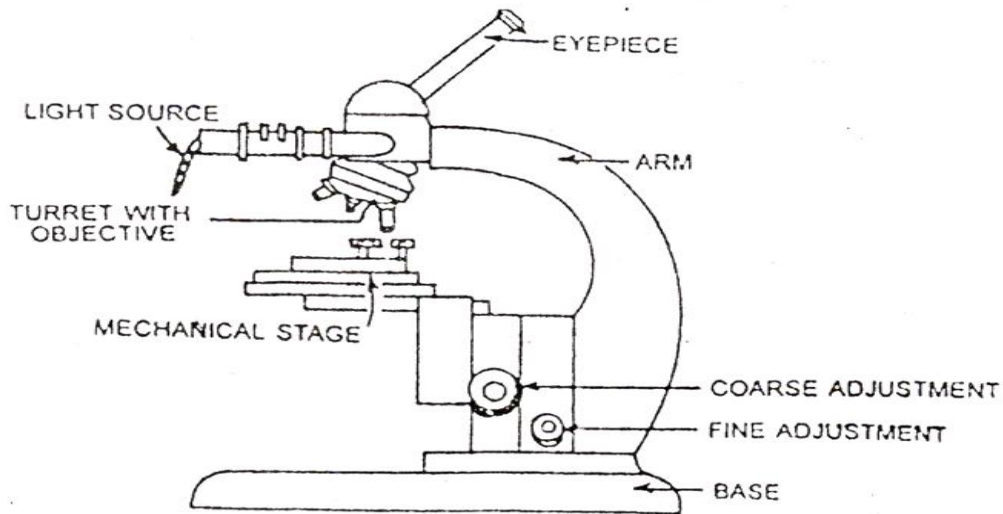
**Fig.8.Ray diagram for working of a metallurgical microscope.**

### Construction:

Two different types of metallurgical microscopes are shown in figure. The lowest portion of metallurgical microscope is called base, which supports all the other parts. Arm (in case of movable stages metallurgical microscope) or frame in case of simple metallurgical microscope) is main casting, which is fixed on base. It supports all other parts of the microscope. Coarse adjustment knob is circular in shape and is fixed on the arm or base. It is primarily used for rough focusing of the specimen. The view which had already been roughly focused by the coarse base and the objectives. It holds the specimen to be viewed. On the top of microscope eyepiece is fitted. It is used for viewing the specimen. Objective is composed of a number of separate lens elements, which behave as a positive and conversing type of lens system.



**Fig.9. (a) A simple metallurgical microscope**



**(b) Movable stage metallurgical microscope**

**Working Procedure:-**

1. Switch on the source of light.
2. Place the specimen on table.
3. With the help of turret bring the objective with proper magnification in line with specimen.
4. Adjust the lenses with the help of coarse adjustment knob, so that micro-structure is seen clearly through the eye piece.
5. Get sharp view of micro-structure by adjusting knob.

### **Precautions:-**

1. Do not touch glasses lenses with fingers. Clean the lenses properly before viewing the specimen.
2. For focusing, fine focusing should be done only after coarse focusing have been done.
3. Adjustment knobs should be operated slowly.
4. Surface of test piece should be clean.
5. Screws must be moved in one direction only avoid backlash error.

### **B. DIAMOND POLISHING MACHINE:-**

Diamond polishing machine is used for polishing specimen to get mirror like surface, which is perfectly flat and without scratches. Rough polishing is carried out by abrasive

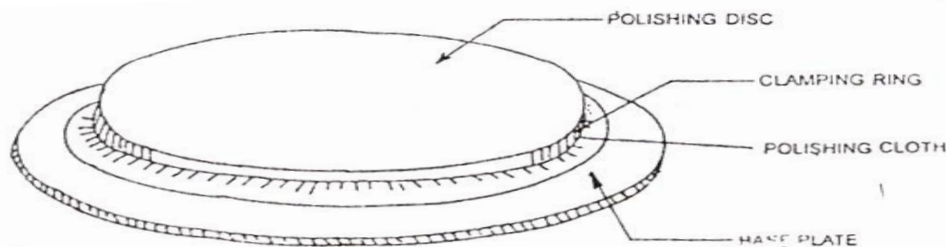
Papers of increasing fineness, while fine polishing is carried out on the polishing machine.

### **Principle:-**

Fine polishing is carried out on polishing machine having rotating polishing disc. This disc is covered with polishing cloth and fine abrasive paste is applied on it. The specimen is held firmly and pressed gently against the rotating disc. Polishing is done till the scratch free and mirror like surface is obtained.

### **Construction:-**

The diamond polishing machine consists of circular shaped base plate. Diamond polishing disc is mounted on this base plate. There plugs of disc are fitted in the there holes of the base plate. The disc is covered with polishing cloth. Polishing cloth is held tightly with the help of clamping device. The cloths commonly used are selvyt, chiffon velvet, micro cloth etc. Water alcohol soluble paste is used for metallographic polishing. Emulsified oil especially suited for polishing of copper and aluminum.



**Fig. 10. Diamond Polishing Disc.**

**Working Procedure:-**

The specimen on which polishing have to be done, should be properly ground. On the upper surface of the polishing cloth, abrasive paste should be applied. The specimen is held rigidly and rubbed on the polishing cloth in a circular motion. Specimen is then viewed under microscope and if surface is not mirror like the polishing procedure be repeated till required surface finish is obtained.

**Precautions:-**

1. Specimen should rub on cloth only after applying abrasive paste.
2. During rubbing excessive pressure should not apply upon specimen.
3. After polishing specimen should be cleaned with a cleaning agent specimen.
4. Avoid too much heat being generated during and polishing. Excessive heat may change the microstructure.
5. The polishing surface should not touch. This may cause the finger prints on the surface.

**Experiment No-5****OBJECT:-**

To prepare specimens of following materials for microscopic examination and examine the microstructures of the specimens of the following materials.

- (1) Brass
- (2) Copper
- (3) Gray cast iron
- (4) Malleable cast iron
- (5) Low carbon steel
- (6) High carbon steel
- (7) High speed steel

**EQUIPMENT:-**

Specimens, cutting machine, grinding machine, polishing machine, metallurgical microscope, enchants etc.

**PROCEDURE:-**

Microscope examination involves the study of structural characteristics ac grain size, segregation, distribution and mode of occurrence of different phases of properly prepared metallic specimens. Preparing metallic specimen and viewing it under the microscope, to determine its microstructure, involves following steps.

1. Cutting off the material from stock
2. Wet grinding
3. Diamond polishing
4. Etching
5. Washing, and rinsing
6. Microscopic examination

### **1. Cutting off the material from stock:-**

The specimen is cut off by means of an abrasive cut machine from stock. The specimen may be round or square from 15 to 25 mm span and of approximately 15 mm height. An abrasive cut off machine consists of a cutting wheel. The wheel is rotated at high speed. A provision is made to cool the specimen during cutting operation.

### **2. Wet Grinding:-**

The specimen cut by abrasive cut off machine is ground over silicon carbide papers. These papers are mounted on wet grinding apparatus. The specimen should be ground first in one direction for a minutes and then in the direction  $90^0$  to the previous one. Abrasive papers of different grades are used. As the grade number increases, the grinding becomes finer. Water is sprayed on the surface of abrasive paper to wash away the small particles removed during grinding.

### **3. Diamond Polishing:-**

To remove fine cratches from the surface of specimen fine polishing is done on diamond polishing machine. The specimen is held rigidly and rubbed on the polishing cloth in a circular of polishing pastes are diamond dust, aluminum, magnesium oxide and alumina. Specimens is cleaned with sprit and dry it with cotton.

### **4. Etching:-**

After getting mirror like surface, it is checked under microscope. There should not be line or spot. The structure of the metallic matrix is developed by etching the polished surface. Etchant is applied on specimen with cotton and rubbing is carried out for sometime. The specimen is cleaned with dry cotton and viewed under microscope. Following table gives some etching reagents and materials with which these are used.

Sr.No	Material of specimen	Etching Reagent	Composition.
-------	----------------------	-----------------	--------------

1.	Iron and steel	Two percent Nital	2 % Nitric acid 98 % Ethylalcohol
2.	Stainless steel	Marble's reagent	$CuSO_4$ -4gm, HCl acid-20cc, Water 20 cc.
3.	Copper	Ferric chloride	Ferric chloride 15 cc, cone, Hcl acid-30cc, Water-200 cc.
4.	Brass, German Sillier Bronzes,	Ferric chloride	Ferric chloride 10 gm, Hcl Acid 30 cc, Water 120 cc.
5.	Ammonium alloys	Sodium hydroxide	Sodium hydroxide 10 gm, water 100 cc.
6.	Tin	Ammonium peroxydisulphate	1 % $(NH_2)_2 S_2O_8$ , 100 cc, water

**5. Washing and rinsing:-**After etching, the metal specimen is properly washed in pure running water. This removes the etchant and other impurities.

**6. Microscope examination:-**

The prepared specimen is placed on the mechanical stage of metallurgical microscope; and microstructure is studied for various phases involved, grain size, impurities etc.

**OBSERVATIONS:-**

Material: .....

Typical Composition: .....

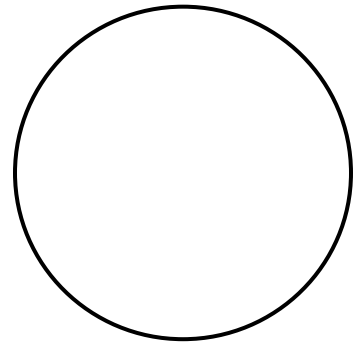
Specimen no. : .....

Magnification. : .....

Etchant. : .....

Structure. : .....

.....



Material: .....

Typical Composition: .....

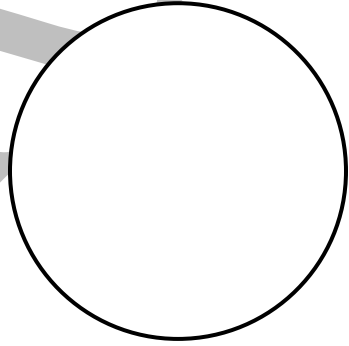
Specimen no. : .....

Magnification. : .....

Etchant. : .....

Structure. : .....

.....



Material: .....

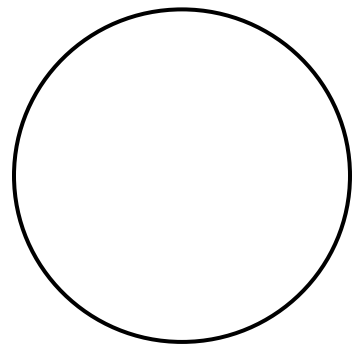
Typical Composition: .....

Specimen no: .....

Etchant: .....

Structure: .....

.....



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## **PRECAUTIONS:-**

1. The specimen should ground 900 to the previous one till the marks of grinding in earlier direction are completely wiped off.
2. During diamond polishing, excessive pressure should not apply on specimen.
3. Avoid too much heat generation during grinding as it may change the microstructure
4. Polished surface should not touch with fingers.
5. Apply abrasive should frequently to the polishing cloth.
6. Microscope should handle very carefully.

## **Experiment No-6**

### **OBJECT:-**

To anneal a given specimen and find out difference in hardness as result of annealing.

### **MATERIALS AND EQUIPMENT:-**

Carbon steel specimens, box type heat treatment furnace, Rockwell hardness testing machine, pair of tongs, quenching bath etc.

### **THEORY:-**

Heat treatment may be defined as a sequence of heating and cooling operations designed to get the desired combination of properties. Before heating, microstructure of steel consists of ferrite, pearlite and changes to austenite. This transformation is completed at higher critical temperature. After the formation of austenite, steel is cooled at a definite cooling rate according to desired properties. At higher cooling rate formation of bainite and martensite, takes place whereas slow cooling rate leads to formation of ferrite and cementite.

Annealing is a softening process which is done to reduce hardness or to relieve internal stresses. In this process hypo- eutectoid steels are heated up to  $(A_{e3}+50)^{\circ}\text{C}$  and hypereutectoid steels upto  $(A_{e1} +50)^{\circ}\text{C}$ . After heating steel is held at this temperature for some time and then slow cooling is done.

### **Procedure:-**

Hardening of specimen is done in the furnace having a temperature of  $820^{\circ}\text{C}$  (for specimen having 0.6 % C), keep the specimen at this temperature for about 30 minutes. With the help of tongs, remove them and quench them in a quenching bath having 10 % sodium chloride brine solution. After drying the specimen measure hardness by Rockwell hardness tester. Now put the

specimen at 8200 c in furnace for 30 minutes. Now let the specimen cool in the furnace about 700<sup>0</sup> c. Removes the specimen and put it in ashes to reduce cooling rate. When temperature of specimen reaches at room temperature measure Rockwell hardness.

**OBSERVATIONS:-**

**1. For hardening of specimens:-**

Specimen No	Rockwell Hardness (Before heat treatment)	Rock well hardness after heat treatment.			
		1	2	3	Average value

**2. Heat Treatment of hardened specimens:-**

Specimen No	Rockwell Hardness (Before heat treatment)	Rock well hardness after heat treatment.			
		1	2	3	Average value

**Experiment No-7**

**Object:**

To normalise a given specimen and to find out difference in hardness as a result of normalizing.

**Materials And Equipment:**

Carbon steel specimens, box type heat treatment furnace, Rockwell hardness testing machine, pair of tongs, quenching bath etc.

**Theory:**

Heat treating may be defined as a sequence of heating and cooling operations designed to get the desired combination of properties. Before heating, microstructure of steel consists of ferrite, pearlite and cementite. During heating changes in structures take place. At lower critical temperature, pearlite changes to austenite. This transformation is completed at higher critical temperature. After the formation of austenite, steel is cooled at a definite cooling rate according to desired properties. At higher cooling rate formation of bainite and martensite, take place whereas slow cooling rate leads to formation of ferrite and cementite

Normalizing is a process of heating steel to austenite phase and cooling it in air. Air cooling provides faster cooling rate than furnace cooling. Normalizing is done to eliminate coarse grained structure by homogenizing the microstructure.

**PROCEDURE:**

Hardening of specimen is done in to the furnace having a temperature of 820<sup>0</sup>C (for specimen having 0.6%C), keeps the specimen at this temperature for about 30 minutes. With the help of tong, remove them and quench them in a quenching bath having 10% sodium choride brine solution. After drying the specimen measure hardness by Rockwell hardness tester. Now put the specimen at 820<sup>0</sup>C infurnace for a period of 30 minutes

For normalizing put this specimen into furnace at a temperature of 8200 C for 25 to 35 minutes. Remove the specimen from furnace and cool it to room temperature in still air. After cleaning measure hardness.

**Observation:**

1. For hardening of specimens:

specimens	Rock well hardness	Rock well hardness after heat treatment.			
No	(Before heat treatment)	1	2	3	Average value

- 2 heat treatment of the hardened specimens:

specimen	Rock well hardness	Rock well hardness after heat treatment.			
No	(before heat treatment)	1	2	3	Average value

**Precautions:**

1. While placing in or taking out the specimen from the furnace, use safety gloves and fire tongs.
2. Tongs should be dry and should grip the piece firmly.
3. Never operate the furnace bare footed.
4. Heating of specimen should be done up to the temperature required. Overheating may spoil specimens.

## Experiment No- 8

### Object:

To temper a specimen and to find out difference in hardness due to tempering

### MATERIALS AND EQUIPMENT:

Carbon steel specimens, box type heat treatment furnace, Rowell hardness testing machine, pair of tongs, quenching bath etc.

### THEORY:

Heat treatment may be defined as a sequence of heating and cooling operations designed to get the desired combination of properties. Before heating microstructure of steel consists of ferrite, pearlite and cementite. During heating changes in structures take place. At lower critical temperature, pearlite changes to austenite. Steel is cooled at a definite cooling rate according to desired properties. At higher cooling rate formation of bainite and martensite, take place whereas slow cooling rate leads to formation of ferrite and cementite.

Normalising is a process of heating steel to austenite phase and cooling it in air. Air cooling provides faster cooling rate than furnace cooling. Normalising is done to eliminate coarse grained structure obtained during rolling, forging etc. and to modify cast dendritic structure and reduce segregation by homogenizing the microstructure.

Tempering is achieved a previously hardened steel to a temperature below the lower critical temperature and cooling back to room temperature. Tempering temperature varies from  $100^{\circ}\text{C}$  to  $680^{\circ}\text{C}$  depending on requirements. Steels are tempered for 1 to 2 hour.

### PROCEDURE:

Hardening of specimen is done in to the furnace having a temperature of  $820^{\circ}\text{C}$  (for specimen having 0.6%C), keeps the specimen at this temperature for about 30 minutes. With the help of tong, remove them and quench them in a quenching bath having 10% sodium chloride brine solution. After drying the specimen measure hardness by rock well hardness tester. Now put the specimen at  $820^{\circ}\text{C}$  in furnace for a period of 30 minutes.

For tempering put this specimen into furnace at  $400^{\circ}\text{C}$  for 30 minutes. Remove it from furnace and quench it in the quenching bath. Clear it and measure its hardness.

### OBSERVATION:

1. For hardening of specimens:

specimens	Rock well handers	Rock well hardness after heat treatment.			
No	(Before heat treatment)	1	2	3	Average value

2.heat treatment of the hardened specimens:

specimen	Rock well hardness	Rock well hardness after heat treatment.			
No	(before heat treatment)	1	2	3	Average value

**PRECAUTION:**

1. While placing in or taking out the specimen from the furnace, use safety gloves and fire tongs.
2. Tongs should be dry and should grip the piece firmly.
3. Never operate the furnace bare footed.
4. Heating of specimen should be done up to the temperature required. Overheating may spoil specimens.

ASRA

## **ECOLOGY AND ENVIRONMENTAL AWARENESS CAMP**

A diploma holder must have knowledge of different types of pollution caused due to industries and constructional activities so that he may help in balancing the eco system and controlling pollution by pollution control measures. He should also be aware of environmental laws related to the control of pollution. This is to be organized at a stretch for 3 to 4 days. Lectures will be delivered on following broad topics. There will be no examination for this subject.

1. Basics of ecology, eco system and sustainable development
2. Conservation of land reforms, preservation of species, prevention of advancement of deserts and lowering of water table
3. Sources of pollution - natural and man made, their effects on living and non-living organisms
4. Pollution of water - causes, effects of domestic wastes and industrial effluent on living and non-living organisms
5. Pollution of air-causes and effects of man, animal, vegetation and non-living organisms
6. Sources of noise pollution and its effects
7. Solid waste management; classification of refuse material, types, sources and properties of solid wastes, abatement methods
8. Mining, blasting, deforestation and their effects
9. Legislation to control environment
10. Environmental Impact Assessment (EIA), Elements for preparing EIA statements
11. Current issues in environmental pollution and its control
12. Role of non-conventional sources of energy in environmental protection

## **ENVIRONMENTAL STUDIES**

### **DETAILED CONTENTS**

1. Basics of ecology, eco system and sustainable development.
2. Conservation of land reforms, preservation of species, prevention of advancement of deserts and lowering of water table
3. Sources of pollution - natural and man made, their effects on living and non-living organisms
4. Pollution of water - causes, effects of domestic wastes and industrial effluent on living and non-living organisms
5. Pollution of air-causes and effects of man, animal, vegetation and non-living organisms
6. Sources of noise pollution and its effects
7. Solid waste management; classification of refuse material, types, sources and properties of solid wastes, abatement methods
8. Mining, blasting, deforestation and their effects
9. Legislation to control environment
10. Environmental Impact Assessment (EIA), Elements for preparing EIA statements
11. Current issues in environmental pollution and its control, Global warming, Green house gases, non-conventional sources of energy, introduction to clean technology.
12. Introduction to Green buildings, site selection, material efficiency, energy efficiency, water efficiency, building form.
13. Role of non-conventional sources of energy in environmental protection