# BENCH WORK AND FITTING

## INTRODUCTION

The term **bench work** denotes the production of an article by hand on the bench.

Where as **fitting** is the assembling of parts together and removing metals to secure the necessary fit, and may or may not be carried out at the bench.

These two types of work require the use of a large number of hand tools and other devices or equipments that involve a number of operations for accomplishing the work to the desired shape and size

## TOOLS USED IN FITTING SHOP

Tools used in bench and fitting shop are classified as under.

1. Marking tools
2. Measuring devices
3. Supporting tools
4. Holding tools
5. Striking tools
6. Cutting tools
7. Tightening tools etc

**1. Marking Tools**

These are sub classified as steel rule, circumference rule, straight edge, steel square, scriber, semi-circular protractor, divider, trammel, prick punch, centre punch, try square, bevel square, combination set and surface gauge.

**2. Measuring Devices**

Commonly used measuring devices used in bench and fitting shop are fillet and radius gauge, screw pitch gauge, surface plate, try square, dial gauge, feeler gauge, plate gauge, wire gauge, Steel rule, Calipers, Dividers, Telescopic gauge, Depth gauge, Micrometers, Vernier calipers, Depth gauges, Slip gauges, Protector, Engineers square, Adjustable bevel, Combination set, Straight edge, Surface gauge, Surface table

**3. Supporting Tools**

These are vee-block, marking table, surface plate, and angle plate.

**4. Holding Tools**

These are vices and clamps. Various types of vices are used for different purposes. They include hand vice, bench vice, leg vice, pipe vice, and pin vice. The clamps are also of different types such as c or g clamp, plane slot, goose neck, double end finger, u-clamp, parallel jaw,and clamping block.

**5. Strking Tools**

These are various types of hammers such as ball peen hammer; straight peen hammer, cross-peen hammer; double face hammer; soft face hammer.

**6. Cutting Tools**

These involve various types of files, scrapers, chisels, drills, reamers, taps, snip or shear and hacksaws.

**7. Tightening Tools**

These are pliers and wrenches, which are sub classified as under.

**Pliers.** These are namely ordinary, needle nose, and special type.

**Wrench.** These are open single ended, open double ended, closed ended adjustable, ring spanner, offset socket, t- socket, box wrench, pipe wrench etc.

**MEASURING TOOLS**

**Steel Rule**

Steel rule is generally employed for purpose of measuring rough dimensions and laying out them. It is always advisable to start measuring from 1 cm mark because the end of the rule is generally worn out

**Scribers**

Scribers are sometimes called the metal worker's pencil. These are made up of high carbon steel and are hardened from the front edge.
Scriber is used for scratching lines on the sheet metal during the process of laying out a job.

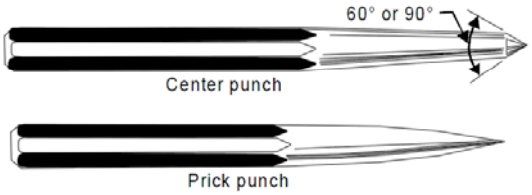
**Divider**

It is used for marking and drawing circle and arcs on sheet metal.

**Prick Punch**

The prick punch is used for indentation marks. It is used to make small punch marks on layout lines in order to make them last longer.

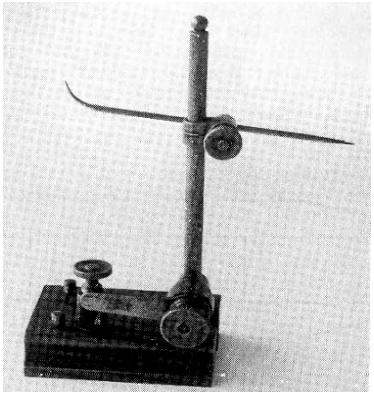
The angle of prick punch is generally ground to 30° or 40° whereas for centre punch it is kept 60 °or 90°.




**Centre Punch**

The centre punch is used for locating centre for indentation mark for drilling purposes.

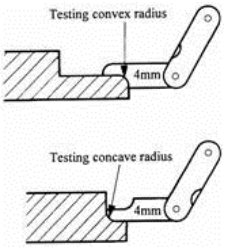
**SURFACE GAUGE or Scribing Block**



The surface gauge is a principal marking tool used generally in the fitting shop.

It consists of a cast iron sliding base fitted with a vertical steel rod. The scriber or marker is set into an adjustable device using a knurled nut at one end. The scriber can be loosened or tightened by means of the nut. The marker is used to set it at any desired inclination, moved to and fro inside the hole accommodating it or adjust its height along the vertical pillar.It is commonly used in conjunction with either a surface plate or marking table. It is used for locating centres of round rod held in V- block, describing straight lines on work held firmly in its position by means of a suitable device like angle plate and also in drawing a number of lines parallel to a true surface.

**FILLET AND RADIUS GAUGE**

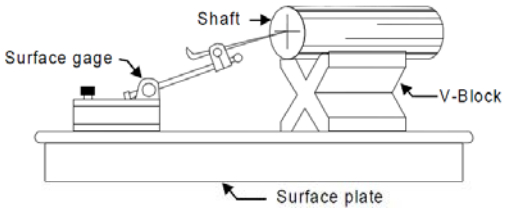




The fillet and radius gauge carries a similar metal case containing a number of steel blades in it. One set of blades, mounted on one end of the case carries concave end faces and the other set at the other end of the case, carries blades, which have convex end formations. The radii of the curvatures of the end formations are of different dimensions and thus provide a fairly wide range for quick checking and measuring of curvature. This instrument is highly useful for measuring and checking the inside and outside radii of fillets and other round surfaces.

**SCREW PITCH GAUGE**


The screw pitch gauge is a very effective and fairly accurate instrument used to identify or check the pitch of the threads cut on different threaded items. It consists of a case made of metal carrying a large number of blades or threaded strips which have teeth of different pitches, cut on their edges and markings corresponding to these pitches on their surfaces. In operation, different blades are applied or tried on the threads one after the other and when any one of them is found meshing with the cut teeth, the relevant reading is read directly from the marking on the matching blade surface. This gauge can be commonly used to measure the pitches of both external and internal threads. The free ends of the screw pitch gauge blades are generally made narrow for enabling them to enter the hollow parts easily while checking the internal threads.

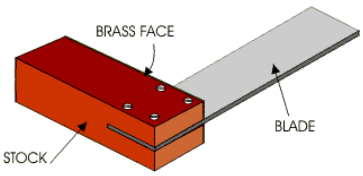
## SURFACE PLATE

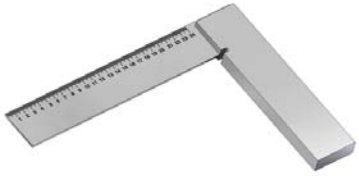


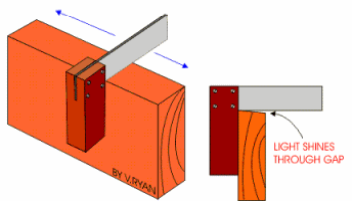

The surface plate is a cast iron plate having generally a square top well planed and square with adjacent machined faces.
The top surface of the plate is finished true by means of grinding and scrapping. It possesses a cast iron base, which is also machined true to keep the top surface of the plate in a perfect horizontal plane. Its specific use is in testing the trueness of a finished surface, testing a try square, providing adequate bearing surface for V-block and angle plates, etc. in scribing work.

## TRY SQUARE

The try square, which is also known as engineer's try square.
It is very important tool required for scribing straight lines at right angles to a true surface or testing the trueness of mutually normal surfaces.
It is made in different sizes out of steel pieces.
In construction, it is similar to a carpenter's try square but is comparatively more accurate.
It consists of a steel blade fitted into a steel stock of rectangular cross-section.

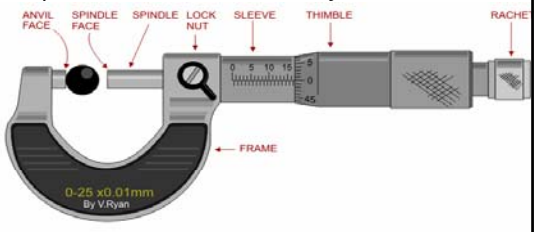




**OUTSIDE MICROMETER**

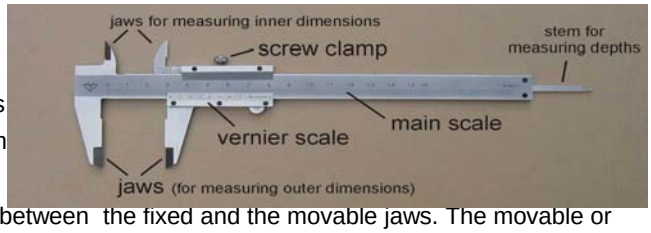
Micrometer works commonly on the principle of nut and bolt assembly.




The sleeve carries inside threads at the end, which forms the nut, and the screwed part of the spindle passes through it. The spindle and the thimble are secured to each other such that by rotating the thimble the spindle rotates. With the result, when the thimble is revolved, it advances towards or retards away from the fixed anvil, together with the spindle of the micrometer.The sleeve carries the graduations, which, in conjunction with the beveled and graduated part of the thimble, give the measure of the opening between the end faces of the anvil and the spindle. The ratchet arrangement provided at the end of the thimble prevents the spindle from pressing further against the surface of the piece being measured after the required feel has been attained, thus facilitating a uniform reading and preventing the instrument from being damaged. Lock nut or locking lever is used for locking the micrometer for a desired amount of time after taking or setting the reading.

**VERNIER CALIPER**

The vernier caliper is commonly used to measure accurately
(1) outside diameters of shafts (2) thicknesses of various parts (3) diameters of holes or rings and (4) internal dimensions of hollow jobs or articles

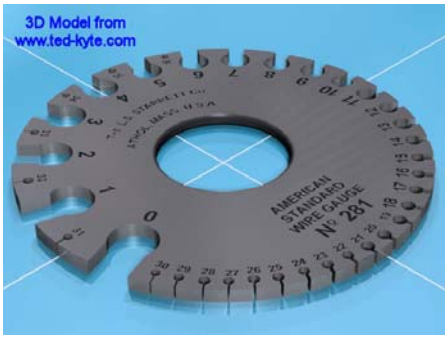



It works on the principle of vernier and can measure the dimensions to an accuracy of 0.02 m
For making a measure -ment, the job is placed between the fixed and the movable jaws. The movable or the sliding jaw is moved until it almost contacts the job kept against the fixed jaw. The sliding jaw assembly of the vernier caliper that carries the fine adjustment screw should be clamped to the graduated beam with the help of adjustment clamp. The two jaws are then brought into contact with the job by moving the sliding jaw with the help of fine adjustment screw. The jaws should make now definite contact with the job but should not be tight. The main slide assembly is then locked to the beam with help of clamp. The caliper is then carefully removed from the job to prevent springing the jaws and the reading is taken.

## CALIPERS

Calipers are generally of two types inside and outside to make internal or external measurements. They do not have direct scale reading. They transfer the measurement from
jobs to scale or vice versa. Fig. 19.16 shows a simple outside caliper. The caliper is held in
a rule as shown in Fig. 19.17 to read the size. It is used to make external measurement such
as thickness of plates, diameter of sphere and cylinders. Fig. 19.18 shows the standard spring
joint outside caliper.

## WIRE GAUGE




The wire gauge is a flat and circular steel sheet metal piece having slots all along its periphery as shown in FIG. These slots have different standard sizes, which are engraved
near their bottom. The size of each slot represents the correct diameter of the wire or
thickness of the sheet of which it represents the gauge. The gauge number varies inversely
as the size of the wire. That is the higher the gauge number, the thinner the wire and vice
versa.

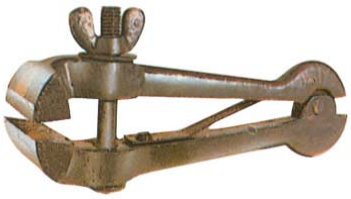
Conversion table - American Wire Gauge - mm. - $mm^2$

| AWG N° | Diam. mm. | Area $mm^2$ | AWG N° | Diam. mm. | Area $mm^2$ |
|---|---|---|---|---|---|
| 1 | 7,350 | 42,400 | 16 | 1,290 | 1,3100 |
| 2 | 6,540 | 33,600 | 17 | 1,150 | 1,0400 |
| 3 | 5,190 | 21,200 | 18 | 1,024 | 0,8230 |
| 4 | 5,190 | 21,200 | 19 | 0,912 | 0,6530 |
| 5 | 4,620 | 16,800 | 20 | 0,812 | 0,5190 |
| 6 | 4,110 | 13,300 | 21 | 0,723 | 0,4120 |
| 7 | 3,670 | 10,600 | 22 | 0,644 | 0,3250 |
| 8 | 3,260 | 8,350 | 23 | 0,573 | 0,2590 |
| 9 | 2,910 | 6,620 | 24 | 0,511 | 0,2050 |
| 10 | 2,590 | 5,270 | 25 | 0,455 | 0,1630 |
| 11 | 2,300 | 4,150 | 26 | 0,405 | 0,1280 |
| 12 | 2,050 | 3,310 | 27 | 0,361 | 0,1020 |
| 13 | 1,830 | 2,630 | 28 | 0,321 | 0,0804 |
| 14 | 1,630 | 2,080 | 29 | 0,286 | 0,0646 |
| 15 | 1,450 | 1,650 | 30 | 0,255 | 0,0503 |

**HOLDING TOOLS**

***Bench vice***

***Machine vice***



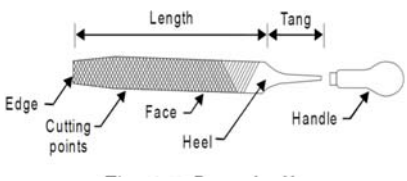
***Hand vice***

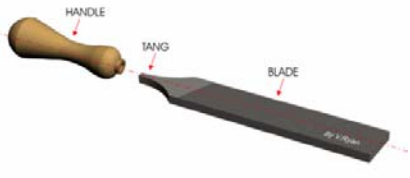
***Pin vice***

**CLAMPING DEVICE**

There are two types of clamps namely C clamp and tool maker clamp. A C-clamp is shown in Fig. 19.38 which is used for gripping the work during construction or assembly
work. Whereas tool maker clamp (Fig. 19.39) is used for gripping or holding smaller jobs.

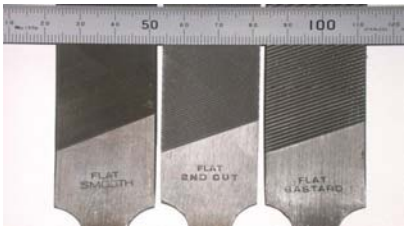
**FILES**



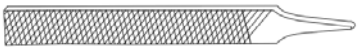

The widely used hand cutting tool in workshops is the file.
It is a hardened piece of high grade steel with slanting rows of teeth. It is used to cut, smooth, or fit metal parts. It is used file or cut softer metals.
It consists of the following parts as shown in Fig.
The tang is the pointed part, which fitted into the handle.
The point is the end opposite the tang.
The heel is next to the handle.
The safe edge or side of a file is that which has no teeth.
It is classified on bases of type or cut of teeth and sectional form.

***Size of a File***
Size of a file is specified by its length. It is the distance from the point to the heel, without the tang. Files for fine work are usually from 100 to 200 mm and those for heavier work from 200 to 450 mm in length.




***Classification of Files***
The files are classified on basis of type of cuts, grade and shapes. These are further sub classified as under

(a) Single cut file



(b) Double cut file

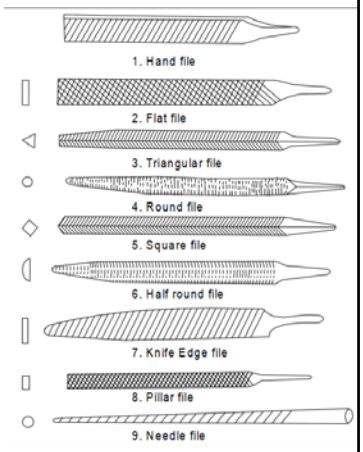
(c) Rasp cut file.

**(A) Type of Cut**
The most commonly used files according to cuts of teeth are shown in Fig.19.41.
(*i*) Single
(*ii*) Double and
(*iii*) Rasp

**(B) Grade of Cut**
Files are cut with teeth of different grades. Those in general are
(*i*) Smooth
(*ii*) Second cut
(*iii*) Bastered
(*iv*) Rough

***Cut or teeth on files***
Teeth or cuts of files can be categorized into two groups namely ***single cut and double cut***.
In single cut files, the teeth are cut parallel to other across the file at an angle of about 60° to the centre line of the file. Such types of file are named as flats and are widely used on hard metal. A double-cut file possesses two sets of teeth, the over-cut teeth being cut at about 60° and the up cut at 75 to 80° to the centre line.
Single-cut and double-cut files are further classified according to the coarseness or spacing between the rows of the teeth. In descending order of roughness, such files are listed as:
(*i*) Smooth (*ii*) Dead smooth (*iii*) Rough
(*iv*) Bastard

(**C) Shape of File**
Common shapes of files are having different cross sections, which cover most requirements.



**Scrapers**

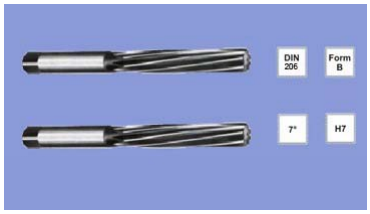
Scrapers are made up of old files and the cutting edge of scraper is hardened and tempered. They are mainly used to scrap metal surfaces by rubbing the work surface. They also produce a bearing surface, which has been filed or machined earlier. The scrapers are hand cutting tools used for removing metal from surfaces in form of thin slices or flakes to produce smooth and fine surfaces.


**Chisel**

Chisel is one of the most important tools of the sheet metal, fitting and forging shop. It is widely used for cutting and chipping the work piece. It is made of high carbon steel or tool steel. It is in the form of a rod having cutting edge at one end, hexagonal or octagonal body and striking head at the other end. The size of a chisel is described by its length and width of edge. When the cutting edge becomes blunt, it is again sharpened by grinding.

**Reamer**

The drill does not always produce the correct hole some time with good finish. Thus a correct hole is produced with good finish of a pre drilled hole using a reamer It is commonly employed to remove minimum amount of metal (100 to 150 micron for rough reaming and 5 to 20 micron for fine reaming) from the hole. During reamings operations, the job should be properly supported and rigidly held.



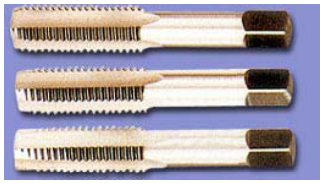

**TAPS**

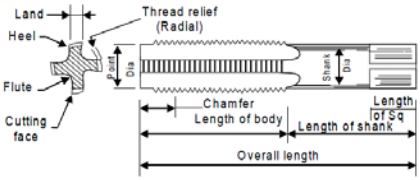
Taps are used for cutting or producing internal threads of either left or right hand kind in nuts or pre-drilled holes.

Taps are threaded externally. The threads being cut by grinding to give a high class finish.

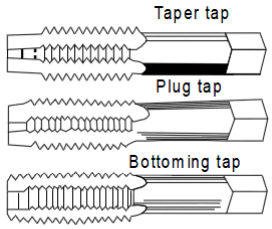
Taps are made up of alloy steel or hardened steel. To provide cutting edges, grooves known as ***flutes*** are ground along the threaded portion of the tap so that the thread is divided into row of teeth.

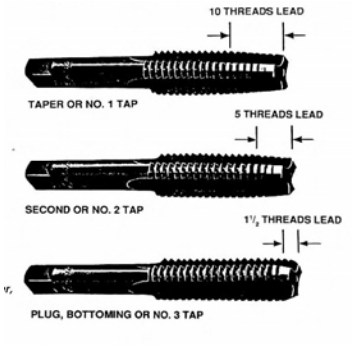
The number of flutes on tap varies from two to eight whereas four being the most common The flutes acts as channels to carry away the chips formed during tapping or cutting threads The nomenclature of a typical tap is shown





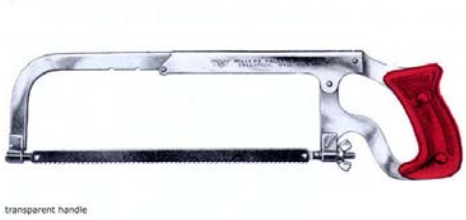
Hand taps are usually made in sets of three:
(1) taper tap
(2) plug tap
(3) bottoming tap
as shown in Fig.
The taper tap is tapered off for 8 or 10 threads, and is used first, cutting to the full thread gradually.
The intermediate tap usually has two or three threads chamfered. The second tap can finish a through hole.
The plug tap has a full-sized un-tapered thread to the end and is the main finishing tap.
In the case of blind hole, a plug tap must be used.



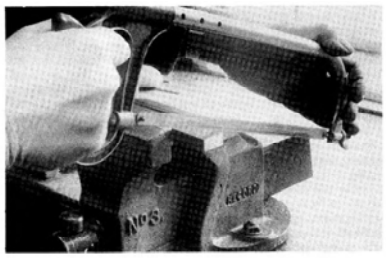




## Hand hacksaw

Hand hacksaws are made in two types namely a fixed frame and adjustable frame.
The former possesses solid frame in which the length cannot be changed and where as the latter comprises the adjustable frame which has a back that can be lengthened or shortened to hold blades of different sizes.



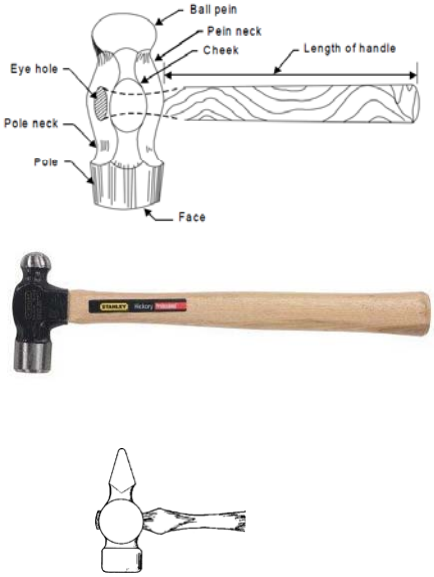

The hand hacksaws are commonly used for sawing all soft metal. They consist of a frame, handle, prongs, tightening screw and nut, and blade as shown in figure.
Its frame is made to hold the blade tightly.
However a ***power operated hacksaw*** can also be used for cutting raw materials in sizes in case of continuous cutting generally occurring frequently in fitting or in machine shops



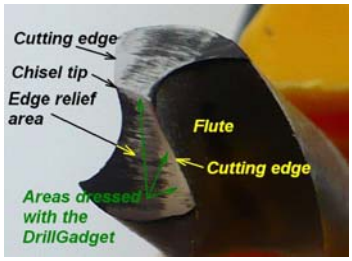
**Sriking Tools**

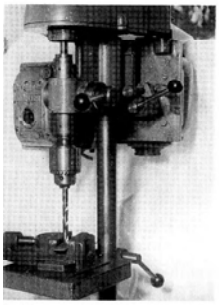
Various types of hammers (such as ball peen hammer, straight peen hammer, cross-peen hammer, double face hammer and soft face hammer) are acting as striking tools.

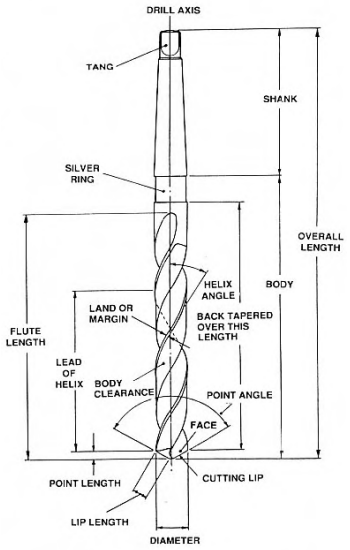
.



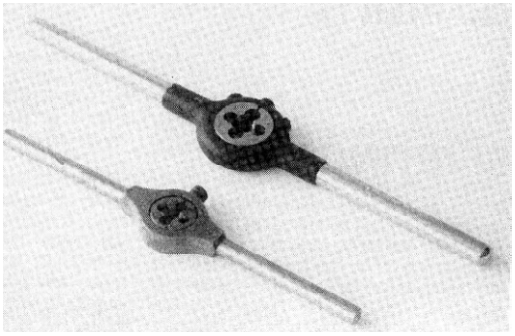

**DRILL**





**Die and Die Stock**



GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

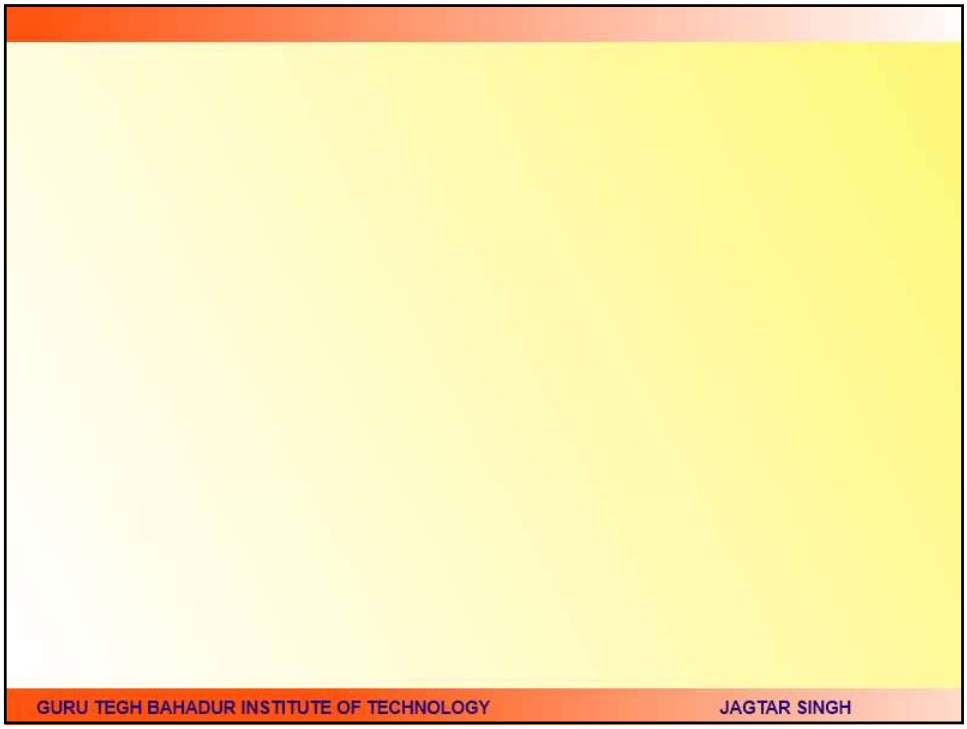
GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

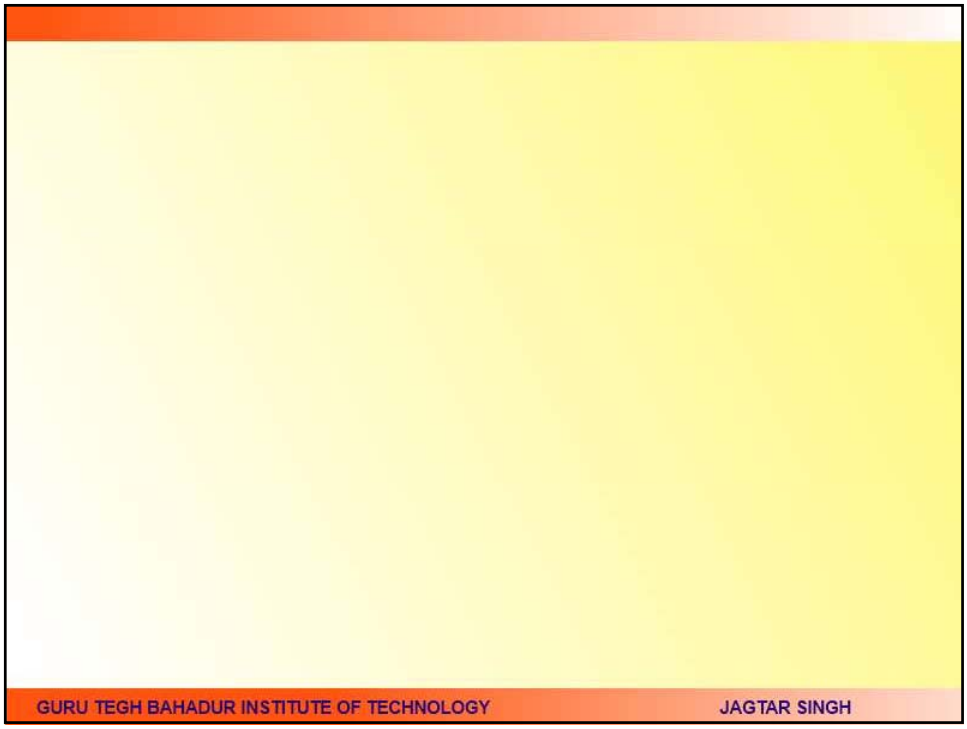
GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH


GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY
JAGTAR SINGH


GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY
JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH

GURU TEGH BAHADUR INSTITUTE OF TECHNOLOGY JAGTAR SINGH