ARUNAI ENGINEERING COLLEGE

VELU NAGAR, TIRUVANNAMALAI – 606 603.

DEPARTMENT OF MECHANICAL ENGINEERING

CE 8462-MANUFACTURINGTECHNOLOGY

LABORATORY –II

LABORATORY MANUAL

MANUFACTURING TECHNOLOGY LABORATORY –II

L T P C

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OBJECTIVES:

To Study and acquire knowledge on various basic machining operations in special purpose Machines and its applications in real life manufacture of components in the industry

LIST OF EXPERIMENTS:

1. Contour milling using vertical milling machine
2. Spur gear cutting in milling machine
3. Helical Gear Cutting in milling machine
4. Gear generation in Hobbing machine
5. Gear generation in gear shaping machine
6. Plain Surface grinding
7. Cylindrical grinding
8. Tool angle grinding with tool and Cutter Grinder
9. Measurement of cutting forces in Milling / Turning Process
10. CNC Part Programming.

OUTCOMES:

- Ability to use different machine tools to manufacturing gears.
- Ability to use different machine tools for finishing operations
- Ability to manufacture tools using cutter grinder
- Develop CNC part programming

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Turret and Capstan Lathes	1 No each
2	Horizontal Milling Machine	2 No
3	Vertical Milling Machine	1 No
4	Surface Grinding Machine	1 No.
5	Cylinderical Grinding Machine	1 No.
6	Radial Drilling Machine	1 No.
7	lathe Tool Dynamometer	1 No
8	Milling Tool Dynamometer	1 No
9	Gear Hobbing Machine	1 No
10	Tool Makers Microscope	1 No
11	CNC Lathe	1 No
12	CNC Milling machine	1 No
13	Gear Shaping machine	1 No
14	Centerless grinding machine	1 No
15	Tool and cutter grinder	1 No

TOTAL – 45 PERIODS

CONTENTS

Ex.No: **STUDY OF MILLING MACHINE**

Date:

- **Definition:**

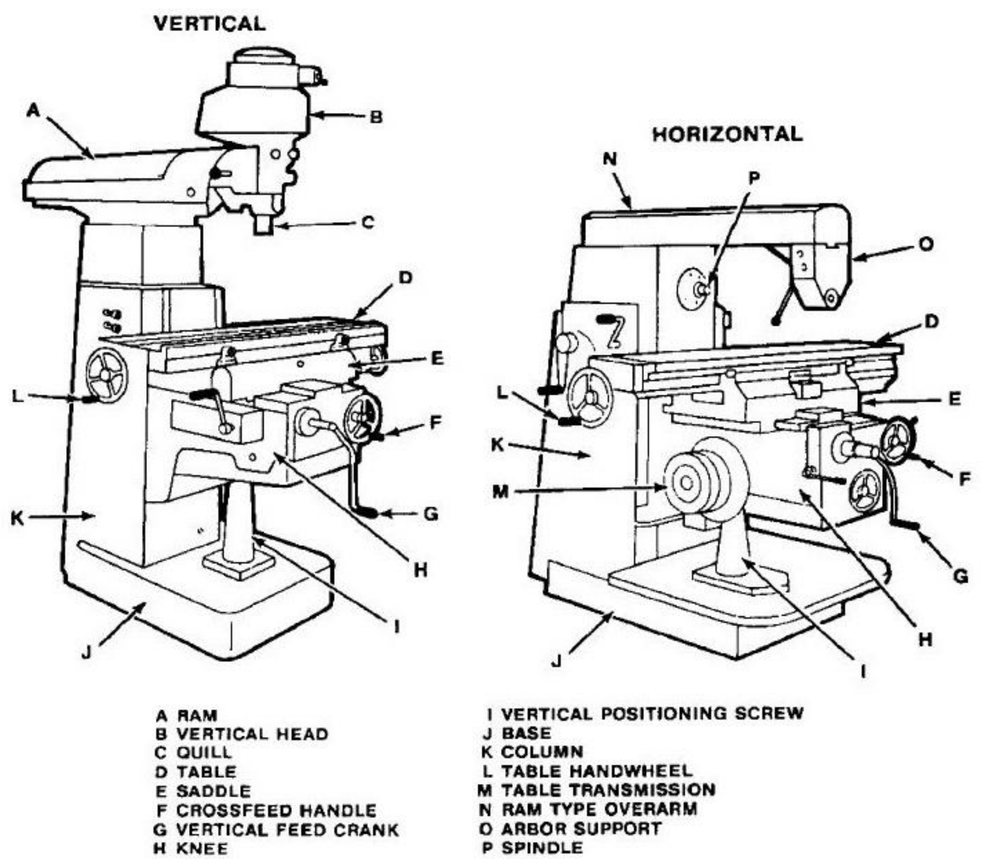
  Milling is the process of machining flat, curved or irregular surface by feeding the work piece against a rotating cutter containing a number of cutting edges

- **Operation:**

  The milling machine consists basically of a motor driven spindle, which mounts and revolves the milling cutter and a reciprocating adjustable worktable, which mounts and feed the work piece

- **Types of Milling Machines:**

1. Knee-type milling machine; **2.** Universal Horizontal milling machine; **3.** Ram type milling machine; **4.** Universal Ram type milling machine; **5.** Swivel cutter head ram type milling machine

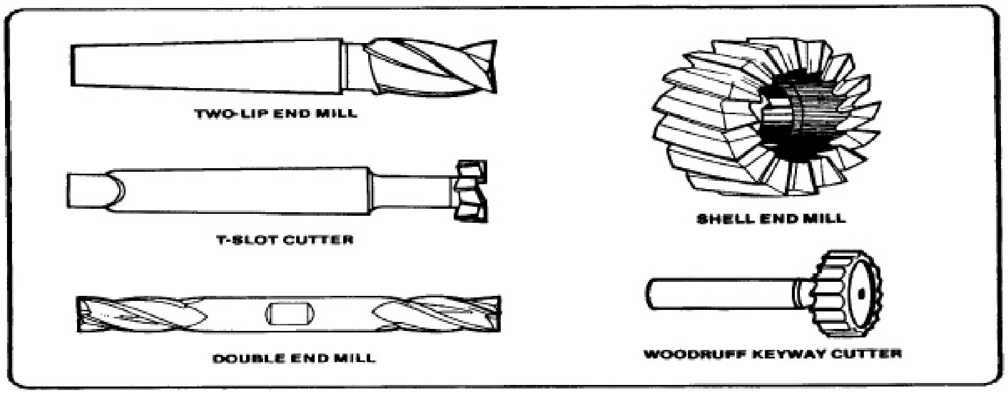


Vertical and Horizontal milling machines

- **Milling Cutters:**

  Milling cutters are usually made of high-speed steel and are with its parts and angles identified. The types of milling cutter are been classified as follows

  1. Helical milling cutter; 2.Saw milling cutter; 3.Side milling cutter; 4.End milling cutter; 5.T slot milling cutter ; 6.Angle milling cutter



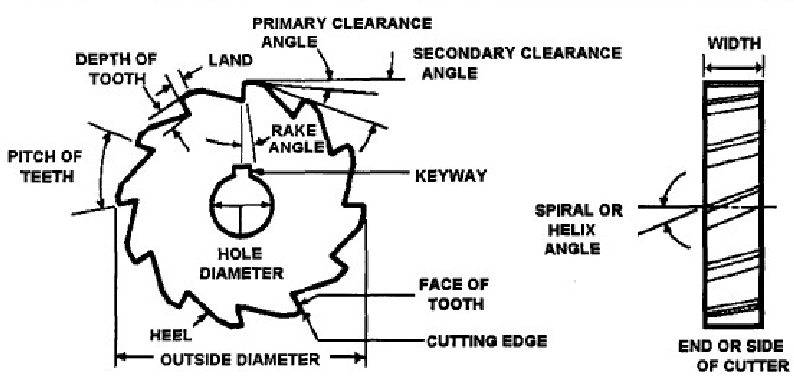
Milling cutter type

- **Selection of milling cutter:**

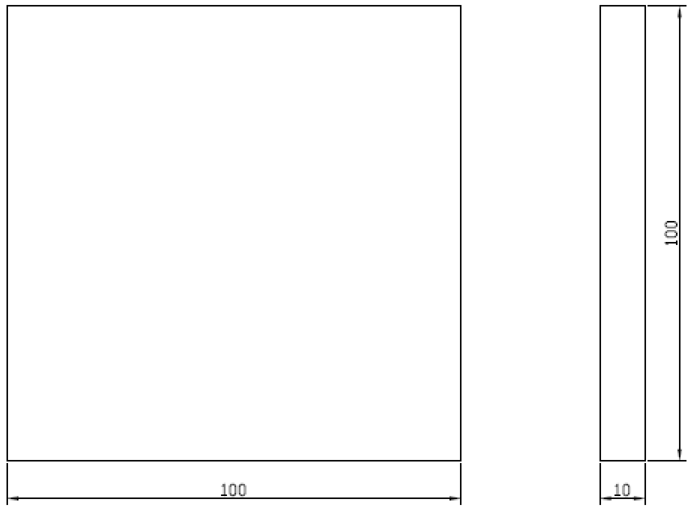
  The selection of milling cutter can be done through the possible ways

  1. High speed steel, stellite and cemented carbides have a distinct advantage of being capable of rapid production when used on a machine that can reach the proper speed.
  2. The harder the material, the greater will be the heat generated in cutting. Cutter should be selected for the heat resisting properties.
  3. The two side milling cutters can be used for the majority of operations

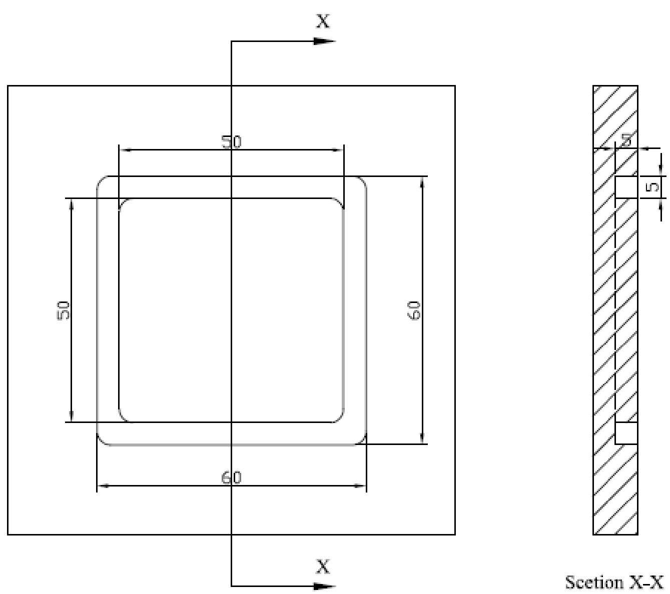
- **Cutting Tool Nomenclature:** Shown below is a self-explanatory figure of cutting tool nomenclature



Cutting tool Nomenclature



Before Machining



After Machining

All Dimensions in mm

Calculation:

- Feed in mm/rev = Feed per tooth (f_t) X number of cutter teeth(n)

- Feed per min (table feed) = F = feed per rev x cutter speed in RPM(V) = f_t X n X V

Ex.No:

CONTOUR MILLING USING VERTICAL MILLING MACHINE

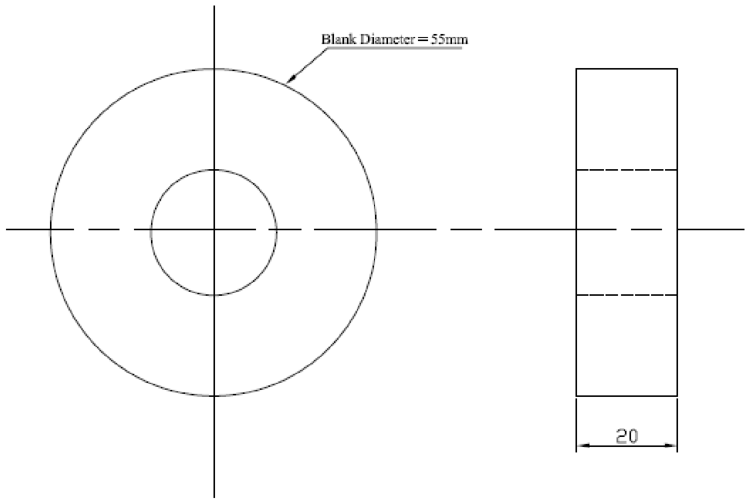
Date:

- **Aim:** To perform the contour milling on given work piece using vertical milling machine
- **Apparatus Required:**
  - Vertical Milling machine
  - HSS – M8 end mill cutter
- **Materials Required:**
  - Aluminium work piece – 100mm X 100mm X 10mm
- **Procedure:**
  - Hold the work piece in the Arbor which holds it perfectly for machining
  - Switch the spindle on and required RPM of rotation is set for the milling cutter
  - The average cutting speed can be taken from the table listed as follows

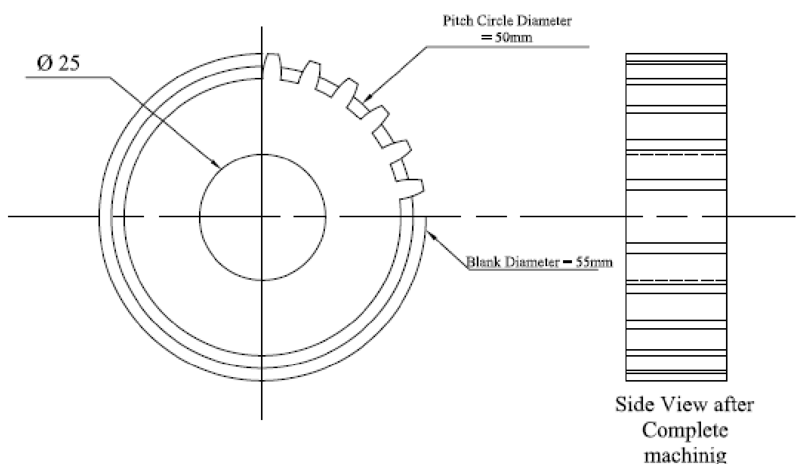
Material of W/p	Brass	Cast Iron	Bronze	Mild Steel	High Carbon steel	Hard Alloy Steel	Aluminium
Cutting speed m/min	45-60	21-30	24-45	21-30	15-18	9-18	150-300

  - Depth of cut can be 3mm to 8mm for roughing operation and 0.5mm to 1.5mm for finishing operation
  - After setting the depth of cut, machining is carried out on the work piece with the specified cutting parameters
  - The required contour profile is produced on the work piece

- **Result:** Hence the required contour profile is produced on the work piece using vertical milling machine



Before Machining



After Machining

All Dimensions in mm

Calculation:

- **Module of the cutter (m) =** 2.5 mm
- **Blank Diameter** = 55 mm
- **Pitch Circle Diameter:**
    - For any gear, Outer Diameter(OD) = Pitch circle diameter + (2 X module)
    - For the given conditions, **Pitch circle diameter (PCD)** = OD – (2 X m)

      = 55 – (2 X 2.5)
      = 50 mm
- **Number Of teeth:**
    - Number of Teeth (Z) = PCD / m
      = 50 / 2.5
      = 20

      Therefore number of teeth = 20
- **Indexing Calculation:**
    - Indexing = 40 / Z = 40 / 20 = 2

Ex.No: **SPUR GEAR CUTTING IN MILLING MACHINE**

Date:

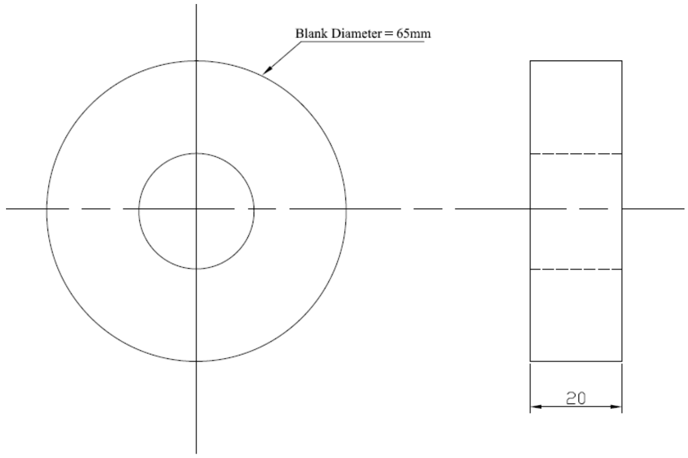
- **Aim:** To produce a spur gear out of the given work piece using milling machine

- **Apparatus Required:**
  - Horizontal Milling machine
  - M10 – End Mill Cutter (HSS)
  - Gear tooth Vernier

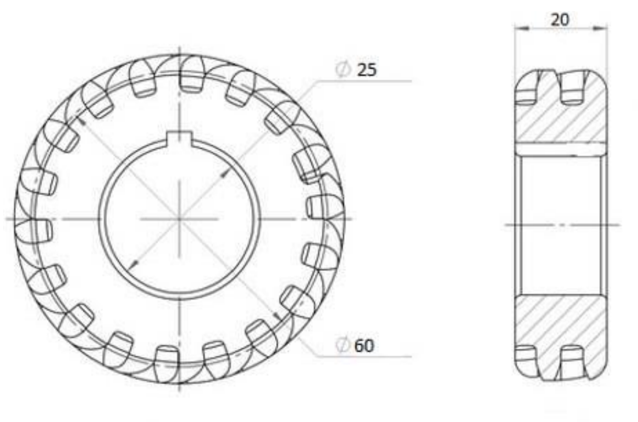
- **Materials Required:**
  - Cast Iron Work piece – 55mm diameter, 20mm thickness

- **Procedure:**
  - The gear blank is held between the dividing head and tailstock using a mandrel.
  - The cutter is mounted on the arbor and the cutter is centred accurately with the gear blank
  - Set the speed and feed for machining. For giving depth of cut, the table is raised till the periphery of the gear blank just touches the cutter
  - The Micrometre dial of vertical feed screw is set to zero at this position. Then the table is raised further to give the required depth of cut
  - The machine is started and feed is given to the table to cut the first groove of the blank.
  - After the cut, the table is brought back to the starting position. Then the gear blank is indexed for the next tooth space
  - This is continued till all the teeth are cut
  - Dimensions of the gear teeth profile are checked using the gear tooth Vernier

- **Result:** Thus a spur gear is made from the give work piece using milling machine



Before Machining



After machining

All Dimensions in mm

- **Calculation:**
  - **Pitch circle Diameter D_P** = Diameter of the Blank(**D**) – (2 X Module(**m**)) = 65-(2X2.5)=60
  - **Number of teeth Z** = Pitch circle Diameter / module = 60 / 2.5 = 24
  - **Circular Pitch P_C** $= \pi D_P / Z$
  - The relationship between **normal pitch** and **transverse pitch** is given by

    $$P_N = P_C \times \cos\alpha$$

  - **Helical Gear considerations:**
    - Helix Angle α is related to Pitch circle diameter (D_P) and the lead of the helix (L) by the following relation

      $$\tan\alpha = \pi D_P / L =$$

    - With any of the two known values, the third value can be found
  - **Indexing Calculation:** Indexing = 40 / Z =

Ex.No: **HELICAL GEAR CUTTING IN MILLING MACHINE**

Date:

- **Aim:** To cut a helical gear out of the given blank in milling machine

- **Apparatus Required:**
    - Horizontal Milling machine
    - M10 – End Milling cutter

- **Materials Required:** Cast Iron Blank – 65mm diameter and 20mm thickness
- **Procedure:**
    - The M10 milling cutter is set on the mandrel
    - The table is swivelled to an inclination of α (Helix Angle) with the axis of work piece
    - The required gear ratio is set between the work table and the mandrel holding the work piece so that movement of the work table rotates the work piece through the proper helix angle progressively
    - The spindle is switched on and the required depth of cut is set before the tool cuts the work piece.
    - Single teeth cavity is cut through the work piece.
    - After Indexing the next tooth is cut in similar fashion and so on
    - The gear tooth dimensions are checked using a gear tooth Vernier

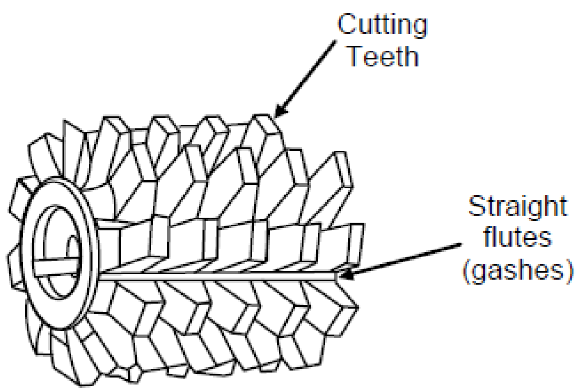
- **Result:** Thus a helical gear is cut out of the given blank using horizontal milling machine

Ex.No:

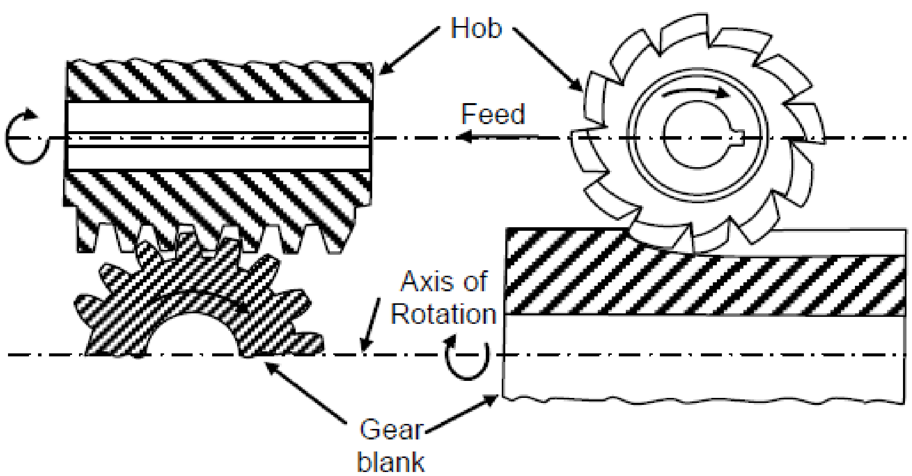
STUDY OF GEAR HOBBING MACHINE

Date:

- Gear Hobbing is a process that generates the gear profile by engagement of the tool and the work piece
- In this process, the gear blank is rolled with a rotating cutter called hob
- The Hob is a multi-point cutting tool having a number of straight flutes all around its periphery parallel to its axis
- These flutes are so shaped by giving proper angles to them so that these work as cutting edges
- In gear Hobbing operation, the hob is rotated at a suitable rpm and simultaneously fed to the gear blank
- Also the gear blank is kept revolving. Rpm of both gear blank and gear hob are so synchronized that for each revolution of gear hob, the gear blank rotates by a distance equal to one pitch distance of the gear to be cut
- Motion of both gear blank and hob are maintained continuously and steady
- A gear hob (tool) and the process of gear Hobbing are illustrated in Figure below



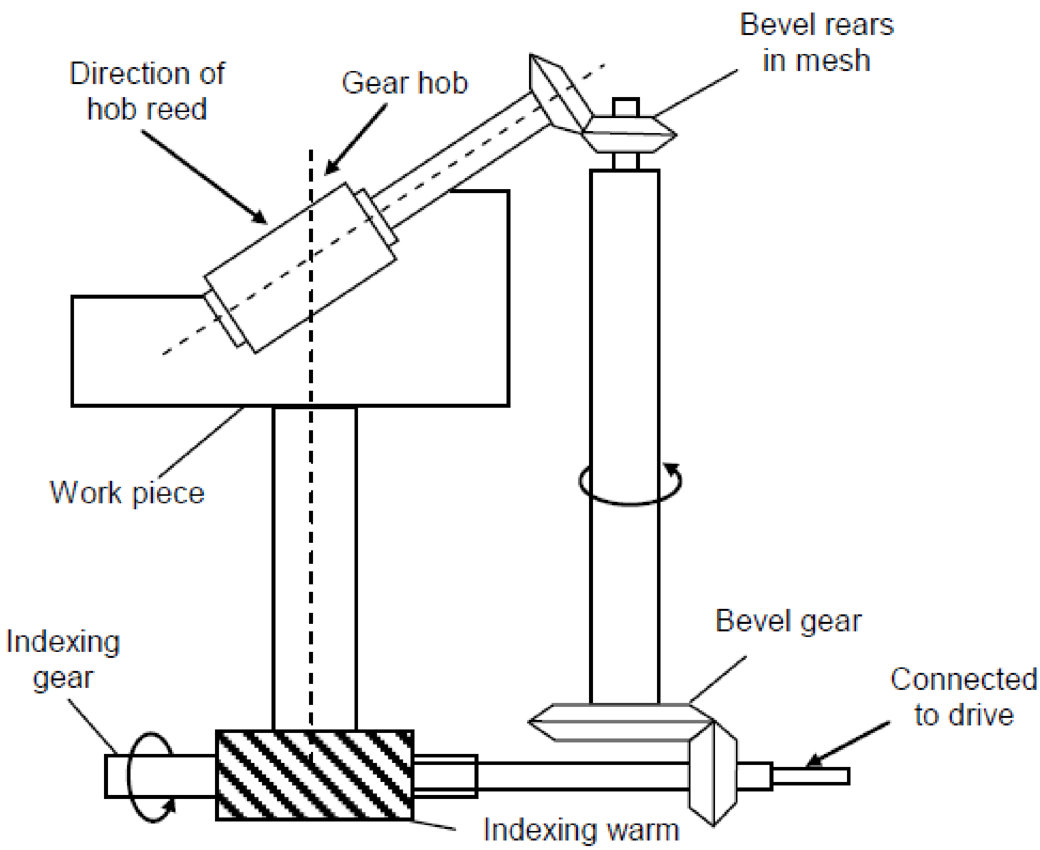
Gear Hob



Schematic of gear Hobbing process

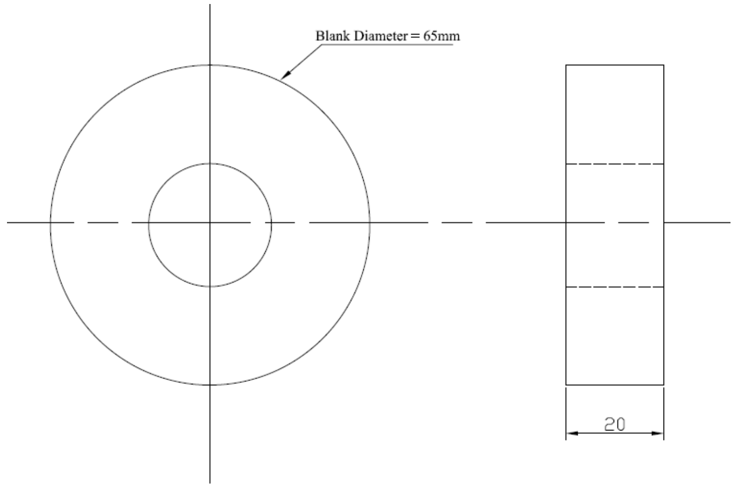
- Three important parameters are to be controlled in the process of gear Hobbing
    - indexing movement
    - feed rate
    - angle between the axis of gear blank and gear Hobbing tool

- A schematic diagram of the setup of a gear Hobbing machine is illustrated in Figure below

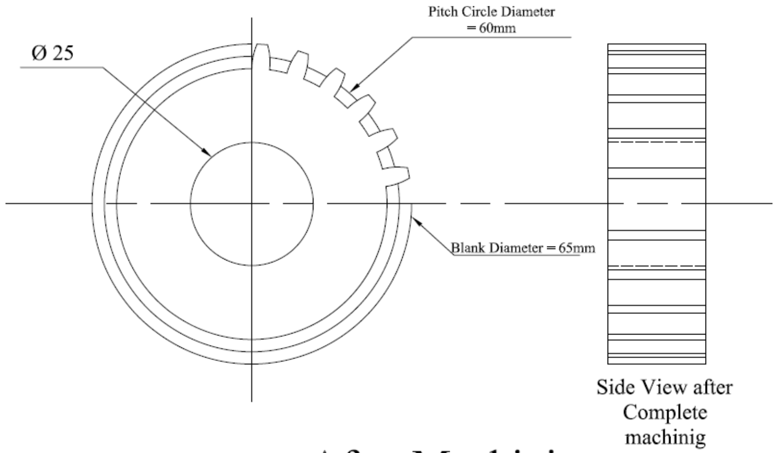


Setup for Gear Hobbing Machine

- The axis of hob is set at an inclination equal to the helix angle of the hob, with the vertical axis of the blank
- If a helical gear is to be cut, the hob axis is set at an inclination equal to the sum of the helix angle of the hob and the helix angle of the helical gear
- Proper gear arrangement is used to maintain rpm ratio of gear blank and hob
- The operation of gear Hobbing involves feeding the revolving hob till it reaches to the required depth of the gear tooth.
- Simultaneously it is fed in a direction parallel to the axis of rotation.
- The process of gear Hobbing is classified into different types according to the directions of feeding the hob for gear cutting.



Before Machining



After Machining

All Dimensions in mm

Calculation:

- **Module of the Hob (m) =** 2.5 mm
- **Blank Diameter** **=** 65 mm
- **Pitch Circle Diameter:**
  - For any gear, Outer Diameter(OD) = Pitch circle diameter + (2 X module)
  - For the given conditions, **Pitch circle diameter (PCD)** = OD – (2 X m)

    = 65 – (2 X 2.5)
    = 60 mm
- **Number Of teeth:**
  - Number of Teeth (Z) = PCD / m
    = 60 / 2.5
    = 24

  Therefore number of teeth = 24
- **Indexing Calculation:**
  - Indexing = 40 / Z = 40 / 24 = 1 2/3

Ex.No:

Gear Generation in Gear Hobbing machine

Date:

- **Aim:** To machine a Spur Gear using a gear Hobbing machine
- **Materials Required:** Cast Iron Blank
- **Tools Required:**
  - Gear Hobbing machine
  - Hob
  - Gear Tooth Vernier
  - Spanners
- **Procedure:**
  - The given work piece is held firmly on the spindle of the gear Hobbing machine
  - The Hob is set at an angle equal to its helix angle, with the axis of the blank for cutting spur gear
  - Gear ratio is set at a desired value to achieve the required speed of the hob and the work piece
  - The machine is switched on. The work piece and the hob are allowed to rotate, at the desired speed
  - The hob or the work piece is given full depth of cut equal to the tooth depth
  - The cutter is given feed for full width of the work piece
  - After machining all the teeth the machine is switched off
  - The dimensions of the teeth are checked using a gear tooth Vernier

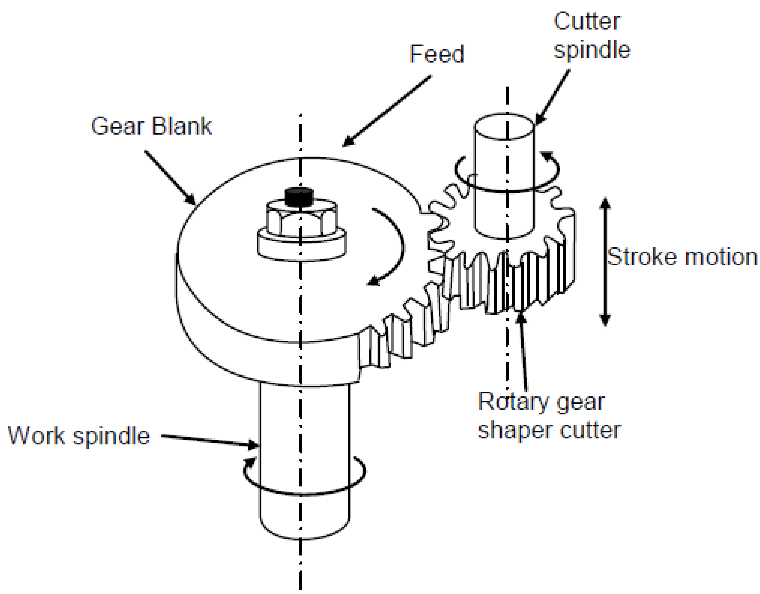
- **Result:** Thus the given blank (work piece) is converted into a gear of required dimensions by gear generation operation in a gear Hobbing machine

Ex.No:

STUDY OF GEAR SHAPER MACHINE

Date:

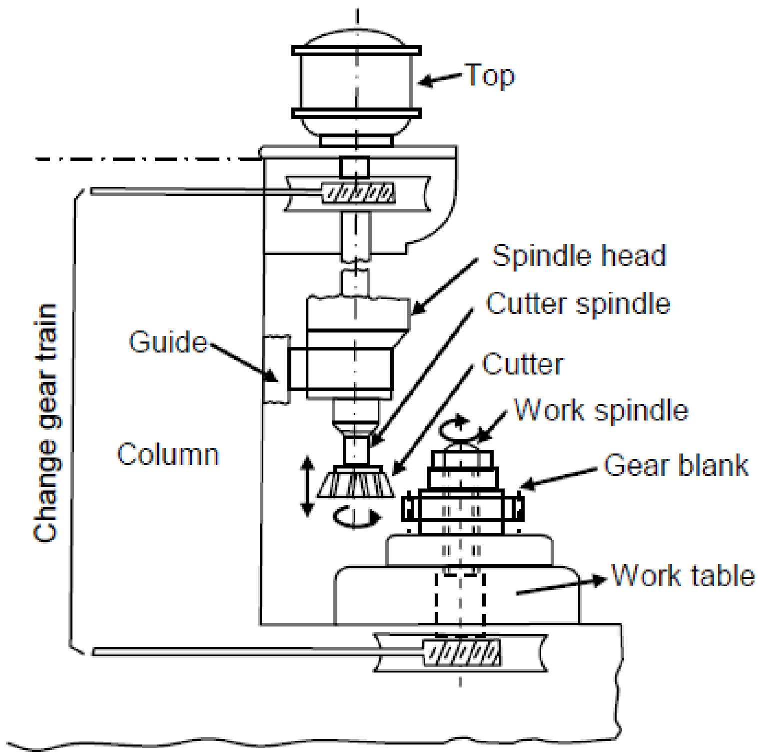
- This process uses a pinion shaped cutter carrying clearance on the tooth face and sides and a hole at its centre for mounting it on a stub arbor or spindle of the machine
- The cutter is mounted by keeping its axis in vertical position
- It is made to reciprocate up and down along the vertical axis up to a pre decided amplitude
- Both the cutter and the gear blank are set to rotate at a very low RPM about their axis
- The relative rpm of both (cutter and blank) can be fixed to any of the available value with the help of a gear train.
- This way all the cutting teeth of cutter come is action one-by-one giving sufficient time for their cooling and incorporating a longer tool life
- The principle of gear cutting by this process as explained above is depicted in the Figure below



Process of Gear Cutting by Shaper Cutter

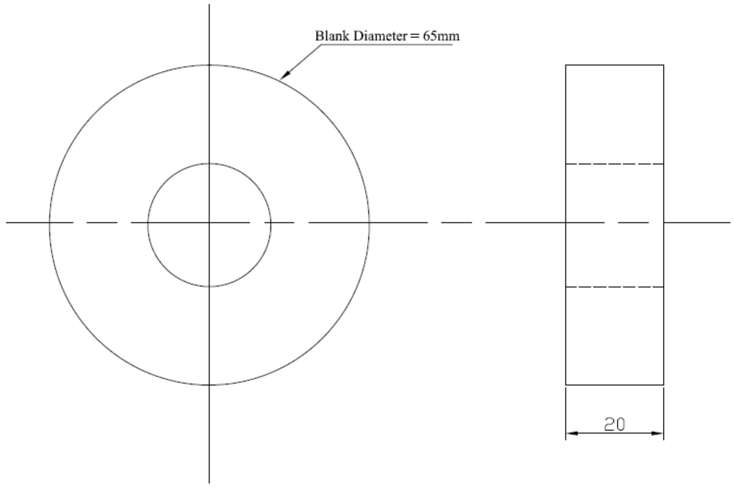
- The main parameters to be controlled in the process are described below
    - **Cutting Speed:**
    - Shaper cutter can move vertically upward and downward during the operation.
    - The downward movement of the cutter is the cutting stroke and its speed (linear) with which it comes down is the cutting speed.
    - Length of cutting stroke can be adjusted to any value out of available values on the machine
    - **Indexing motion:**

- Indexing motion is equivalent to feed motion in the gear shaping operation. Slow rotations of the gear cutter and work piece provide the circular feed to the operation.
- These two rpms are adjusted with the help of a gear train
- **Depth Of Cut:**
- The required depth is maintained gradually by cutting the teeth into two or three pass
- In each successive pass, the depth of cut is increased as compared to its previous path
- This gradual increase in depth of cut takes place by increasing the value of linear feed in return stroke

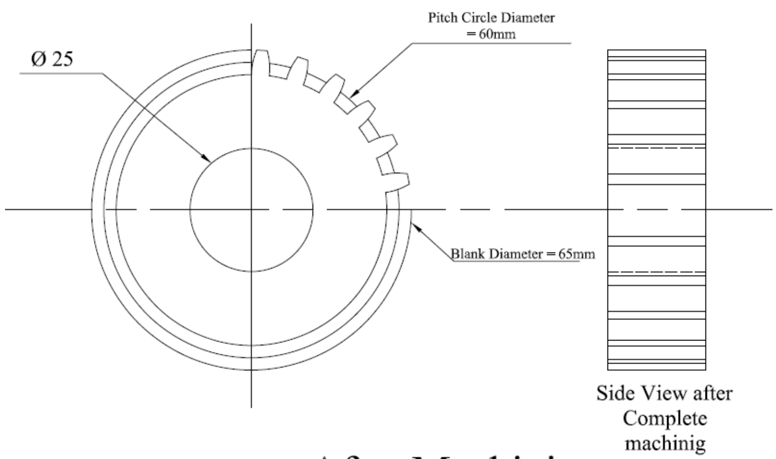


Setup for Gear Shaping Machine

- A Schematic representation of gear shaper is shown above with various parts
- The main advantage of gear shaper is that the process can be used to make a variety of gears and the cycle time for producing one work piece is very less compared to many other processes. Close tolerances can be maintained
- The main disadvantage is that there is no cutting in the return stroke. The process cannot be used to manufacture worm and worm wheel, which is a special type of gear



Before Machining



After Machining

All Dimensions in mm

- **Calculation:**

Ex. No: **SPUR GEAR CUTING IN GEAR SHAPER MACHINE**

Date:

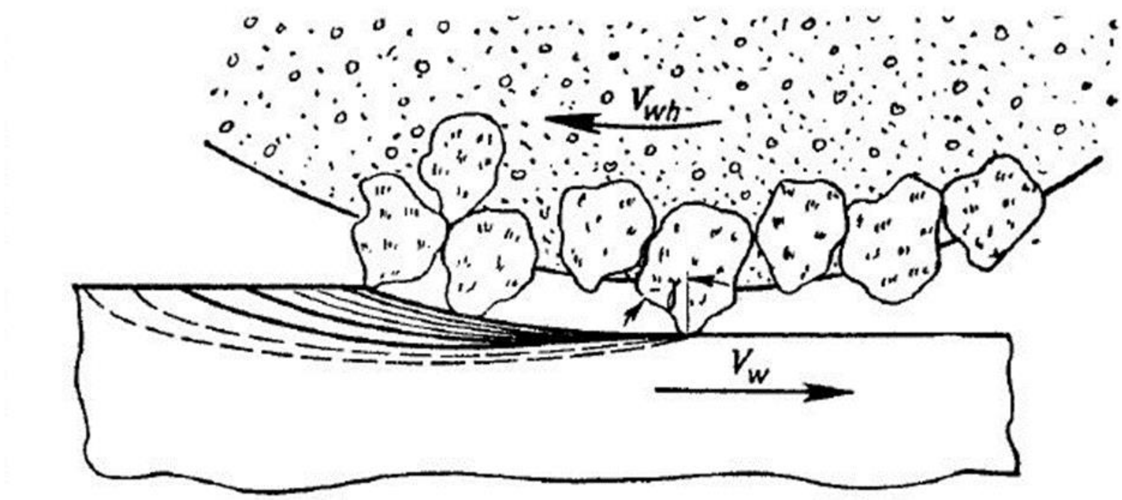
- **Aim:** To machine the given gear blank into a spur gear in gear shaper machine
- **Apparatus Required:**
    - Gear Shaper Machine
    - Shaper cutter
- **Material required:**
    - Cast iron blank
- **Procedure:**
    - The given gear blank is mounted on the work piece spindle
    - The shaper cutter having the necessary cutting teeth in the shape if tooth spacing of the required work piece is mounted on the cutter spindle
    - Necessary gear ratio is set between the work piece spindle and the cutter spindle for the purpose of indexing
    - Machine is switched on and shaping process of the tooth spacing of the gear profile is done with the shaper cutter, in two to four passes per teeth. This feed motion is given during the return stroke
    - With the indexing done through a gear train, the cutter gradually rotates and the work piece rotates in accordance with the cutter, as if they are two gears in mesh
    - With one complete revolution of the work piece on its spindle the gear shaping process will be complete
    - The dimensions of the gear teeth are checked using a gear tooth Vernier
- **Result:** Thus the required spur gear is cut from the given blank by gear shaping process

Ex.No:

STUDY OF GRINDING MACHINE

Date:

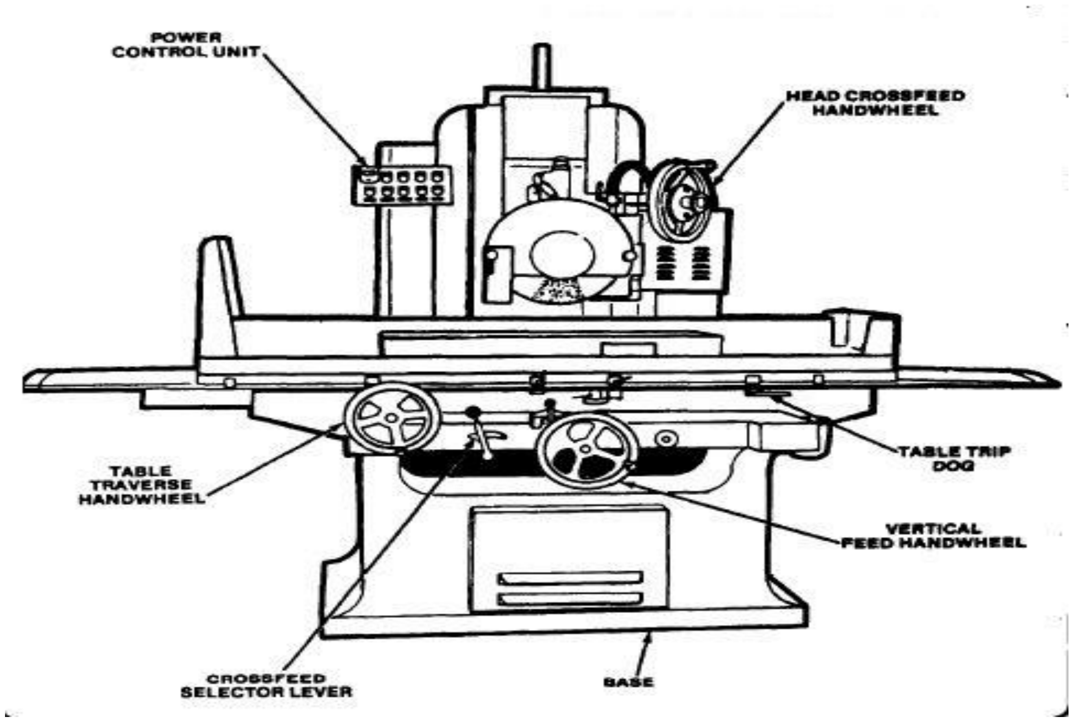
- Grinding is the process of removing metal by the application of abrasives which are bonded to form a rotating wheel.
- When the moving abrasive particles contact the work piece, they act as tiny cutting tools, each particle cutting a tiny chip from the work piece.
- It is a common error to believe that grinding abrasive wheels remove material by a rubbing action;
- Actually, the process is as much a cutting action as drilling, milling, and lathe turning.
- A schematic of grinding operation is shown below



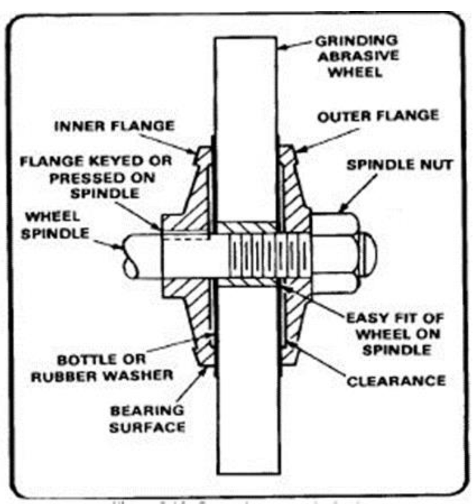
Mechanism of Grinding

- **Types of Grinding Machines:**
  - The various types of grinding machines are described as follows
    - Utility grinding machine
    - Cylindrical grinding machine
    - Surface grinding machine.
    - Angle Grinder
    - Tool Grinding machine

- **Construction of Grinding Machine and wheel**
    - The construction of grinding machine and grinding wheel are described in figure as follows

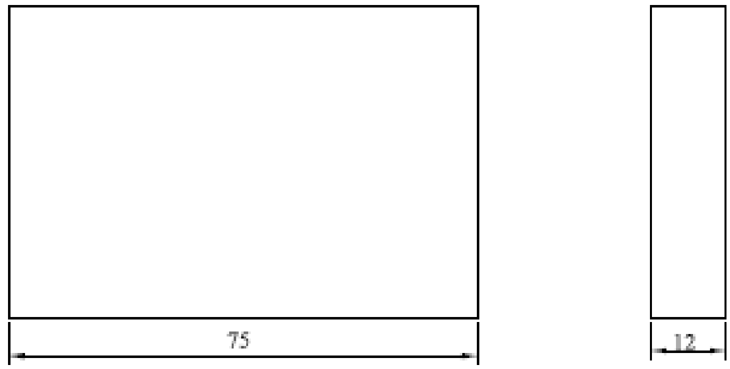


Reciprocating surface grinding machine

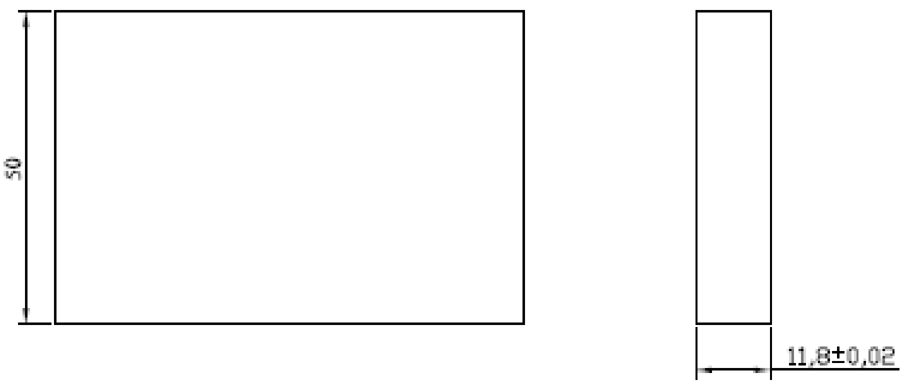


Perfect located grinding wheel

- **Applications**
    - The Grinding operations are mainly used for the applications are described as follows
      I) Surface finishing ii) slitting & parting iii) De scaling, de burring IV) Stock removal finishing of flat as well as cylindrical surface



Before Grinding



After Grinding

All Dimensions in mm

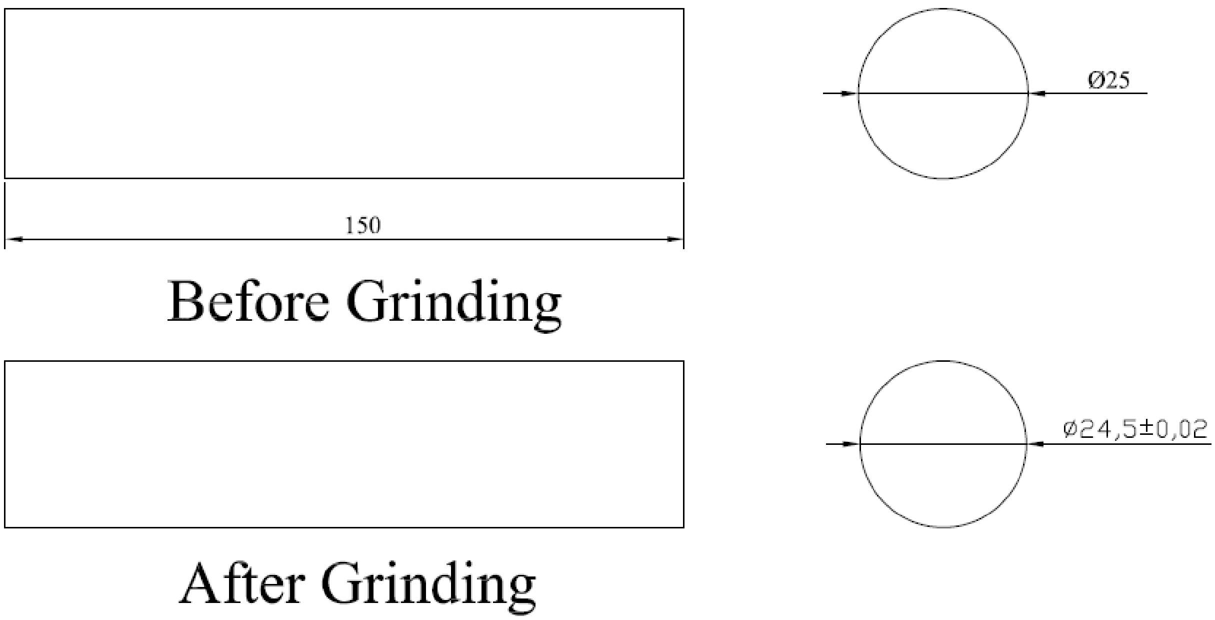
Ex. No:

PLAIN SURFACE GRINDING

Date:

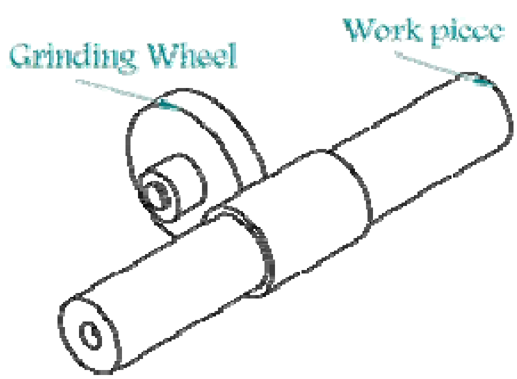
- **Aim:** To perform plain surface grinding on the given work piece to the required dimensions
- **Apparatus required:**
  - Grinding machine
  - Grinding Wheel
  - Vernier Calliper
- **Material Required:**
  - MS / CI plate 12mm X 50mm X 75mm
- **Procedure:**
  - First the work piece is placed on the magnetic chuck
  - The positioning of the work piece is aligned at right angles to the grinding wheel and exactly parallel to the sides of the magnetic chuck by using slip gauges if necessary
  - The magnetic chuck is switched on and the powerful electromagnet holds the job firmly in position
  - Now the spindle is turned on and the grinding wheel is just touched the work piece surface to mark its zero / reference position
  - Now the required feed, either totally or in steps, is given to the grinding wheel and the wheel is traversed all over the work piece
  - Same procedure is repeated until the required dimensions are achieved
  - Care should be taken for maintaining the surface finish
  - Finally the dimensions are checked using either a Vernier calliper or a screw gauge

- **Result:** Thus plain surface grinding is performed on the given work piece up to the required dimensions



All Dimensions in mm

Cylindrical grinding Process Schematic:



Ex.No: # **CYLINDRICAL GRINDING**

Date:

- **Aim:** To grind the cylindrical surface of the given work piece by cylindrical grinding
- **Apparatus Required:**
  - Grinding machine
  - Cylindrical grinding wheel setup
  - Steel Rule
  - Vernier Calliper
- **Materials Required:**
  - Cast iron work piece
- **Procedure:**
  - First the given work piece is preliminarily finished to the pre-required dimensions on a lathe before beginning the grinding process
  - Now the work piece is fitted in the chuck of the cylindrical grinding machine
  - The grinding wheel is just touched with the work piece and is taken as the zero reference
  - Coolant circulation is switched on and the grinding wheel is engaged with the work piece
  - Both the work piece and the grinding wheel roll on contact with each other like two gears in mesh
  - Now slowly the wheel is moved over the entire length of the work piece to get the grinded finish
  - After one feed is over, the grinding wheel is moved further towards the axis of the work piece and the process is repeated until the required dimensions are achieved
  - Finally the dimensions are checked using a Vernier calliper

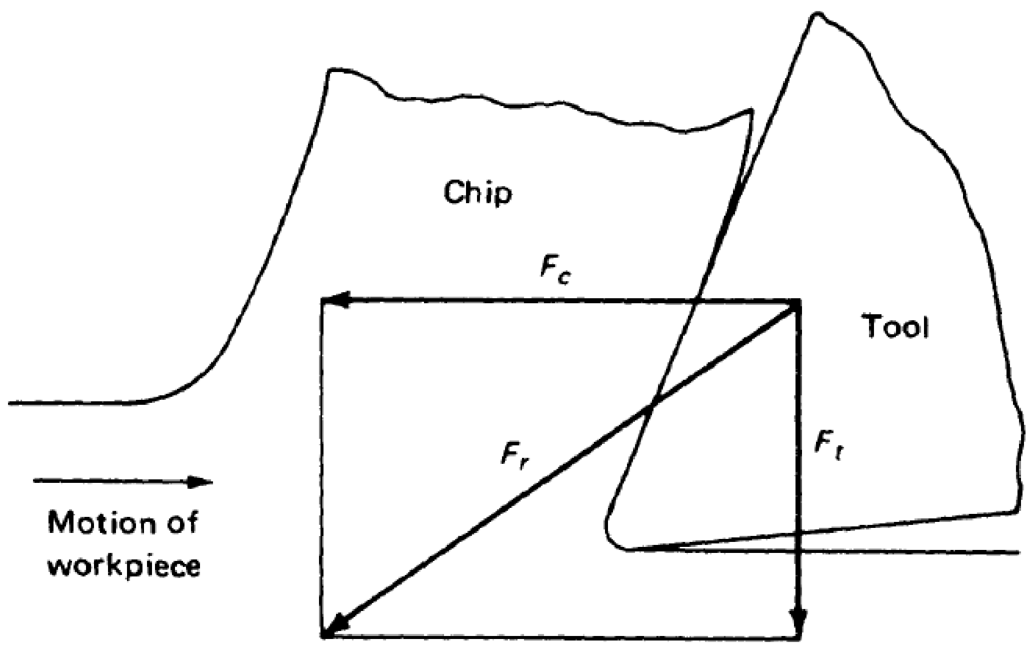
- **Result**: Thus cylindrical grinding is performed on the given work piece to the given dimensions

Ex. No:

Study of Tool Dynamometer

Date:

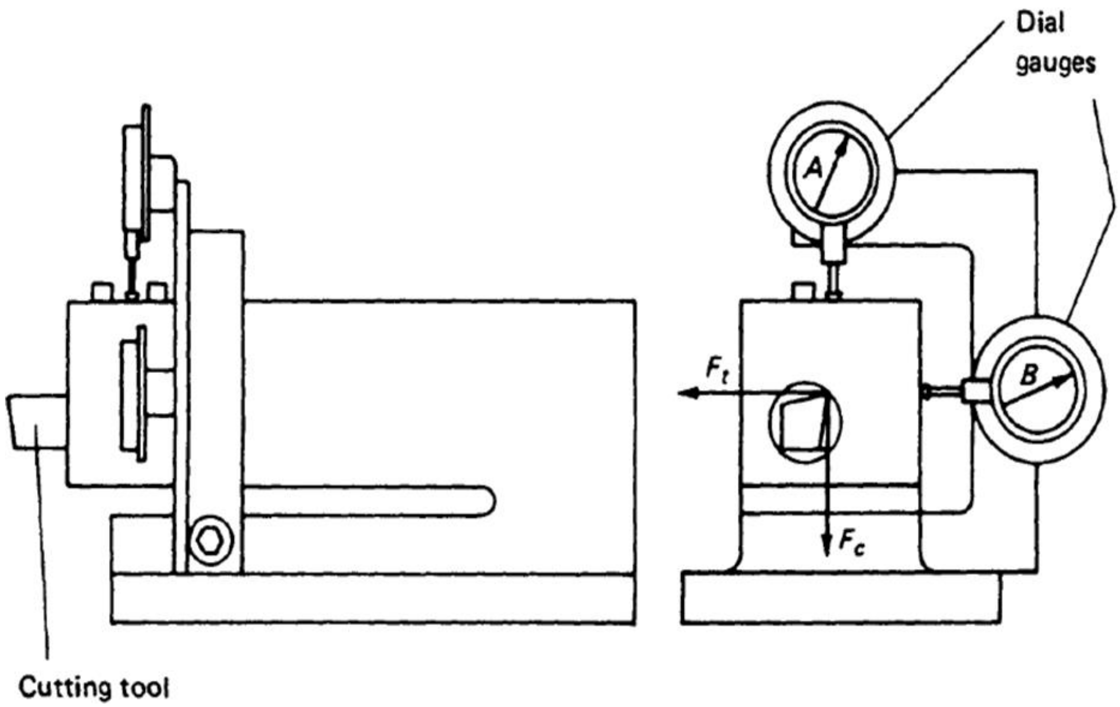
- In orthogonal cutting resultant force applied to the chip by the tool lies in a plane normal to the tool cutting edge
- This force is usually found experimentally by measurement of two of its components
  - Cutting force - F_C
  - Thrust Force - F_T
- The Principal cutting force is the resultant of these two forces and the figure below explains the same



Cutting forces in chip formation

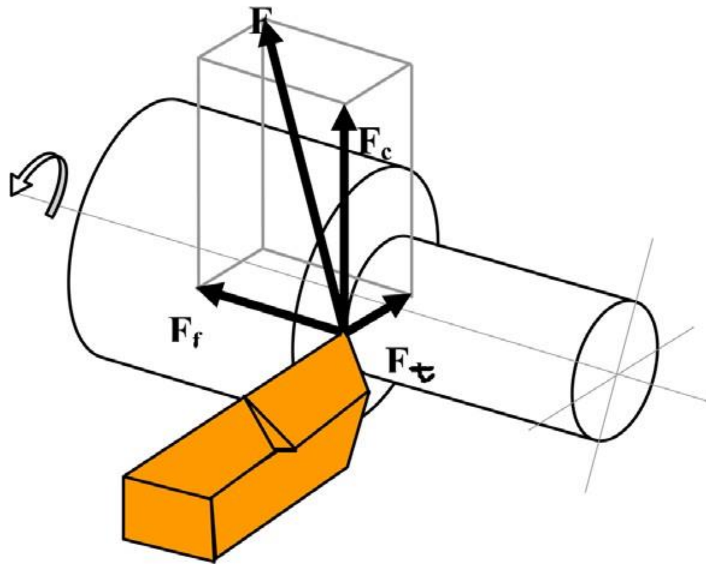
- In most metal cutting force dynamometers, tool force is determined by measuring the deflection or strain in the elements supporting the cutting tool
- The dynamometer must give deflections that are large enough to be measured accurately. Hence the design of a dynamometer largely depends on the strain or deflection measuring device employed
- A simple two component type cutting force dynamometer is shown below
- Here it can be observed that the cutting tool is supported on the tool post like a cantilever

- The vertical and horizontal deflections of the cantilever under the action of the resultant tool force are taken as a measure of the two force components F_C and F_T



Simple two component tool dynamometer for lathe

- Many effective dynamometers have been developed using a range of deflection / strain measuring methods including strain gauges, piezoelectric load cells etc for increased resolution and stiffness
- The two force components F_C and F_T thus measured using the dynamometer can be used to calculate various important variables in the process of continuous chip formation
- The forces thus calculated determines the stress / load on the tool during machining and hence is a very important data for designing the tool shank
- They also give us a bare minimum value of load that the work piece has to withstand which is imposed upon it during machining. So during the design of the product itself, considerations are to be given such that the work piece will not fail during machining, owing to the cutting force imposed on it during machining process
- Thus the cutting force measurement gives us a deep insight into the tool life, product design, tool design etc., and hence is a very important for any manufacturing firm doing mass production



Forces involved in turning process

A typical dynamometer sensing unit setup around carbide tipped cutting tool

<u>Principal Forces Measurement Tabulation:</u>

S.No	Depth of cut (mm)	Speed (RPM)	F_C KgF	F_T KgF
1	0.2mm			
2	0.5mm			
3	0.8mm			

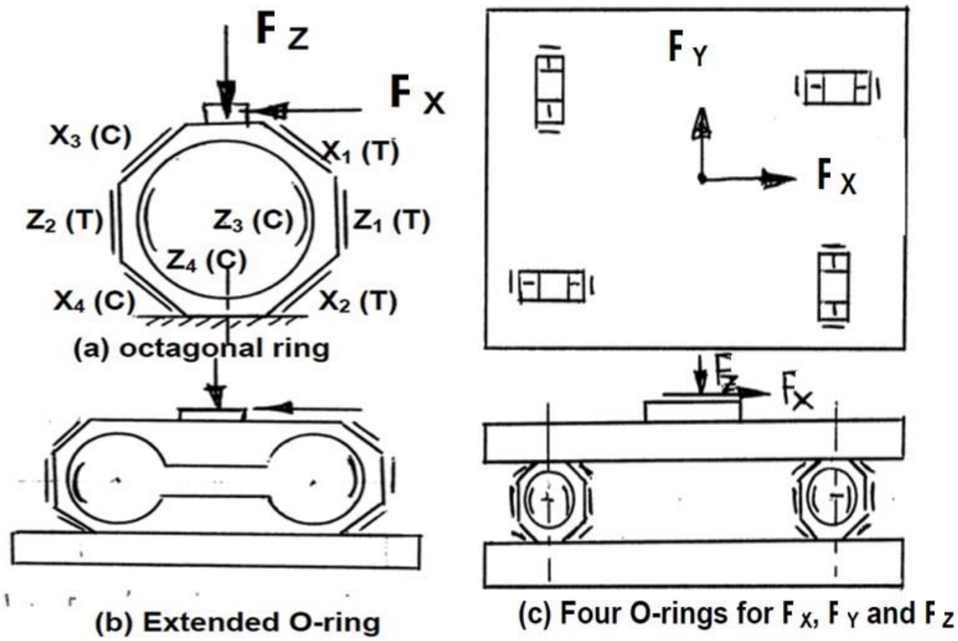
Ex.No: **LATHE CUTTING FORCE MEASUREMENT**

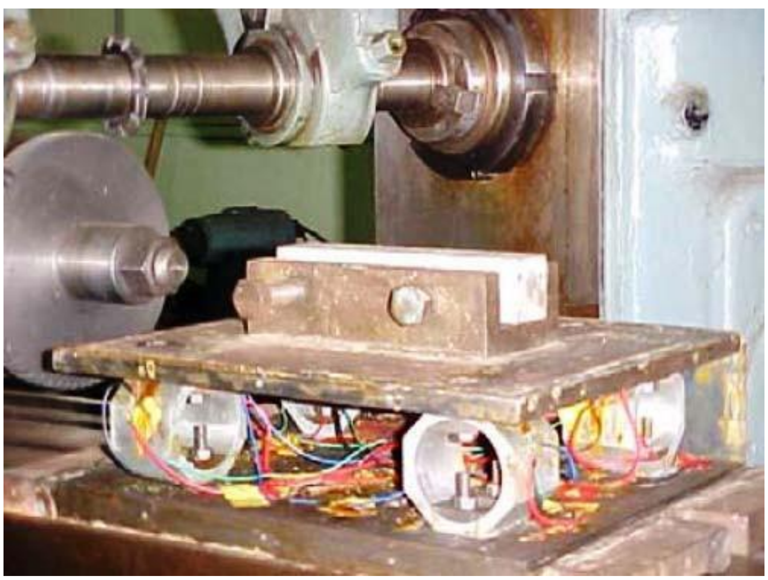
Date:

- **Aim:** To measure the principal forces in orthogonal machining by lathe tool dynamometer
- **Apparatus Requires:**
  - Centre lathe
  - Cutting tool with carbide tip insert
  - Lathe tool Dynamometer

    (i) Sensing Unit (ii) Force Indicator Unit (iii) Connecting wires
- **Material Required:**
  - MS / CI work piece for which the principal cutting forces of machining are to be measured
- **Procedure:**
  - The tool on which the dynamometer is to be mounted is first fixed on the tool post of the lathe
  - Next the dynamometer is inserted via the cutting edge and is pushed and made square with the tool post, resting suspended on the tool itself through the slot on the dynamometer
  - Now the dynamometer setup is tightened so that any further movement / deflection of the tool body will activate the strain gauges and will give output
  - Now the sensing unit of the dynamometer is connected to the force indicator unit with the help of the connecting wires
  - First the lathe is switched on and the carbide tip of the tool is just made to touch the work piece surface very gently and the force indicator setup is calibrated to read zero
  - Now the machining is carried out and the corresponding values of the principal forces cutting force (F_C) and Thrust force (F_T) are noted down
  - The same experiment is repeated for various depth of cuts and cutting speeds and the values of the corresponding principal forces are tabulated

- **Result:** Thus the principal forces F_C and F_T turning in lathe are measured using a dynamometer and the results are tabulated





Milling force measurement – strain gauge octagonal ring setup

Cutting force measurement Tabulation:

S.No	Depth of cut (mm)	Speed (RPM)	F_X KgF	F_Y KgF	F_Z KgF
1	0.2mm				
2	0.5mm				
3	0.8mm				

Ex. No: **MILLING – CUTTING FORCE MEASUREMENT**

Date:

- **Aim:** To measure the cutting forces in milling process using a side milling cutter
- **Apparatus Required:**
  i) Horizontal milling machine ii) Side Milling cutter iii) Milling dynamometer
- **Material Required:**
  - MS or CI work piece of required dimensions
- **Procedure:**
  - The principal difference between the lathe tool dynamometer and the milling dynamometer is that, in a lathe the tool is stationary whereas in the milling machine the tool is rotating cutter
  - Hence here the dynamometer sensing unit cannot be fixed to the tool but could be fixed to the work piece that is stationary
  - Work piece is kept on a platform which is mounted over four octagonal rings as shown in figure
  - The octagonal ring is mounted with a strain gauge for measuring transverse force and one for measuring radial force.
  - In total the setup has four octagonal rings place in strategic positions as shown in the figure. Hence in total there are four strain gauges measuring transverse force and four for measuring radial force
  - As the milling process proceeds, forces in all the three directions are measures by summing up the data from all the strain gauges and taking average
  - The results are displayed in the force indicator unit of the dynamometer
  - The experiment is repeated for various feeds, cutting speeds and depth of cuts
  - The cutting forces in all three directions are tabulated

- **Result:** Thus the cutting forces involved in milling operation have been measured using a dynamometer

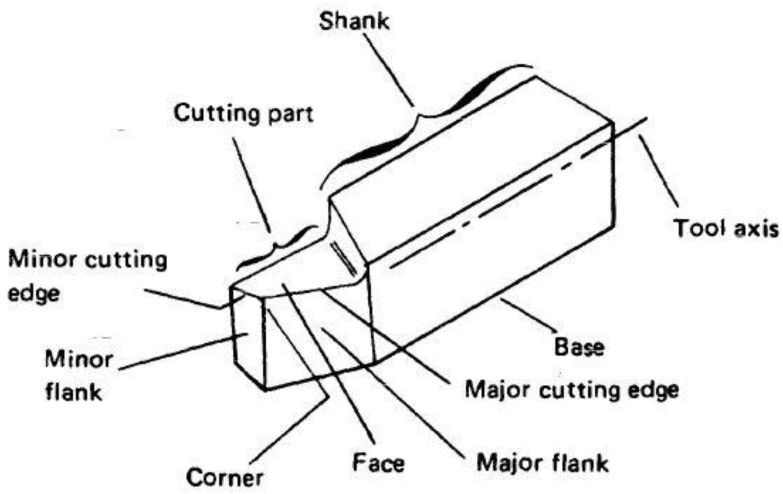
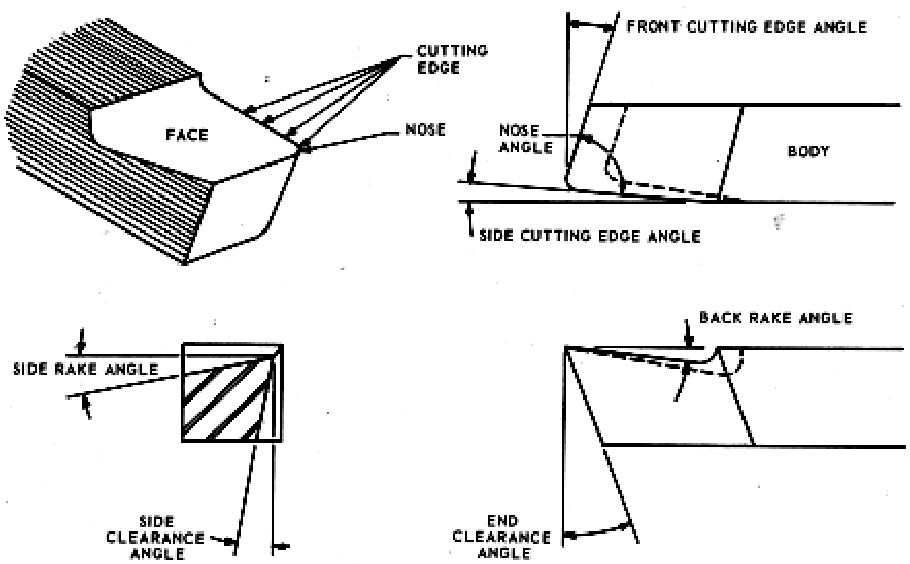


Figure 1.4 Typical single-point tool.

Single point cutting tool Nomenclature



Single point cutting tool angles

Grinding Angles To be followed:

Back Rake angle	Side Rake Angle	End cutting edge angle	Side cutting edge angle	End Clearance angle	Side Clearance Angle
8°	**10°**	**15°**	**15°**	**5°**	**5°**

Ex. No: **GRINDING A SINGLE POINT CUTTING TOOL**

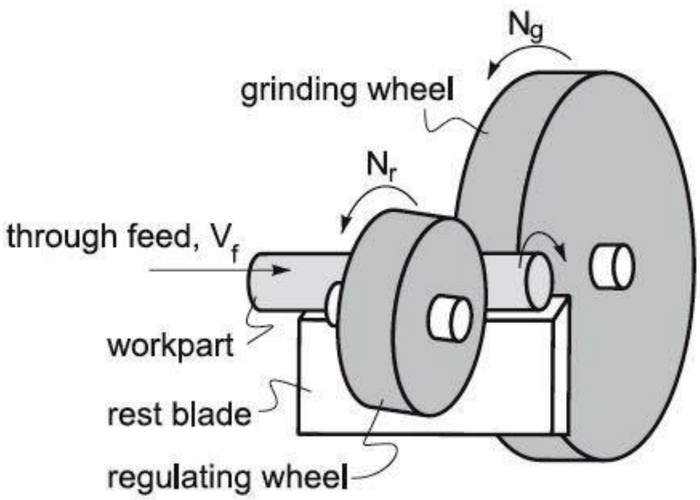
Date:

- **Aim:** To perform grinding operation on the given HSS tool bit to make it into a single point cutting tool
- **Apparatus Required:**
  - Universal two axis vice
  - Tool grinding machine, with alumina wheel
  - Tool maker's microscope
- **Material Required:**
  - HSS tool bit
- **Procedure:**
  - The given tool mounted on the vice and the jaws of the vice are tightened
  - The horizontal axis nut is loosened and the required angle is set on the vice with respect to the end cutting edge angle and the end cutting edge is ground first
  - Similarly the side cutting edge inclination is set on the vice and the side cutting edge is ground
  - Now the vertical axis nut of the vice is loosened and the back rake angle is set on the vice, the back rake angle is ground
  - Now the vice is loosened and the tool is removed from the vice and is fixed in a different position, with the cutting edge pointing upwards, perpendicular to the previous position
  - Now similarly end clearance, side clearance and side rake angle are ground
  - Thus a single point cutting tool is made out of the given HSS blank
- **Result:** Thus single point cutting tool has be ground out of the given HSS blank using tool grinder and universal 2 axis vice

Ex.No: **STUDY OF CENTERLESS GRINDING**

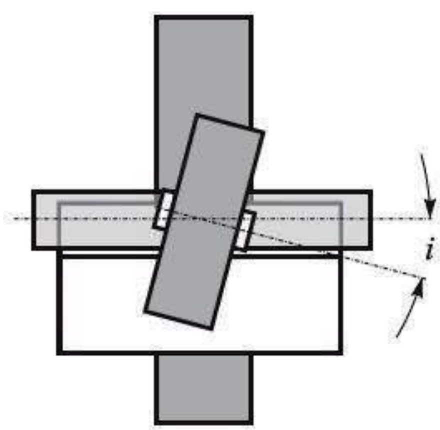
Date:

- Centerless grinding is the process of continuously grinding cylindrical surfaces, in which the work piece is not supported by centers or chucks but by a resting blade
- The work piece is ground between two wheels
- The larger grinding wheel does the grinding while the smaller regulating wheel does not contribute to the material removal process
- The schematic of the Centerless grinding process is shown below



Centerless grinding setup

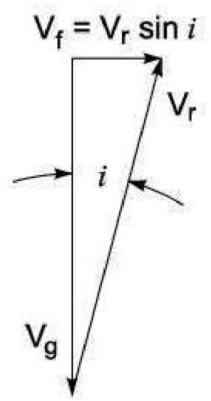
- The regulating wheel is tilted at an angle i, which in turn regulates the velocity of axial movement of the cylindrical work piece



Centerless grinding wheels & work piece position

- The relative position of the wheels and the work piece, along with the inclination of the regulating wheel is shown above

- There are three velocities involved in the above setup. They are
    - Velocity of the Grinding wheel, $\mathbf{V_g}$
    - Velocity of the regulating wheel, $\mathbf{V_r}$
    - Velocity of Feed / axial movement of the work piece against the wheels, $\mathbf{V_f}$
- The relationship of these three velocities is shown by the following self-explanatory velocity triangle



Velocity Triangle

- Centerless grinding can be internal or external, traverse feed or plunge grinding
- But anyway, external is the most common type of Centerless grinding
- Centerless grinding is most suited for mass production and a Centerless grinding machine is shown below

Centerless Grinding Machine

- The main disadvantage of Centerless grinding process is that, it requires specialised machinery which can perform no other task

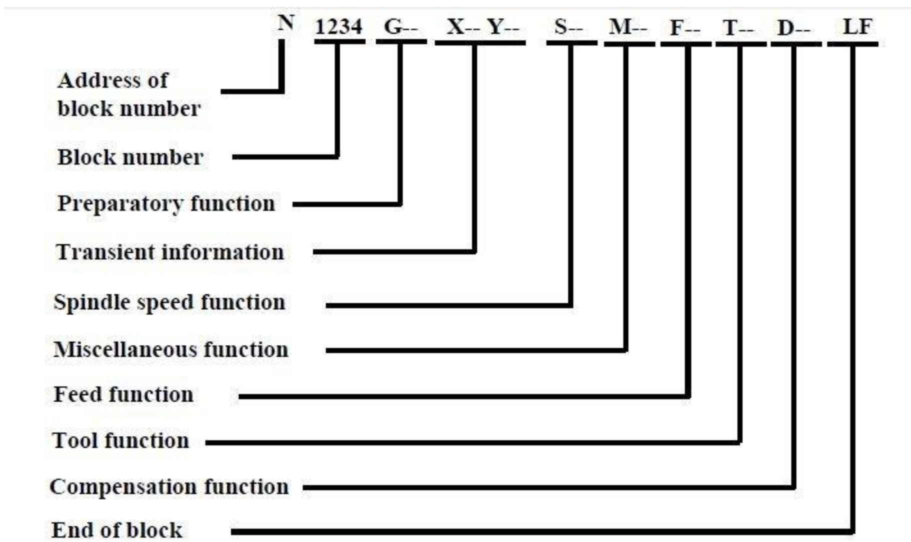
Ex.No: **STUDY OF CNC MACHINES AND FANUC CODING**

Date:

- Modern precision manufacturing demands extreme dimensional accuracy and surface finish
- Such performance is very difficult to achieve manually, if not impossible, even with expert operators
- In cases where it is possible, it takes much higher time due to the need for frequent dimensional measurement to prevent overcutting
- Development of computer numerically controlled (CNC) machines has also made possible the automation of the machining processes with flexibility to handle production of small to medium batch of parts
- A typical CNC machining centre is shown below

CNC Turning Centre

- Here programs are written in the form of special codes specifically coded for CNC machine
- Each code performs a specific task assigned, with the integration of the microprocessor of the on board computer, which in turn regulates the voltage supplied to the various actuators of the machining centre such as
    - Servo Motor of the main spindle / chuck
    - Stepper motor of the tool carriage
    - Stepper motor of the tool changer pallet
    - Coolant on / off pumps and so on
- It is mandatory to have a sound knowledge of the coding, in order to write a part program which in turn is executed by the machine once the program is loaded on to its RAM
- The structure of the coding system is shown below, which shows the typical coding used for various functions of a lathe



CNC program structure

- Given below is the system of coding used for writing CNC part programs

- **GROUPS OF PROGRAM WORDS:**

  The sequence of the words in an NC – block is designated as follows:

S.No	Address	Definition
1	N	Block number
2	G	G-functions
3	X, Y, Z	Coordinates
4	I, J, K	Interpolation Parameter
5	F	Feed
6	S	Speed
7	T	Tool position
8	M	Additional functions

- **SEQUENCE OF PROGRAM WORDS:**

- **Block number N:**
  - The block number is the first word in a block and designates it.
  - It can only be conferred once. The block number has no influence on the execution of the individual blocks since they are involved in following the order in which they were entered into the control.
- **G – FUNCTION:**
  - Together with the words for the coordinates, this word essentially determines the geometric part of the NC program. It consists of the address letter G and a two-digit code.
- **COORDINATES X, Y, Z:**
  - The coordinates X, Y, Z define the target points that are needed for travel.
- **INTERPOLATION PARAMETERS I, J, K:**
  - The interpolation parameters I, J, K are e.g. used to define the centre of a circle for circular movements. They are usually entered incrementally.
- **FEED F:**
  - The speed at which the tool is to be moved is programmed with the function F; the in feed speed is usually entered in mm/min. For turning, the unit mm/min pertaining to spindle rotation can also be used.
- **SPINDLE SPEED S:**
  - This function is for entering the spindle speed. It can be directly programmed in rotations per minute.
- **TOOL POSITION T:**
  - The address T together with a numerical code designates a specific tool. The definition of this address differs according to the control and can have the following functions:
    - Saving the tool dimensions in the tool offset table.
    - Loading the tool from the tool magazine.

- **ADDITIONAL FUNCTIONS M:**

  - The additional functions, also known as auxiliary functions, primarily contain technical data that is not programmed in the words with address letters F, S, T.

  - These functions are entered with the address letter M and a two-digit code.

G – CODES & M – CODES FOR FANUC TURNING:

G – Code	Function	M – Code	Function
G00	Rapid transverse	M00	Program stop
G01	Linear interpolation	M01	Optional stop
G02	Circular interpolation (clockwise)	M02	End of program
G03	Circular interpolation (anti clockwise)	M03	Spindle rotation (cw)
G04	Dwell	M04	Spindle rotation (ccw)
G20	Input in inch	M05	Spindle stop
G21	Input in mm	M06	Auto tool change
G28	Go to reference	M07	Mist coolant on
G40	Cutter compensation cancel	M08	Flood coolant on
G41	Compensation left	M09	Coolant off
G42	Compensation right	M10	Chuck open
G50	Coordinate system setting	M11	Chuck close
G70	Finishing cycle	M20/21	ATC arm in/out
G71	Stock removal in turning	M22/23	ATC arm down/up
G72	Stock removal in facing	M24/25	ATC arm clamping
G73	Pattern repeating	M32/33	ATC cw/ ccw
G74	Peck drilling	M38	Door open
G75	Diameter drilling	M39	Door close
G76	Multiple threading cycle	M62/63	Aux 1/2 on
G81	Drilling cycle, spot boring	M98	Sub program call
G82	Drilling cycle, counter boring	M99	End of sub program
G83	Peck drilling cycle		
G90	Turning cycle		
G92	Threading cycle		
G94	Facing cycle		
G98	Feed per minute		
G99	Feed per revolution		

G – CODES & M – CODES FOR FANUC MILLING:

G – Code	Function	M – Code	Function
G00	Rapid transverse	**M00**	Program stop
G01	Linear interpolation	**M01**	Optional stop
G02	Circular interpolation (clockwise)	**M02**	End of program
G03	Circular interpolation /(anti clockwise)	**M03**	Spindle rotation (cw)
G04	Dwell	**M04**	Spindle rotation (ccw)
G20	Input in inch	**M05**	Spindle stop
G21	Input in mm	**M06**	Auto tool change
G28	Go to reference	**M07**	Mist coolant on
G40	Cutter compensation cancel	**M08**	Flood coolant on
G41	Compensation left	**M09**	Coolant off
G42	Compensation right	**M10**	Work clamp
G50	Coordinate system setting	**M11**	Work unclamp
G73	Fast peck drilling	**M20/21**	ATC arm in/out
G84	Tapping cycle	**M22/23**	ATC arm down/up
G85	Boring cycle	**M24/25**	ATC arm clamping
G90	Absolute Command	**M32/33**	ATC cw/ ccw
G91	Incremental command	**M38**	Door open
G92	Set datum	**M39**	Door close
G94	Feed per minute	**M62/63**	Aux 1/2 on
G95	Feed per revolution	**M70**	X mirror ON
G98	Return to initial position	**M71**	X mirror OFF
G99	Return to R point	**M80**	Y mirror ON
		M81	Y mirror OFF
M99	End of sub program	**M98**	Sub program call

- **OTHER FUNCTION:**

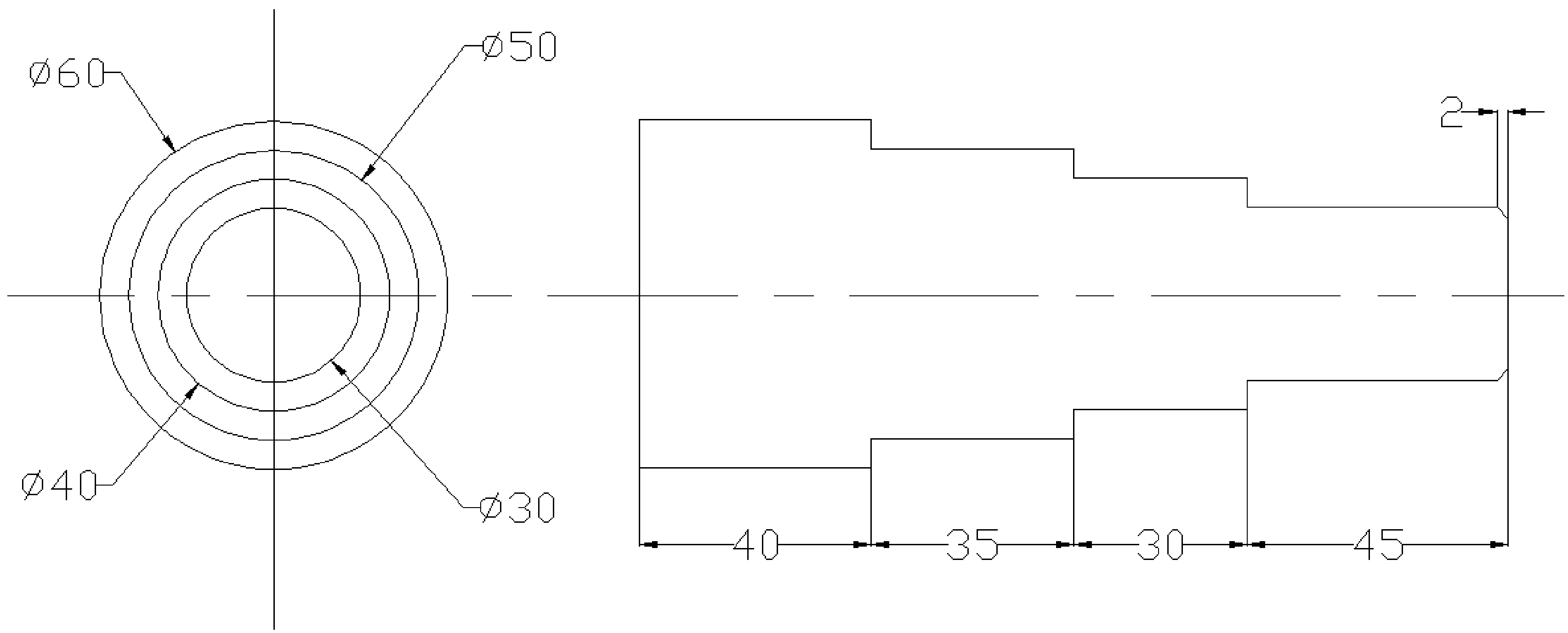
Code	Function
N	Sequence number
X, Y, Z, A, B, C	Coordinate axis motion command
R	Arc radius, thread lead
I, J, K	Coordinate values of arc centre
F	Feed rate thread lead
S	Spindle speed
T	Tool number, Tool offset number
B	Index table
H	Designation of offset number
P, X	Dwell time

- **CANNED CYCLE:**
  - A canned cycle or fixed cycle may be defined as a set of instructions inbuilt or stored in the system memory to perform a sequence of operations.
  - It is a combination of machine movements that perform machining operations like drilling, milling, boring and tapping.
  - This cycle simplifies the program by using a single block with a G-code to specify the machining operations usually specified in several blocks. It is also called as fixed cycle.

- **Result:**

Thus the important features, programming structures, codes used in manual part programming were studied.

NC PART PROGRAM FOR FACING TURNING AND CHAMFERING



ALL DIMENSIONS ARE IN mm

Ex.No: **NC PART PROGRAM FOR FACING TURNING AND CHAMFERING**

Date:

- **AIM:**

To write a program and simulate the tool path for the operation involved in the component as given in the figure using FANUC turning software.

- **SOFTWARE USED:**

FANUC Turning simulator

- **PROGRAM CODE:**

CODE	CODE DESCRIPTION	EXPLANATION
[BILLET	X60 Z150	Work piece size of 60mm diameter 150mm length
G21 G40 G98		Input in mm, Cutter compensation cancel, Feed per minute
G28	U0 W0	Go to reference 0,0
M06	T0101	Tool change and select tool T0101 from tool kit
M03	S1200	Spindle rotates at the speed of 1200 Rpm in clockwise direction
G96 G00	X60 Z1	Constant cutting speed ON, Move tool to 60mm in X axis and 1mm in Z axis from its home position
G90	X59 Z -110 F30	By turning operation remove 1mm for the length 110mm
	X58	By turning operation remove 1mm for the length 110mm
	X57	By turning operation remove 1mm for the length 110mm
	X56	By turning operation remove 1mm for the length 110mm
	X55	By turning operation remove 1mm for the length 110mm

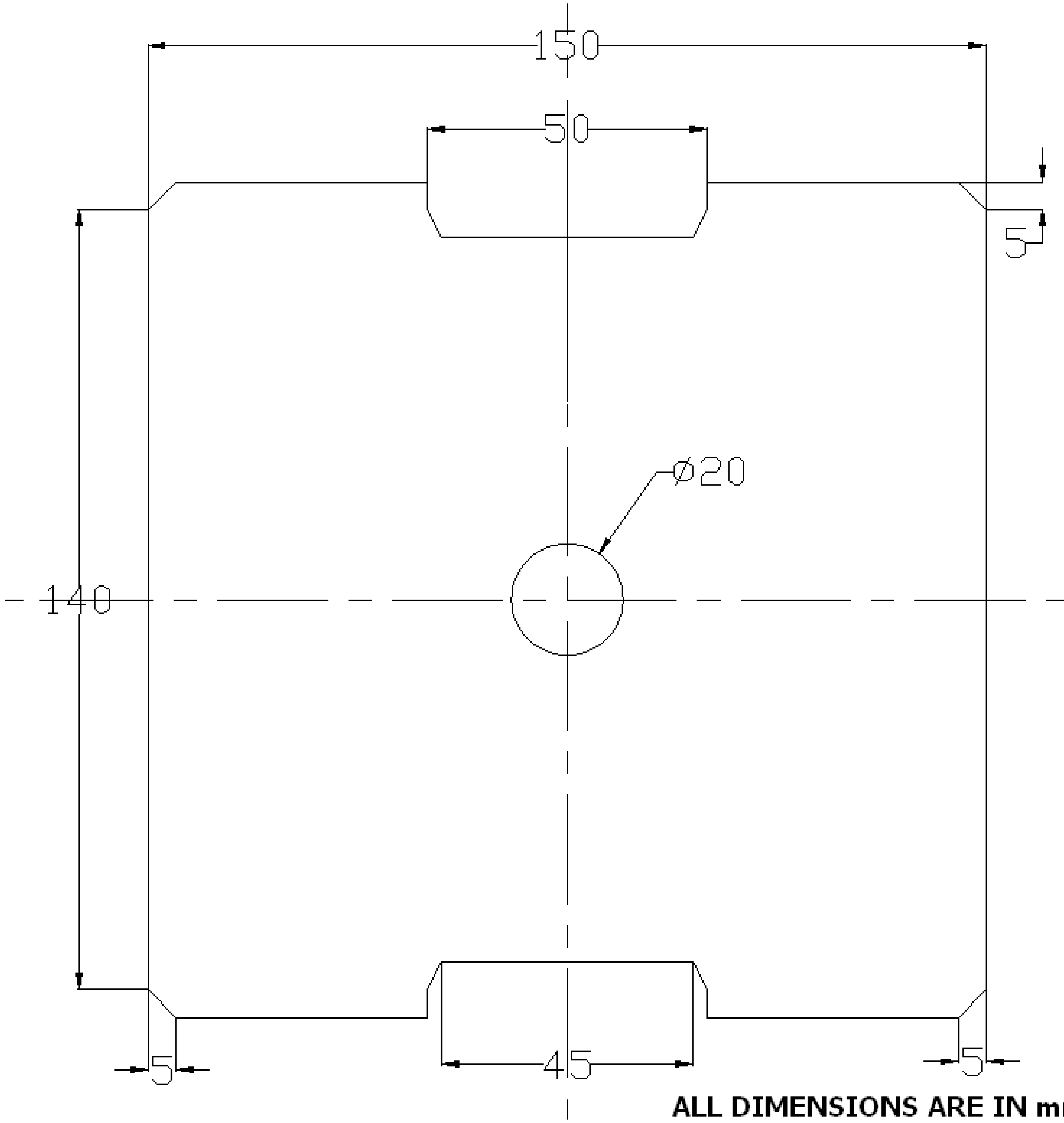
CODE	CODE DESCRIPTION	EXPLANATION
	X54	By turning operation remove 1mm for the length 110mm
	X53	By turning operation remove 1mm for the length 110mm
	X52	By turning operation remove 1mm for the length 110mm
	X51	By turning operation remove 1mm for the length 110mm
	X50	By turning operation remove 1mm for the length 110mm
G00	X50 Z1	Move tool to 50mm in X axis and 1mm in Z axis from its position
G90	X49 Z-75	By turning operation remove 1mm for the length 75mm
	X48	By turning operation remove 1mm for the length 75mm
	X47	By turning operation remove 1mm for the length 75mm
	X46	By turning operation remove 1mm for the length 75mm
	X45	By turning operation remove 1mm for the length 75mm
	X44	By turning operation remove 1mm for the length 75mm
	X43	By turning operation remove 1mm for the length 75mm
	X42	By turning operation remove 1mm for the length 75mm
	X41	By turning operation remove 1mm for the length 75mm
	X40	By turning operation remove 1mm for the length 75mm
G00	X40 Z1	Move tool to 40mm in X axis and 1mm in Z axis from its position
G90	X39 Z-45	By turning operation remove 1mm for the length 45mm
	X38	By turning operation remove 1mm for the length 45mm
	X37	By turning operation remove 1mm for the length 45mm
	X36	By turning operation remove 1mm for the length 45mm
	X35	By turning operation remove 1mm for the length 45mm
	X34	By turning operation remove 1mm for the length 45mm
	X33	By turning operation remove 1mm for the length 45mm

CODE	CODE DESCRIPTION	EXPLANATION
	X32	By turning operation remove 1mm for the length 45mm
	X31	By turning operation remove 1mm for the length 45mm
	X30	By turning operation remove 1mm for the length 45mm
G00	X30 Z1	Move tool to 30mm in X axis and 1mm in Z axis from its position
G90	X30 Z-2 R2 F30	By turning operation, chamfering is done with the radius 2mm for the length 2mm
G28	U0W0	Go to reference 0,0
M05		Spindle stop
M30		End of program

- **RESULT:**

Thus the program for given component drawing was written and checked using FANUC turning simulator

NC PART PROGRAM FOR CIRULAR POCKETING



ALL DIMENSIONS ARE IN mm

Ex.No: **NC PART PROGRAM FOR CIRULAR POCKETING**

Date:

- **AIM:** To write a program and simulate the tool path for the operation involved in the component as given in the figure using FANUC milling software.

- **SOFTWARE USED:**

  FANUC Milling simulator

- **PROGRAM CODE:**

CODE	CODE DESCRIPTION	EXPLANATION
[BILLET	X150 Y150 Z20	Work piece size of 150mm length, 150mm width and 20mm thickness
[TOOL DEF	T01 L65 T10	Selecting the tool series T01, length 65mm
G21 G40 G98		Input in mm, Cutter compensation cancel, Return to initial position
M06		Auto tool change
M03	S1500	Spindle rotates at the speed of 1500 Rpm in clockwise direction
G00	X0 Y0 Z0	Go to reference 0, 0, 0
G00	X0 Y5	Move tool in Y axis for 5mm
G01	Z-5 F30	Linear interpolation, move tool in Z axis for 5mm(Depth of cut)
G01	X5 Y0	Linear interpolation, move tool in X axis for 5mm with 5 mm in Z axis as depth of cut
G01	X50 Y0	Move tool in X axis for 50mm with 5 mm in Z axis as depth of cut

CODE	CODE DESCRIPTION	EXPLANATION
G01	X50 Y10	Linear interpolation, move tool in X axis for 50mm and in Y axis for 10mm with 5 mm in Z axis as depth of cut
G01	X52.5 Y15	Linear interpolation, move tool in X axis for 52.5mm and in Y axis for 15mm with 5 mm in Z axis as depth of cut
G01	X97.5 Y15	Linear interpolation, move tool in X axis for 97.5mm and in Y axis for 15mm with 5 mm in Z axis as depth of cut
G01	X100 Y10	Linear interpolation, move tool in X axis for 100mm and in Y axis for 10mm with 5 mm in Z axis as depth of cut
G01	X100 Y0	Linear interpolation, move tool in X axis for 100mm with 5 mm in Z axis as depth of cut
G01	X145 Y0	Linear interpolation, move tool in X axis for 145mm with 5 mm in Z axis as depth of cut
G01	X150 Y5	Linear interpolation, move tool in X axis for 150mm and in Y axis for 5mm with 5 mm in Z axis as depth of cut
G01	X150 Y145	Linear interpolation, move tool in X axis for 150mm and in Y axis for 145mm with 5 mm in Z axis as depth of cut
G01	X145 Y150	Linear interpolation, move tool in X axis for 145mm and in Y axis for 150mm with 5 mm in Z axis as depth of cut
G01	X100 Y150	Linear interpolation, move tool in X axis for 100mm and in Y axis for 150mm with 5 mm in Z axis as depth of cut
G01	X97.5 Y135	Linear interpolation, move tool in X axis for 97.5mm and in Y axis for 135mm with 5 mm in Z axis as depth of cut

CODE	CODE DESCRIPTION	EXPLANATION
G01	X52.5 Y135	Linear interpolation, move tool in X axis for 52.5mm and in Y axis for 135mm with 5 mm in Z axis as depth of cut
G01	X50 Y140	Linear interpolation, move tool in X axis for 50mm and in Y axis for 140mm with 5 mm in Z axis as depth of cut
G01	X50 Y150	Linear interpolation, move tool in X axis for 50mm and in Y axis for 150mm with 5 mm in Z axis as depth of cut
G01	X5 Y150	Linear interpolation, move tool in X axis for 5mm and in Y axis for 150mm with 5 mm in Z axis as depth of cut
G01	X0 Y145	Linear interpolation, move tool in Y axis for 145mm with 5 mm in Z axis as depth of cut
G01	X0 Y5	Linear interpolation, move tool in Y axis for 5mm with 5 mm in Z axis as depth of cut
G00	X0 Y0 Z0	Go to reference 0, 0, 0
G170	R0 P0 Q1 X75 Y75 Z-5 I0 J0 K10	Move tool in X axis for 75mm and in Y axis for 75mm , 5 mm in Z axis as depth of cut, interpolation coordinates I as 0mm, J as 0mm and K as 10mm(Radius of the circle)
G171	P90 S1500 R15 F100 B2500 J200	Spindle speed as 1500Rpm, each cycle with 1mm depth of cut
G00	X0 Y0 Z0	Go to reference 0, 0, 0
G28	U0 W0	Go to home position
M05		Spindle stop
M30		End of program

- **RESULT:** Thus the program for given component drawing was written and checked using FANUC Milling simulator.

Ex.No: # STUDY OF CAPSTAN AND TURRET LATHE

Date:

- The conventional general purpose automated lathes can be classified as,
  - (a) Semiautomatic :
    - (i) Capstan lathe (ram type turret lathe) (ii)Turret lathe (iii)Multiple spindle turret lathe (iv)Copying (hydraulic) lathe
  - (b) Automatic :
    - Automatic cutting off lathe, Single spindle automatic lathe, Swiss type automatic lathe , multiple spindle automatic lathes

The characteristic features of semiautomatic lathes are;

• some major auxiliary motions and handling operations like bar feeding, speed change, tool change etc. are done quickly and consistently with lesser human involvement

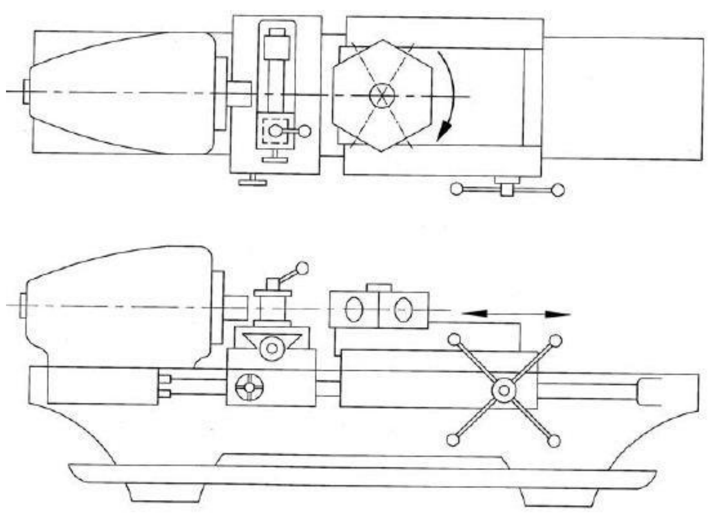
• The operators need lesser skill and putting lesser effort and attention

• Suitable for batch or small lot production

• Costlier than centre lathes of same capacity

- **Capstan and Turret lathes**

The semiautomatic lathes, capstan lathe and turret lathe are very similar in construction, operation and application



Schematic configuration of capstan lathe.

- **In contrast to centre lathes, capstan and turret lathes**

• Are semiautomatic

• Possess an axially movable index able turret (mostly hexagonal) in place of tailstock

• Holds large number of cutting tools; up to four in index able tool post on the front slide, one in the rear slide and up to six in the turret (if hexagonal) as indicated in the schematic diagrams.

• Are more productive for quick engagement and overlapped functioning of the tools in addition to faster mounting and feeding of the job and rapid speed change.

• Enable repetitive production of same job requiring less involvement, effort and attention of the operator for pre-setting of work–speed and feed rate and length of travel of the cutting tools

• Are relatively costlier are suitable and economically viable for batch production or small lot production.

- **Differences in between capstan and turret lathes:**

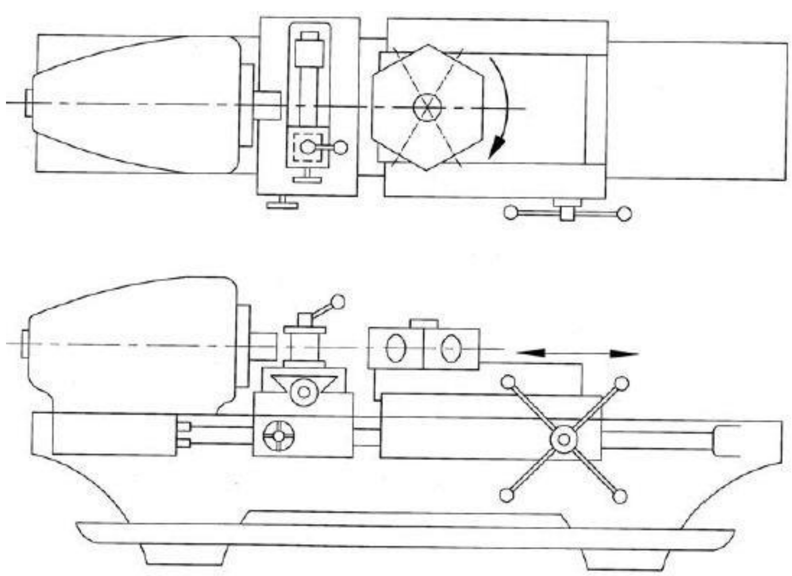
• Turret lathes are relatively more robust and heavy duty machines

• Capstan lathes generally deal with short or long rod type blanks held in collet, whereas turret lathes mostly work on chucking type jobs held in the quick acting chucks

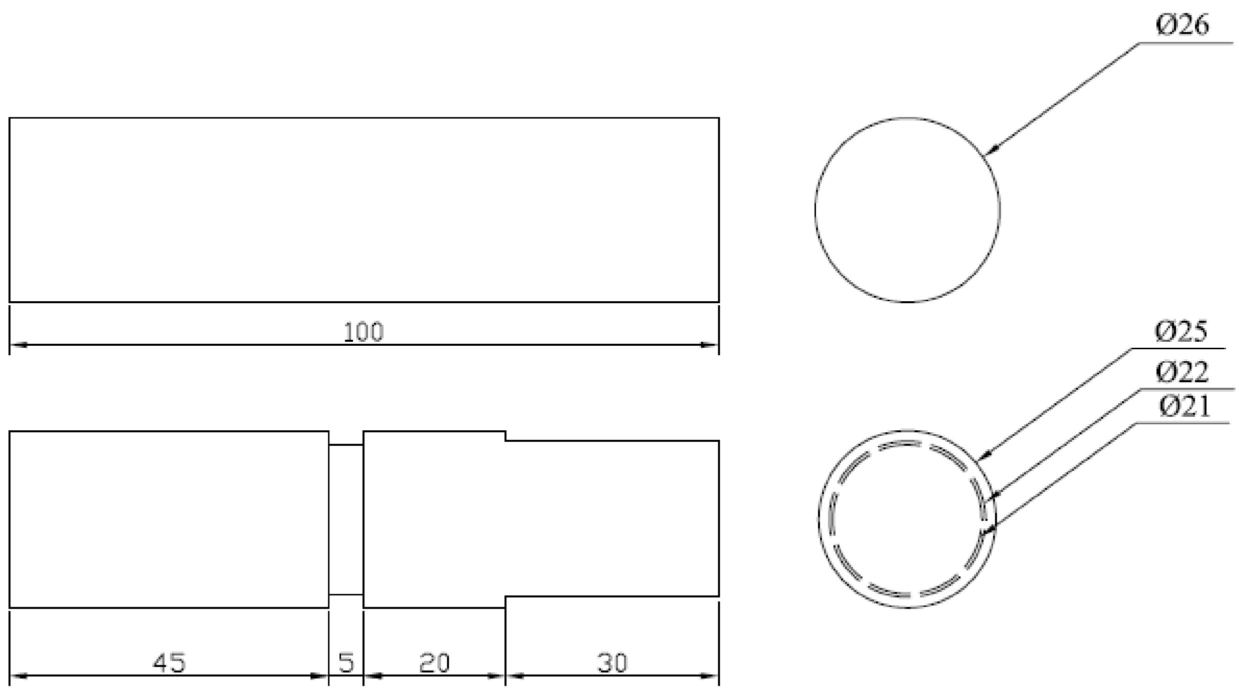
• In capstan lathe, the turret travels with limited stroke length within a saddle type guide block, called auxiliary bed, which is clamped on the main bed. And heavy turret being mounted on the saddle which directly slides with larger stroke length on the main bed as indicated in figure

• One additional guide rod or pilot bar is provided on the headstock of the turret lathes as shown in Figure, to ensure rigid axial travel of the turret head

• External screw threads are cut in capstan lathe, if required, using a self-opening die being mounted in one face of the turret, whereas in turret lathes external threads are generally cut, if required, by a single point or multipoint chasing tool being mounted on the front slide and moved by a short lead screw and a swing type half nut.



Schematic configuration of capstan lathe.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Ex no: **MACHINING IN CAPSTAN LATHE**

Date:

- **Aim:**

  To perform the multiple operations on the given work piece using Capstan lathe.

- **Apparatus Required:**

  - Capstan lathe
  - H.S.S single point cutting tool
  - Parting tool

- **Material Used:**

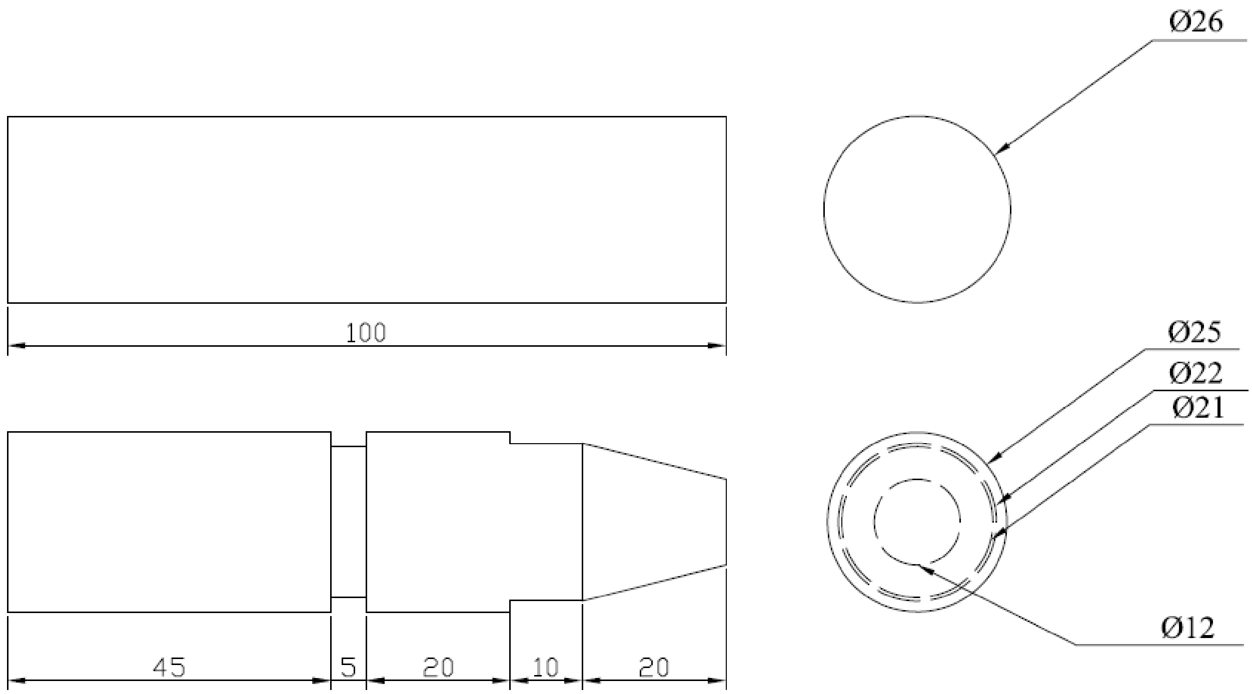
  - MS rod

- **Procedure:**

- Switch on the machine and the driving power of all the cutting tools comes from the spindle.
- Hold the work piece in the collet which holds the work piece perfectly for machining.
- Set the tools in the as per sequence of the operation required in the multiple spindle.
- Then start the machining as usual as in centre lathe.
- After the completion of first operation adjust the handle in order to move the next tool and perform the next operation

- **Result:**

  Hence the component is produced as per the required shape in capstan lathe



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Ex no: **MACHINING IN TURRET LATHE**

Date:

- **Aim:**

To perform the multiple operations on the given work piece using turret lathe.

- **Apparatus Required:**
    - Turret lathe
    - H.S.S single point cutting tool
    - Parting tool
- **Material Used:**
    - MS rod
- **Procedure:**

- Switch on the machine and the driving power of all the cutting tools comes from the spindle.
- Hold the work piece in the collet which holds the work piece perfectly for machining.
- Set the tools in the as per sequence of the operation required in the multiple spindle.
- Then start the machining as usual as in centre lathe.
- After the completion of first operation adjust the handle in order to move the next tool and perform the next operation

- **Result:**

Hence the component is produced as per the required shape in capstan lathe

VIVA QUESTIONS

SHAPER

1. What is shaper?

The machine which is having a reciprocating type of machine tool with single point cutting tool used to produce flat surfaces called as shaper.

2. Define one pass of the cutting tool.

The combination of one forward and one return stroke is known as one pass.

3. Define cutting ratio of a shaper.

The ratio between the cutting stroke time to return stroke time.

4. How the feed and depth of cut is given to the shaper?

Feed is given by rotating the down feed screws of tool head. Depth of cut is given by rotating by raising or elevating the table.

5. Mention any four shaper specification.

Maximum length of stroke, Type of driving mechanism, power of the motor, speed and feed available.

6. State any two advantages of hydraulic drive.

Higher cutting to return ratio can be obtained. Infinite range of cutting speeds is available.

7. State the type of mechanism followed on a shaper and how it works?

Rock and pinion mechanism is used. The rotary motion of electric drive is converted into reciprocating motion of the ram by using gears and slotted link.

8. State any two reasons for making the stroke length greater than work length.

If the crank pin is adjusted in such a way from the center of the bull gear, the rocker arm reciprocates for a larger distance. So, the stroke length is increased.

9. Define depth of cut.

Amount of metal removed in one revolution or in cut is known as depth of cut.

10. How planer differs from a shaper?

In planer the work reciprocates while the tool is stationary.
In shaper the tool reciprocates while the work is stationary.

PLANER

1. State the uses of planer.

The planer is used for machining heavy and large casting. Ex: Lathe bed guide ways, machine guide ways etc.

2. List the various type of planers.

Double hosing planer, open side planer, pit planer, edge planer and divided table planer.

3. What is the main advantage in pit planer?
Heavy and large work pieces can be held and machined easily.

4. How to specify a planer?
Maximum length of the table, total weight of the planer, power of the motor, range of speeds and feed available, type of drives required.

5. What are the various types of quick return mechanism?
Open and cross belt drive, Electric drive, Hydraulic drive

DRILLING & BORING

1. Classify drilling machines.
Portable drilling machine, Sensitive drilling machine, upright drilling machine, radial drilling machine, Multi spindle drilling machine, Automatic drilling machine and Deep hole drilling machine.

2. What are the various types of drilling machines?
Plain type, Semi-universal type, Universal type.

3. What is gang drilling machine?
When a number of single spindle with essential speed and feed are mounted side by side on one base and have common worktable, is known as gang drilling machine.

4. Specify a drilling machine.
Maximum size of the drill in mm that the machine can operate. Table size of maximum, dimensions of a job can mount on a table in square meter. Maximum spindle travel in mm. Number of spindle speed and range of spindle speeds in r.p.m.

5. List any four machining operations that can be performed on a drilling machine.
Drilling, countersinking, Tapping, Trepanning.

6. What is meant by reaming?
Reaming is sizing and finishing the already drilled hole. The tool used for reaming is known as reamer.

7. What is the use of a tapping tool?
A tap is a tool which is used for making internal threads in a machine component.

8. What are the types of boring machines?
Horizontal boring machine, Vertical boring machine, Precision boring machine
Jig boring machine.

9. What are the types of horizontal boring machine?
Table type , floor type, planer type, multi-spindle type.

10. What are the three types of vertical boring machine?.

Vertical boring mill, Vertical turret lathe boring machine, Vertical precision boring machine.

11. Name the various operations performed on a horizontal boring machine

Boring, facing, drilling and reaming.

12. List out the possible operations which can be done on a vertical boring machine.

Cylindrical turning, taper turning, boring, turning plane surface and forming.

13. Specify the importance of jig boring machine.

A jig boring machine is a precision boring machine used for boring accurate holes at proper center to center distances.

14. What is super finishing?.

The process of obtaining a surface of the highest class of finish is known as super finishing.

15. What is meant by honing?.

An abrading process of finishing previously machined surfaces is known as honing.

MILLING

1. What are the specifications of milling machine?.

The table length and width, Maximum longitudinal cross and vertical travel of the table, number of spindle speeds and feeds, Power of driving motor, Floor space and net weight.

2. Classify milling machine.

1. Column and knees type
   a. plain milling machine, b.Vertical milling machine, c. Universal milling machine, d. Ram- type milling machine, e. Omniversal milling machine.
2. Bed-Type milling machine
   a. simplex milling machine b. duplex milling machine c. Triplex milling machine.
3. Plano-type milling machine.
4. Special purpose milling machine
   a.. Rotary table milling machine b. Drum milling machine c. Profile milling machine.

3. List the principle parts of horizontal or plain milling machine.

Base, column, knee, saddle, table, overarm and arbor.

4. How omniversal milling machine differs from universal milling machine?.

This is a modified form of a plain milling machine. It is provided with two spindles, one of which is in the horizontal plane while the other is carried by a universal swiveling head.

5. Classify bed type milling machine.

The bed type milling machines are classified as simplex, duplex and triplex machine.

6. What are the various types of special purpose milling machines?.

Rotary table or continuous milling machine, Drum type milling machine
Profile or contour milling machine.

7. List the various types of milling attachments.

Vertical milling attachment, universal milling attachment, High speed milling attachment, Rotary attachment, slotting attachment, Rack milling attachment, Universal spiral milling machine.

8. What are the advantages of up milling process?

It does not require a backlash eliminator. Safer operation due to separating forces between cutter and work.

9. Write any ten nomenclature of plain milling processes.

Body of cutter, cutting edge, face fillet, Gash, Lead, Land, Outside diameter, Root diameter, Cutter Angles.

10. Classify peripheral milling processes.

Up milling or conventional milling, Down milling or climb milling.

11. What are the advantages of down milling process?

Cutter with higher rake angles can be used. This reduces power requirements. Cutter wear is less because chip thickness is maximum at the start of the cut.

12. Define “face milling”.

Face milling is the operation performed by a milling cutter to produce flat machined surfaces perpendicular to the axis of rotation.

13. What is meant by plain or slab milling.

Plain or slab milling is the operation of producing flat horizontal surface parallel to the axis of the cutter using a plain or slab milling cutter.

14. List out various milling operations.

Plain milling, Face milling, Angular milling, Straddle milling, Gang milling, Form milling, End milling, T-slot milling, Gear cutting.

15. Define Straddle and Gang milling.

Straddle milling operation is the production of two vertical flat surfaces on the both sides of the job by using two side milling cutters which are separated by collars. Gang milling is the production of many surfaces of a job simultaneously by feeding the table against a number of required cutters.

16. What is meant by term indexing?

Indexing is the process of dividing the periphery of a job in to equal number of divisions.

17. What are the three types of dividing heads?.

Plain or simple dividing head, Universal dividing head, Optical dividing head.

18. What is cam milling?.

Cam milling is the operation of producing cams in a milling machine by the use of a universal dividing head and a vertical milling attachment.

19. What are the specifications of milling machine?.

The table length and width, Maximum longitudinal cross and vertical travel of the table, number of spindle speeds and feeds, Power of driving motor, Floor space and net weight.

GRINDING

1. What is the process of self –sharpening of the grinding wheel?.

During machining, the blunt abrasive grains will be released from the wheel surface. In their place, new abrasive grains project from the surface of the wheel.

This process is called self-sharpening of the grinding wheel.

2. State the purpose of grinding.

To remove small amount of metal from work pieces and finish then to close tolerances. To obtain a better surface finish.

3. Classify grinding machine.

Precision grinders, Rough grinders, Cylindrical grinders, Internal grinders, surface grinders, tool grinders, Special purpose grinding machines.

4. What is meant by centerless grinding?.

Centerless grinding is performed on work pieces which do not have centers, such as pistons, valves, rings, tubes, balls, wrist pins, drills, bushings, shafts etc. Centerless grinding can be done on both external and internal cylindrical surfaces.

5. What are the Various methods of centreless grinding?.

Through feed, In feed, End feed.

6. What are the different methods used in gear grinding process?.

Forming process, Generating process.

7. What are the purposes of gear grinding process?.

To improve the surface finish of teeth.

To increase the accuracy of teeth.

To remove the distortion due to heat treatment process.

8. List the various gear finishing process.
Gear shaving, Gear Burnishing, Gear grinding. Gear lapping.

GEAR GENERATING

1. What do you understand by gear generating?

Gear generating process is based on the fact that any two motives gear of the some module will mesh exactly. In this process one of the gears act as cutter. Due to relative rolling motion of the cutter and blank, gear teeth are generated.

2. Distinguish between the forming and generating methods?

Single point Tool (Forming): Here the tool is a single point tool. The job should be indexed for every tooth; The tool is fixed.
Pinion type cutter (Generating): Here the tool is also a gear made of hard steels, (Used as cutter). The job is not indexed for every tooth. The cutter as well as the blank rotates simultaneously meshing with each other.

3. What are the factors affecting geometrical accuracy of the circular component .in shape? Geometrical accuracy of the circular component depends upon: a) The trueness of the work piece rotation, b) Parallelism of the tool movement with the work spindle axis, c) The effect of the tool wear.

4. Write the advantages of gear shaping (Generating)?

The advantages of Gear shaping are: a) with a particular module of DP cutter, gears having the same module of DP but different number of teeth can be cut accurately, b) Quicker and economical, c) Only one cutter is used for cutting all spur gears of same pitch, d) Both internal and external gears can be cut.

5. What is the main disadvantage of gear shaping?

The main disadvantage of gear shaping is that Worm and worm wheels cannot be generated on a gear shaper.

6. When do you prefer shaping process for generating a gear?

Gear shaping is preferred for operations like cutting gear segments, cutting, spur gear, herring-bone gears, splines and sprockets etc., of gear shaping over other diameter.

7. What are the advantages of gear shaping over the other methods?

The advantages are:
a) The finished gear has a generated profile
b) It is suitable for cutting internal gears
c) Only one cutter is used for cutting all spur gears of the same pitch.

8. What are the specific types of gears that could be formed specifically by gear shaping process? Shaping process can operate on classes of gearing outside the capacity of other methods. Example are: a) Internal gears with or without back shroud, b) Cluster gears.

9. Distinguish between gear shaping and gear planning?

Gear shaping:

a) The job is indexed and tool reciprocates

b) Gear can be generated by using form tool as well as pinion cutter.

Gear planning:

a) Job is indexed and reciprocated but the tool is fixed.

b) Gear can be produced by means of form tool and Rack cutters.

10. What is the basic condition to use 'Bobbing' in geers?

Hobbing can be done only if the gear blank to be generated are of the same modules