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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

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LECTURE HANDOUTS

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Mechanics of Chip Formation

Introduction :

- Regardless of the tool being used or the metal being cut, the chip forming process occurs by a mechanism called plastic deformation.
- This deformation can be visualized as shearing. That is when a metal is subjected to a load exceeding its elastic limit.

Prerequisite knowledge for Complete understanding and learning of Topic:

- Chip forming process
- Chip less Process
- Metal Shearing
- Elastic limit

Detailed content of the Lecture:

- In any engineering industry, components are made into various shapes and sizes by using metals.
- These shapes and sizes are formed either by using non cutting or chipless operations such as forging, blanking, rolling, pressing, etc or by using metal cutting or chip forming operations such as turning, milling, drilling, shaping etc.
- In metal cutting operations, the required shape is obtained by a suitable metal removing process.
- During machining the excess material is gradually removed from the parent metal by using the suitable tools in the form of chips.
- The following are the basic objectives of the economical and efficient machining practice:
- Quick metal removal

- high class surface finish
- Economy in tool cost
- Less power consumption
- Economy in the cost of replacement and sharpening of tools
- The minimum idle time of machine tools

METAL REMOVING PROCESS

- Non cutting process of Chip less Process
- Cutting Process or chip forming process

- In non cutting process or chip less process, the metal is shaped under the action o forces or heat or combination of both force and heat. Since there is no cutting of metal, the chip formation will not be there.
- Eg; forging, drawing, spinning, rolling, extruding etc
- In the cutting process or chip forming process, the required shape of metal is obtained by removing the unwanted material from the workpiece in the form of chips.
- Eg; Turning, Drilling, Milling, Boring etc.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=Lu9cl-EG9Ss

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-320-322

Journal of Manufacturing Science and Engineering, February 2020, Volume 142, Issue 2

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Single Point Cutting Tool, Forces In Machining

Introduction :

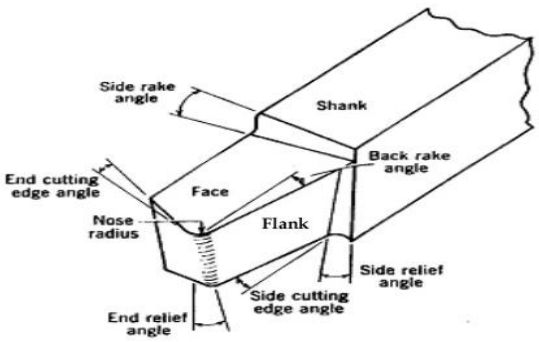
- Cutting tool is any tool that is used to remove material from the workpiece by means of shear deformation. Types are
  - Single point cutting tool
  - Multi point cutting tool
- Cutting **forces** are exerted in three planes to deform and shear away material in the form of a chip.
- As a rake angle becomes more negative, cutting **forces** increase and edge strength improves. A dependent rake is based on the lead angle of the tool and is common for external turning tools

Prerequisite knowledge for Complete understanding and learning of Topic:

- Rake angle
- shear deformation
- Cutting force

Detailed content of the Lecture:

Tool signature for single point cutting tool



Parts of single point cutting tool

- Shank: The body of the tool which is not grained is called as shank
- Face: The surface over the chip of the metal slides is known as face
- Flank: The surface of the tool which is facing the work piece is known as flank. In single point cutting tool, generally there are two flanks namely end flank and side flank.
- Base; It is the bottom surface of the shank. Generally, it is flat in nature
- Nose; The junction of sides and end cutting edges are called nose
- Cutting Edge: It is the junction of face and flank. It is generally denoted by two types of cutting edges.
- End cutting edge
- Side cutting edge

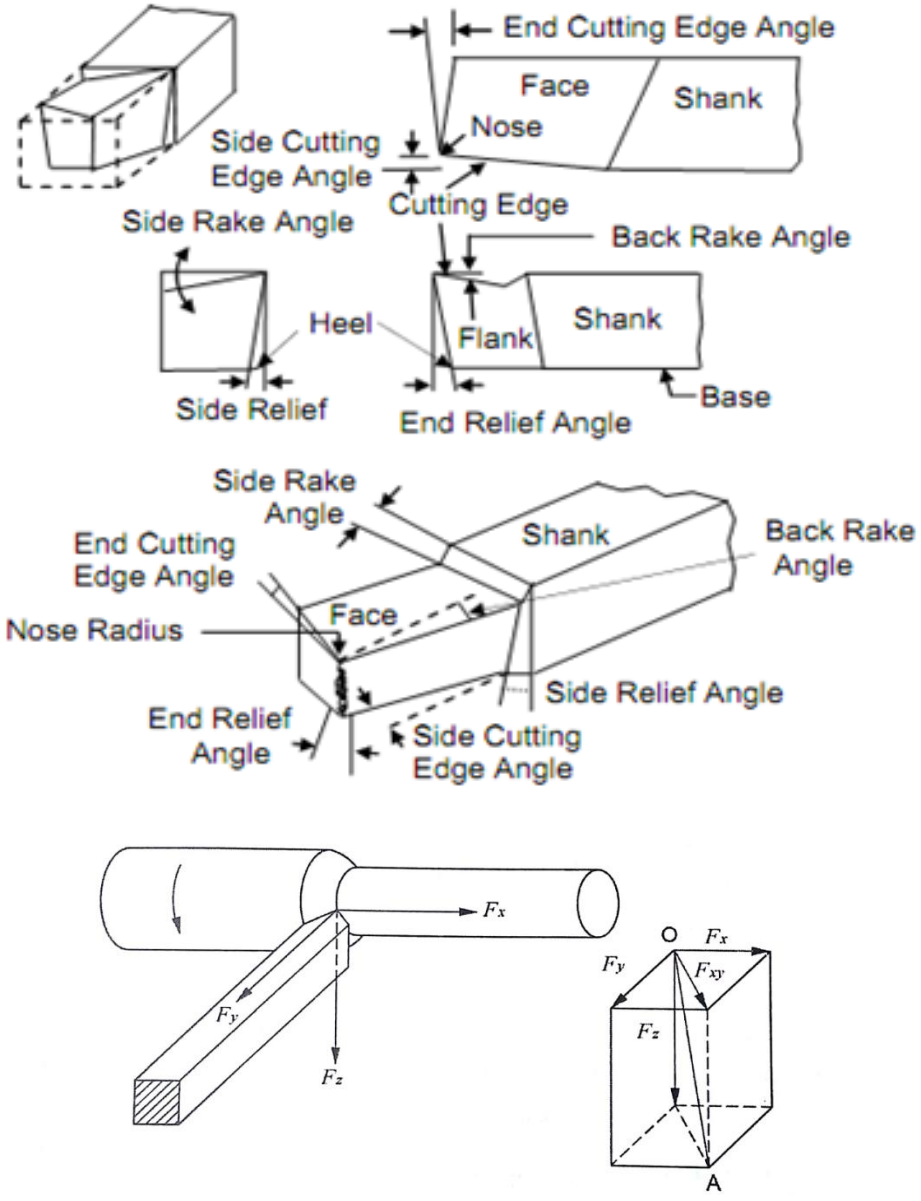


Figure 1.15 Cutting forces during turning

Forces in Machining

- If you make a free body analysis of the chip, forces acting on the chip would be as follows. At cutting tool side due to motion of chip against tool there will be a frictional force and a normal force to support that.
- At material side thickness of the metal increases while it flows from uncut to cut portion. This thickness increase is due to inter planar slip between different metal layers. There should be a shear force (Fs) to support this phenomenon.
- According to shear plane theory this metal layer slip happens at single plane called shear plane. So shear force acts on shear plane. Angle of shear plane can approximately determined using shear plane theory analysis.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=Mn9jpqI8rao

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-322-341

International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 11, Pg No-1165-1167.

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Course Name with Code : **19RAC03 Manufacturing Technology :**

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Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Types Of Chip

Introduction :

There are mainly three chips types.

- Continuous **chips**: According to its name, continuous **chips** have a continuous segment.
- Discontinuous **chips** or segmental **chips**: According to its name, this **chips** form in segment.
- Continuous **Chips** with built up edge:

Prerequisite knowledge for Complete understanding and learning of Topic:

- Chips
- Cutting tool
- Material Properties

Detailed content of the Lecture:

- A discontinuous chip comes off as small chunks or particles. When we get this chip it may indicate, Brittle work material Small or negative rake angles Coarse feeds and low speeds
- A continuous chip looks like a long ribbon with a smooth shining surface. This chip type may indicate, Ductile work materials Large positive rake angles, Fine feeds and high speeds
- Continuous chips with a built up edge still look like a long ribbon, but the surface is no longer smooth and shining.
- Under some circumstances (low cutting speeds of ~0.5 m/s, small or negative rake angles), Work materials like mild steel, aluminum, cast iron, etc., tend to develop so-called built-up edge, a very hardened layer of work material attached to the tool face, which tends to act as a cutting edge itself replacing the real cutting tool edge.
- The built-up edge tends to grow until it reaches a critical size (~0.3 mm) and then passes off with the chip, leaving small fragments on the machining surface. Chip will break free and cutting forces are smaller, but the effects is a rough machined surface.

The built-up edge disappears at high cutting speeds.

- Chip control Discontinuous chips are generally desired because They are less dangerous for the operator Do not cause damage to workpiece surface and machine tool Can be easily removed from the work zone Can be easily handled and disposed after machining.
- There are three principle methods to produce the favourable discontinuous chip: Proper selection of cutting conditions Use of chip breakers Change in the work material properties

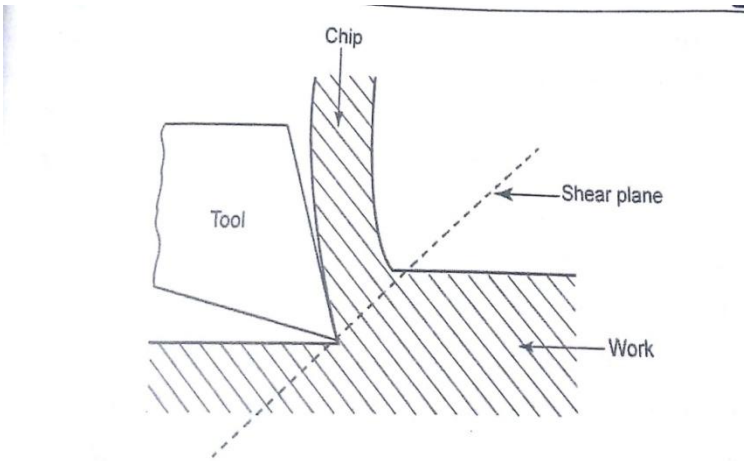

Figure 1.10 Continuous chip

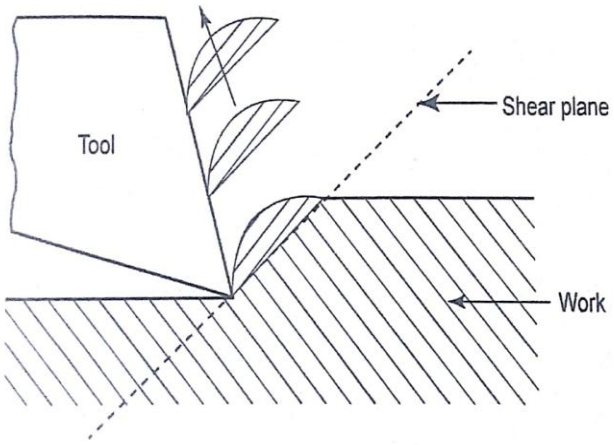

Figure 1.11 Discontinuous chip

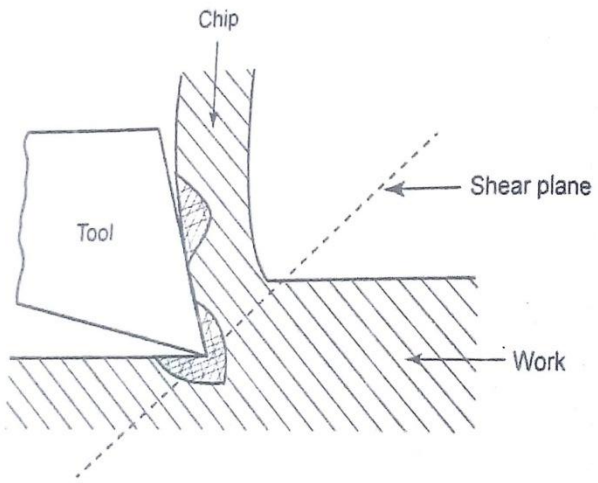

Figure 1.12 Continuous chip with built-up edge

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=Dsb0Xd8NCvA

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-348-352

International Advanced Materials Research 505:31-36, Volume: 04 Issue: 11, Pg No-31-36

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Course Name with Code : **19RAC03 Manufacturing Technology :**

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Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Cutting Tool Nomenclature

Introduction : (Maximum 5 sentences)

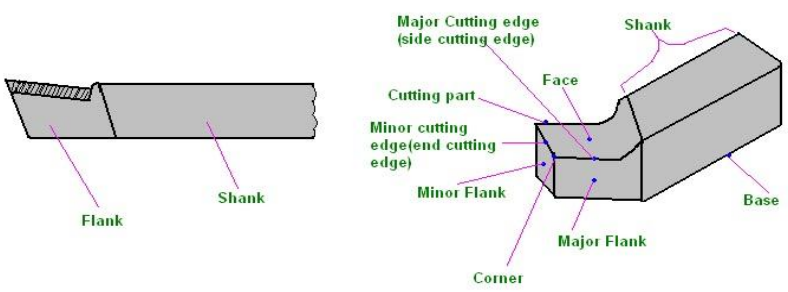
- Single-point tools are used in turning, shaping, planning and similar operations, and remove material by means of one cutting edge. The main features of the cutting edge are:
  - Form of the cutting edge: radius or waterfall or trumpet.
  - Cutting edge angles (free angle and rake angle)
  - Form and size of the chamfers.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Shank
- Flank
- Face
- Cutting edge Angle

Detailed content of the Lecture:

Nomenclature of single point cutting tool:



- Back Rake is to help control the direction of the chip, which naturally curves into the work due to the difference in length from the outer and inner parts of the cut.
- It also helps counteract the pressure against the tool from the work by pulling the tool into the work.
- Side Rake along with back rake controls the chip flow and partly counteracts the resistance of the work to the movement of the cutter and can be optimized to suit the particular material being cut.
- Brass for example requires a back and side rake of 0 degrees while aluminum uses a back rake of 35 degrees and a side rake of 15 degrees. Nose Radius makes the finish of the cut smoother as it can overlap the previous cut and eliminate the peaks and valleys that a pointed tool produces.
- Having a radius also strengthens the tip, a sharp point being quite fragile. All the other angles are for clearance in order that no part of the tool besides the actual cutting edge can touch the work.
- The front clearance angle is usually 8 degrees while the side clearance angle is 10-15 degrees and partly depends on the rate of feed expected. Minimum angles which do the job required are advisable because the tool gets weaker as the edge gets keener due to the lessening support behind the edge and the reduced ability to absorb heat generated by cutting.
- The Rake angles on the top of the tool need not be precise in order to cut but to cut efficiently there will be an optimum angle for back and side rake.

Angles of Single point cutting tool

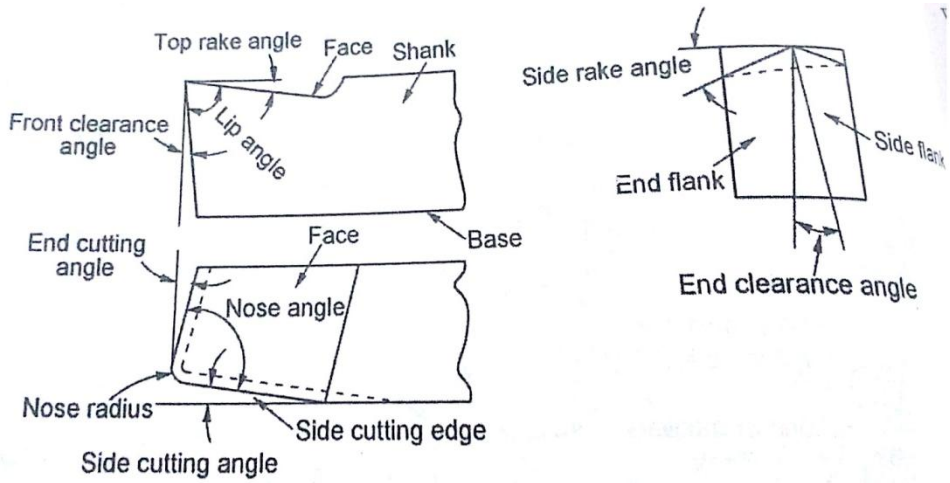


Figure 1.7 Nomenclature of a single point cutting tool

- Back rack angle or Top rack angle

It is also called top rake angle. It is the angle between the face of the tool and the line parallel to the base of the tool. It is the slope given to the face or surface of the tool.

- Side rack angle

  It is the slope given to the face or top of the tool. It is the angle between the tool face and the line parallel to the base of the tool as shown in fig. 1.1. This slope is given from the nose along the length of the tool.

- Side relief angle

  The angle between the side flank and a line perpendicular to the base of the tool is known as side relief angle.

- End relief angle

  The angle between end flank and a line perpendicular to the base of the tool measured at right angles to the end flank is known as end relief angle. This angle prevents the cutting tool from rubbing against the job

- End cutting edge angle

  End cutting edge angle is the angle between the end cutting edge and a line perpendicular to the tool shank

- Side cutting edge angle

  Side cutting edge angle is the angle between the side cutting edge and the side of the tool shank.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=BHEYrGrvp6U

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-348-352

International Journal of Machine Tools and Manufacture, Volume 43, Issue 3, February 2003, Pages 301-305

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Orthogonal Metal Cutting

Introduction :

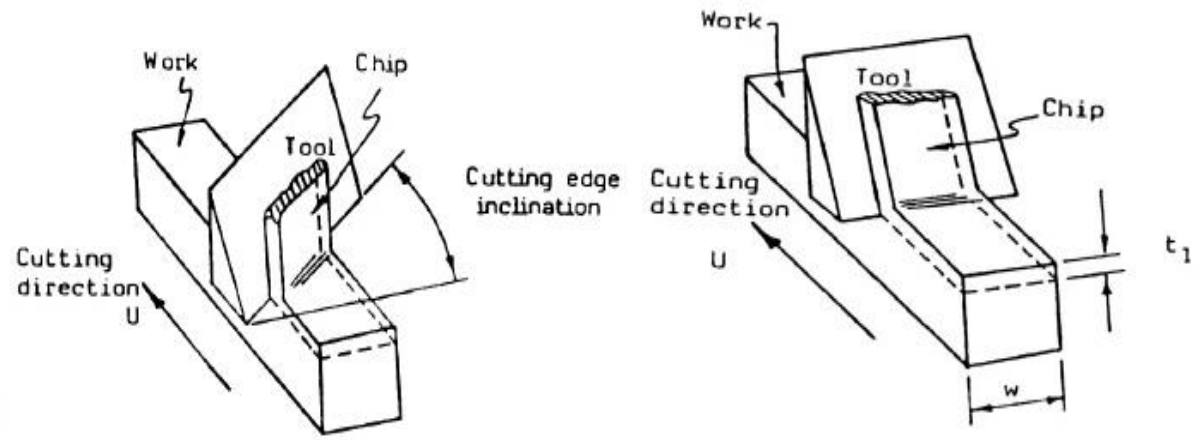
- Orthogonal cutting is a type of metal cutting in which the cutting edge of wedge shape cutting tool is perpendicular to the direction of tool motion.
- In this cutting the cutting edge is wider than width of cut.

Prerequisite knowledge for Complete understanding and learning of Topic:

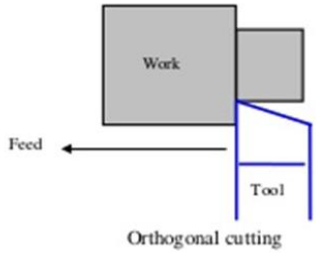
- Metal cutting
- Direction of tool motion
- Cutting edge

Detailed content of the Lecture:

Orthogonal and Oblique cutting process

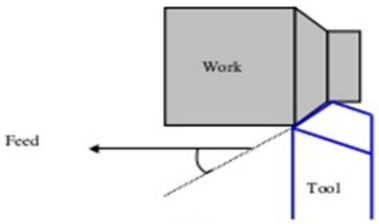


Orthogonal Cutting



Orthogonal cutting

Oblique Cutting



Oblique cutting

Orthogonal metal cutting	Oblique metal cutting
Cutting edge of the tool is perpendicular to the direction of tool travel.	The cutting edge is inclined at an angle less than 90^{o} to the direction of tool travel.
The direction of chip flow is perpendicular to the cutting edge.	The chip flows on the tool face making an angle.
The chip coils in a tight flat spiral	The chip flows side ways in a long curl.
For same feed and depth of cut the force which shears the metal acts on smaller areas. So the life of the tool is less.	The cutting force acts on larger area and so tool life is more.
Produces sharp corners.	Produces a chamfer at the end of the cut
Smaller length of cutting edge is in contact with the work.	For the same depth of cut greater length of cutting edge is in contact with the work.
Generally parting off in lathe, broaching and slotting operations are done in this method.	This method of cutting is used in almost all machining operations.

- Depending on whether the stress and deformation in cutting occur in a plane (two- dimensional case) or in the space (three-dimensional case), we consider two principle types of cutting
- Orthogonal cutting the cutting edge is straight and is set in a position that is perpendicular to the direction of primary motion. This allows us to deal with stresses and strains that act in a plane. Oblique cutting the cutting edge is set at an angle.
- According to the number of active cutting edges engaged in cutting, we distinguish again two types of cutting: Single-point cutting the cutting tool has only one major cutting edge Examples: turning, shaping, boring Multipoint cutting the cutting tool

has more than one major cutting edge Examples: drilling, milling, broaching, reaming.

- Abrasive machining is by definition a process of multipoint cutting. Cutting conditions Each machining operation is characterized by cutting conditions, which comprises a set of three elements:

  Cutting velocity: The traveling velocity of the tool relative to the work piece. It is measured in m/s or m/min.

  Depth of cut: The axial projection of the length of the active cutting tool edge, measured in mm. In orthogonal cutting it is equal to the actual width of cut.

  Feed: The relative movement of the tool in order to process the entire surface of the work piece. In orthogonal cutting it is equal to the thickness of cut and is measured in mm.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=l1I9C9v0yAw

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-364-367

Elsevier, Science Direct, Procedia CIRP, Volume 46, 2016, Pages 35-38

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Thermal Aspects

Introduction :

- In cutting, nearly all of energy dissipated in plastic deformation is converted into heat that in turn raises the temperature in the cutting zone.
- Since the heat generation is closely related to the plastic deformation and friction, we can specify three main sources of heat when cutting, Plastic deformation by shearing in the primary shear zone Plastic deformation by shearing and friction on the cutting face Friction between chip and tool on the tool flank

Prerequisite knowledge for Complete understanding and learning of Topic:

- Energy dissipation
- Plastic deformation
- Friction

Detailed content of the Lecture:

- If coolant is used in cutting, the heat drawn away by the chip can be as big as 90% of the total heat dissipated. Knowledge of the cutting temperature is important because it: Affects the wear of the cutting tool.
- Cutting temperature is the primary factor affecting the cutting tool wear can induce thermal damage to the machined surface. High surface temperatures promote the process of oxidation of the machined surface.
- The oxidation layer has worse mechanical properties than the base material, which may result in shorter service life.
- Causes dimensional errors in the machined surface. The cutting tool elongates as a result of the increased temperature, and the position of the cutting tool edge shifts toward the

machined surface, resulting in a dimensional error of about 0.01~0.02 mm.

- Since the processes of thermal generation, dissipation, and solid body thermal deformation are all transient, some time is required to achieve a steady-state condition

Cutting temperature determination

- Cutting temperature is either measured in the real machining process, or predicted in the machining process design.
- The mean temperature along the tool face is measured directly by means of different thermocouple techniques, or indirectly by measuring the infrared radiation, or examination of change in the tool material microstructure or micro hardness induced by temperature.
- Some recent indirect methods are based on the examination of the temper color of a chip, and on the use of thermo sensitive paints.
- There are no simple reliable methods of measuring the temperature field. Therefore, predictive approaches must be relied on to obtain the mean cutting temperature and temperature field in the chip, tool and work piece.
- For cutting temperature prediction, several approaches are used: Analytical methods: there are several analytical methods to predict the mean temperature. The interested readers are encouraged to read more specific texts, which present in detail these methods.
- Due to the complex nature of the metal cutting process, the analytical methods are typically restricted to the case of orthogonal cutting. Numerical methods: These methods are usually based on the finite element modeling of metal cutting.
- The numerical methods, even though more complex than the analytical approaches, allow for prediction not only of the mean cutting temperature along the tool face but also the temperature field in orthogonal and oblique cutting

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=U7exNCTgPcY

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-413-417

Journal of Manufacturing Science and Engineering, 113(3): 311-319

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Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Cutting Tool Materials

Introduction :

- The cutting tool materials must possess a number of important properties to avoid excessive wear, fracture failure and high temperatures in cutting.
- The following characteristics are essential for cutting materials to withstand the heavy conditions of the cutting process and to produce high quality and economical parts

Prerequisite knowledge for Complete understanding and learning of Topic:

- Material Properties
- Fracture Failure

Detailed content of the Lecture:

- **Carbon Steels** It is the oldest of tool material. The carbon content is 0.6~1.5% with small quantities of silicon, Chromium, manganese, and vanadium to refine grain size.
- Maximum hardness is about HRC 62. This material has low wear resistance and low hot hardness. The use of these materials now is very limited.
- **High-speed steel (HSS)** First produced in 1900s. They are highly alloyed with vanadium, cobalt, molybdenum, tungsten and Chromium added to increase hot hardness and wear resistance. Can be hardened to various depths by appropriate heat treating up to cold hardness in the range of HRC 63-65. The cobalt component give the material a hot hardness value much greater than carbon steels. The high toughness and good wear resistance make HSS suitable for all type of cutting tools with complex shapes for relatively low to medium cutting speeds. The most widely used tool material today for taps, drills, reamers, gear tools, end cutters, slitting, broaches, etc.
- **Cemented Carbides** Introduced in the 1930s. These are the most important tool materials

today because of their high hot hardness and wear resistance. The main disadvantage of cemented carbides is their low toughness. These materials are produced by powder metallurgy methods, sintering grains of tungsten carbide (WC) in a cobalt (Co) matrix (it provides toughness). There may be other carbides in the mixture, such as titanium carbide (TiC) and/or tantalum carbide (TaC) in addition to WC.

- **Ceramics** Ceramic materials are composed primarily of fine-grained, high-purity aluminum oxide (Al2O3), pressed and sintered with no binder. Two types are available: White, or cold-pressed ceramics, which consists of only Al2O3 cold pressed into inserts and sintered at high temperature. Black, or hot-pressed ceramics, commonly known as cermets (from ceramics and metal). This material consists of 70% Al2O3 and 30% TiC. Both materials have very high wear resistance but low toughness; therefore they are suitable only for continuous operations such as finishing turning of cast iron and steel at very high speeds. There is no occurrence of built- up edge, and coolants are not required.
- **Cubic boron nitride (CBN**) and synthetic diamonds Diamond is the hardest substance ever known of all materials. It is used as a coating material in its polycrystalline form, or as a single-crystal diamond tool for special applications, such as mirror finishing of non-ferrous materials. Next to diamond, CBN is the hardest tool material. CBN is used mainly as coating material because it is very brittle. In spite of diamond, CBN is suitable for cutting ferrous materials.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=VFBMJHdqjcs

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-413-417

Journal of Materials Processing Technology, Volume 56, Issues 1–4, January 1996, Pages 16-23

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Tool Wear, Tool Life

Introduction :

Tool wear Wear is loss of material on an asperity or micro-contact, or smaller scale, down to molecular or atomic removal mechanisms.

- It usually progresses continuously. Tool wear describes the gradual failure of cutting tools due to regular operation
- The tool life is the duration of actual cutting time after which the tool is no longer usable.
- There are many ways of defining the tool life, and the common way of quantifying the end of a tool life is by a limit on the maximum acceptable flank wear

Prerequisite knowledge for Complete understanding and learning of Topic:

- Wear of Tool
- Gradual failure
- Flank wear

Detailed content of the Lecture:

- The life of a cutting tool can be terminated by a number of means, although they fall broadly into two main categories:
- Gradual wearing of certain regions of the face and flank of the cutting tool, and abrupt tool failure. Considering the more desirable case Œ the life of a cutting tool is therefore determined by the amount of wear that has occurred on the tool profile and which reduces the efficiency of cutting to an unacceptable level, or eventually causes tool failure. When the tool wear reaches an initially accepted amount, there are two options,
- To resharpen the tool on a tool grinder, or To replace the tool with a new one. This second possibility applies in two cases, When the resource for tool resharpening is exhausted. or

The tool does not allow for resharpening, e.g. in case of the indexable carbide inserts Wear zones Gradual wear occurs at three principal locations on a cutting tool.

- Accordingly, three main types of tool wear can be distinguished, Crater wear Flank wear Corner wear Crater wear: consists of a concave section on the tool face formed by the action of the chip sliding on the surface.
- Crater wear affects the mechanics of the process increasing the actual rake angle of the cutting tool and consequently, making cutting easier. At the same time, the crater wear weakens the tool wedge and increases the possibility for tool breakage. In general, crater wear is of a relatively small concern.
- Flank wear: occurs on the tool flank as a result of friction between the machined surface of the workpiece and the tool flank. Flank wear appears in the form of so-called wear land and is measured by the width of this wear land, VB, Flank wear affects to the great extend the mechanics of cutting.
- Cutting forces increase significantly with flank wear. If the amount of flank wear exceeds some critical value (VB > 0.5~0.6 mm), the excessive cutting force may cause tool failure.
- Corner wear: occurs on the tool corner. Can be considered as a part of the wear land and respectively flank wear since there is no distinguished boundary between the corner wear and flank wear land. We consider corner wear as a separate wear type because of its importance for the precision of machining. Corner wear actually shortens the cutting tool thus increasing gradually the dimension of machined surface and introducing a significant dimensional error in machining, which can reach values of about 0.03~0.05 mm.

Tool life

- Tool wear is a time dependent process. As cutting proceeds, the amount of tool wear increases gradually. But tool wear must not be allowed to go beyond a certain limit in order to avoid tool failure.
- The most important wear type from the process point of view is the flank wear, therefore the parameter which has to be controlled is the width of flank wear land, VB. This parameter must not exceed an initially set safe limit, which is about 0.4 mm for carbide cutting tools. The safe limit is referred to as allowable wear land (wear criterion).
- The cutting time required for the cutting tool to develop a flank wear land of width is called tool life, T, a fundamental parameter in machining. The general relationship of VB versus cutting time is shown in the figure (so-called wear curve).
- Although the wear curve shown is for flank wear, a similar relationship occurs for other wear types. how to define the tool life T for a given wear criterion VBk Parameters, which affect the rate of tool wear, are Cutting conditions (cutting speed V, feed f, depth of cut d) Cutting tool geometry (tool orthogonal rake angle) Properties of work material

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=8CV3K6k-g-0

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-413-417

Science Direct, Elsevier, Procedia Engineering, Volume 97, 2014, Pages 241-250

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LECTURE HANDOUTS

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RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **I - Theory of Metal Cutting** **Date of Lecture:**

Topic of Lecture: Surface Finish, Cutting fluids and Machinability

Introduction : (Maximum 5 sentences)

- Surface finish, also known as surface texture or surface topography, is the nature of a surface as defined by the three characteristics of lay, surface roughness, and waviness.
- It comprises the small, local deviations of a surface from the perfectly flat ideal (a true plane).

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Surface texture
- Surface roughness

Detailed content of the Lecture:

- The machining processes generate a wide variety of surface textures. Surface texture consists of the repetitive and/or random deviations from the ideal smooth surface.
- These deviations are Roughness: small, finely spaced surface irregularities (micro irregularities) Waviness: surface irregularities of grater spacing (macro irregularities) Lay: predominant direction of surface texture
- Three main factors make the surface roughness the most important of these parameters: Fatigue life: the service life of a component under cyclic stress (fatigue life) is much shorter if the surface roughness is high Bearing properties: a perfectly smooth surface is not a good bearing because it cannot maintain a lubricating film.
- Wear: high surface roughness will result in more intensive surface wear in friction. Surface finish is evaluated quantitatively by the average roughness height, Ra Roughness control Factors, influencing surface roughness in machining are Tool geometry (major cutting edge angle and tool corner radius), Cutting conditions (cutting velocity and feed), and

Work material properties (hardness).

- The influence of the other process parameters is outlined below: Increasing the tool rake angle generally improves surface finish Higher work material hardness results in better surface finish
- Tool material has minor effect on surface finish. Cutting fluids affect the surface finish changing cutting temperature and as a result the built- up edge formation

Cutting fluids

- During metal cutting, heat is generated due to plastic deformation of metal, friction of the tool work piece interface.
- This will increase temperature of both work piece and the tool. Hence, the hardness of the tool decreases. This leads to tool failure.
- Cutting fluids are used to carry away the heat produced during machining. At the same time, it reduces the friction between the tool and chip. Cutting fluids usually in the form of a liquid are applied to the chip formation zone to improve the cutting conditions

Functions of Cutting Fluid

- Cutting fluid cools the cutting tool and work piece.
- It improves the surface finish as stated earlier
- It causes the chips to break up into small parts. It protects the finished surface from corrosion.
- It washes away the chips from the tool. It prevents the tool from fouling. It prevents corrosion of work and machine

Properties of Cutting Fluid

- It should have good lubricating properties to reduce frictional forces and to decrease the power consumption.
- High heat absorbing capacity.
- It should have a high specific heat, high heat conductivity and high film coefficient.
- High flash point.
- It should be odorless
- It should be non-corrosive to work and tool
- It should have low viscosity to permit free flow of the liquid It should be harmless to operators and the bearings
- It should be transparent so that the cutting action of the tool may be observer. It is especially desirable in precision work.
- It should be economical to use.

MACHINABILITY

- Machining may be easier in some materials whereas it may be difficult in other. This

difference may be attributed to the Machinability of the various materials.

- Machinability is defined as the ease with which a material can be satisfactorily machined. It can also be measured by the following factors:
  - The life of tool before tool failure or re-sharpening.
  - The quality of the machined surface.
  - The power consumption per unit volume of removed

Work variables

The various work variables affecting Machinability are

- Chemical composition of work piece material.
- Micro-structure composition of work piece material.
- Mechanical properties like ductility, toughness, brittleness etc. Physical properties of work piece material.

Tool Variables

The various tool variables affecting Machinability are

- The geometry and tool material.
- Nature of engagement of tool with the work.
- Rigidity of tool.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=-IvhmjpxM-s

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-389-390

International Journal of Machining and Machinability of Materials, Vol.22.

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: Centre lathe, constructional features, specification

Introduction :

A lathe is a father of all machine tools.

- A lathe removes metal by rotating the work piece against a single point cutting tool.
- The following operations can be done by using lathe: Turning, Taper turning, Eccentric turning, Chamfering, Facing, Drilling, Boring, Reaming, Tapping, Knurling, Forming, Grooving, Polishing, Spinning and Thread cutting.

Prerequisite knowledge for Complete understanding and learning of Topic:

- Function of a Lathe
- The principal parts of an Engine Lathe
- Specification of a Lathe
- Various Types of Lathe

Detailed content of the Lecture:

The principal parts of an engine lathe are,

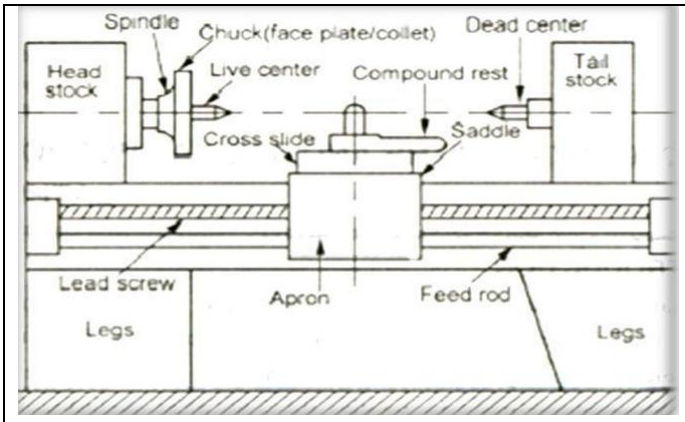
(i) Bed

(ii) Head stock

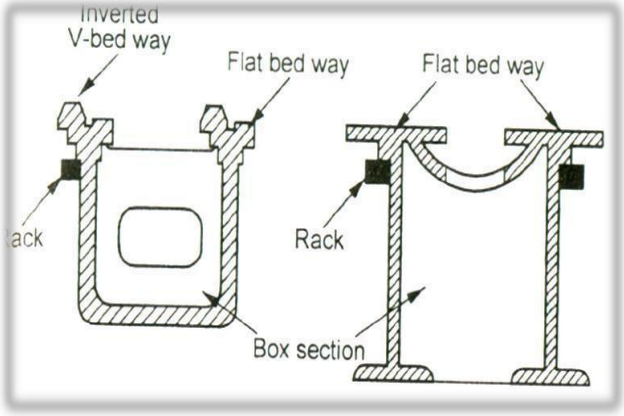
(iii) Tail stock

(iv) Carriage

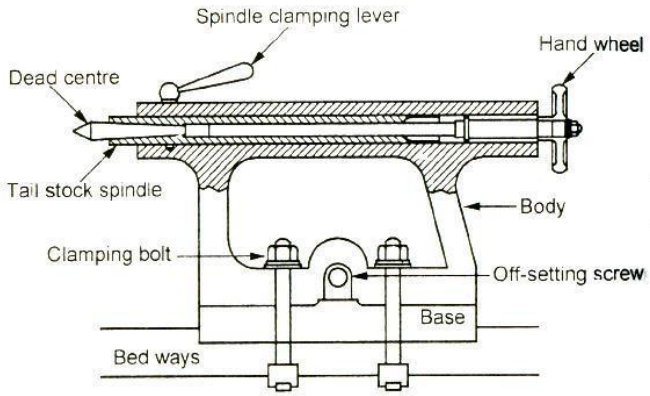
(v)Feed Mechanism



Engine lathe



Lathe Bed



Tail Stock

CARRIAGE

The carriage is a moving part that slides over the guide ways between headstock and the tailstock. It carries the following parts:

(i) Saddle
(ii) Cross Slide
(iii) Compound Rest:
(iv) Tool Post

SPECIFICATION OF A LATHE

- The length of bed.
- Maximum distance between dead and live centers.
- Type of bed i.e. straight, semi gap or gap type.
- The height of centers from the bed.
- Swing over the bed.
- Swing over the cross slide.
- Width of the bed.
- Spindle bore.
- Spindle speed.
- H.P. of main motor and rpm.
- Number of spindle speeds.
- Spindle nose diameter.
- Feeds.

TYPES OF LATHE

1. Speed Lathe
   - Wood working lathe.
   - Metal spinning lathe.
   - Metal turning lathe.
   - Polishing lathe.
2. Engine lathe
   - Step cone pulley drive lathe.
   - Geared lathe.
   - Variable speed lathe.
3. Bench lathe
4. Tool room lathe.
5. Semi Automatic lathe
   - Capstan lathe
   - Turret lathe
6. Automatic lathe
7. Special purpose lathe
   - Crank shaft lathe
   - Wheel lathe
   - Duplicating lathe.
8. Copying lathe

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=1e6L6Gk0RbI

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg- 215-223

Process Capability Analysis of a Centre Lathe Turning Process in Engineering 08(03):79-85 · January 2016

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: operations – taper turning methods

Introduction : (Maximum 5 sentences)

- Different operations carried out on a lathe are: centering, straight turning, taper turning, Eccentric turning, Shoulder turning, chamfering, thread-cutting, facing, parting-off, drilling, boring, reaming, tapping, knurling, filing, grooving, spinning, forming, milling, grinding etc.A lathe removes metal by rotating the work piece against a single point cutting tool.
- Taper turning - the operation of producing conical surface on the cylindrical work piece on lathe.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Various operation
- Form tool method.
- Tailstock set over method.
- Compound rest method.
- Taper turning attachment method.

Detailed content of the Lecture:

Centering

right hand turning tool is clamped on the tool post. For light cuts, the tool may be inclined towards the headstock but the tool may be inclined towards the tailstock for heavy cuts. Automatic or hand feed can be used.

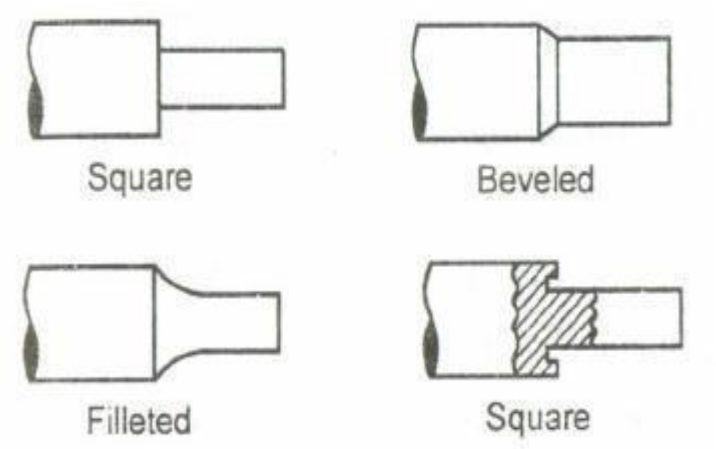
There are two types of straight turning

(a) Rough turning.

(b) Finish turning.

Shoulder Turning

Stepped diameter work piece are turned at the shoulder. It is called as *shouldering.* The various types of shoulders are shown in fig.2.51.



Facing

Machining the end of the work piece to produce flat surface is called facing. The work may be held in a chuck or between centers. The work is rotate about the lathe axis. A facing tool is fed perpendicular to the axis of the lathe. The feeding may be done by hand or power.

Chamfering

Chamfering is the process of beveling or turning a slope at the end of the work piece. This is done for removing burrs and blends the sharp edges. Generally, chamfering is done for jobs after knurling, rough turning and thread cutting.

Knurling

Knurling is the process of producing a diamond shaped pattern or impression on the surface of the work piece; It is used to give a good gripping surface on the work piece.

Filing

Filing is the process of removing burs, sharp comers, and feed marks on a work piece by removing very small amount of metal.

Forming

Forming is the process of producing concave, convex and any irregular shape on the work piece by a form tool.

Grooving

Grooving is the process of reducing the diameter of the work piece over a very narrow surface

Parting-off

Parting-off is the process of cutting the work piece into two halves.

Eccentric turning

An eccentric is used for obtaining reciprocating motion from rotary motion. It is useful for turning a crankshaft, camshaft or an eccentric on a shaft. In such parts, the centre of one

cylinder is out of the centre of other cylinder.

Drilling

Drilling is the operation of producing cylindrical hole in a work piece. It is done **by rotating the cutting edge of a cutter known as drill.**

Reaming

Reaming is the operation of finishing and sizing hole which is already drilled. Reamer is used for this purpose. It has a multiple cutting edges.

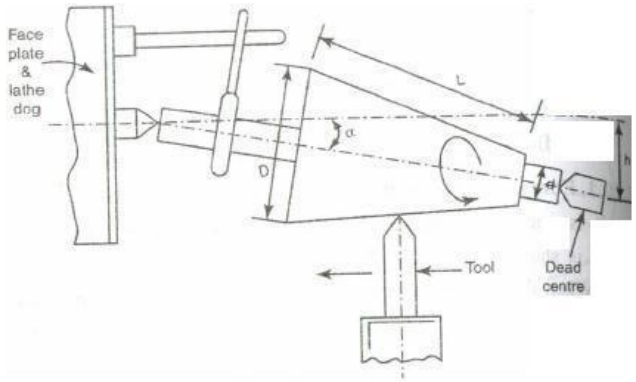
TAPER TURNING METHODS

(a) Form tool method.

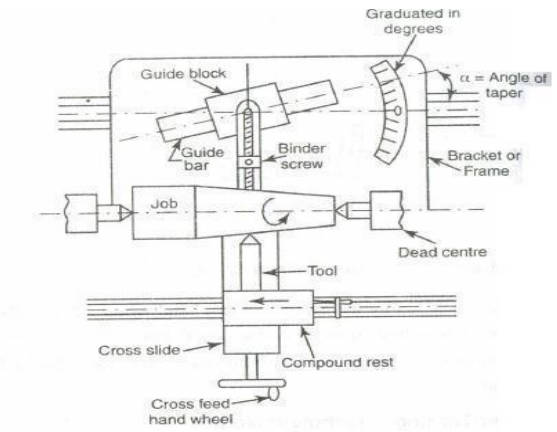
(b) Tailstock set over method.

(c) Compound rest method.

(d) Taper turning attachment method.



Tailstock set over method.



Taper turning attachment method.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=PItK-rbaKLI

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-224-228

Improvement In Swivelling The Compound Slide Taper Turning Method in Journal of Applied Science and Computations ISSN NO: 1076-5131

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: thread cutting methods, special attachments,

Introduction : (Maximum 5 sentences)

- A process that produces a helical ridge of uniform section on the work piece.
- Threading is the process of creating a screw thread
- Milling and grinding are performed on lathes by using special attachments.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- process of thread cutting
- The principal parts of an Engine Lathe
- For cutting grooves or keyways
- For cutting multiple grooves and gear wheel
- Grinding Attachment

Detailed content of the Lecture:

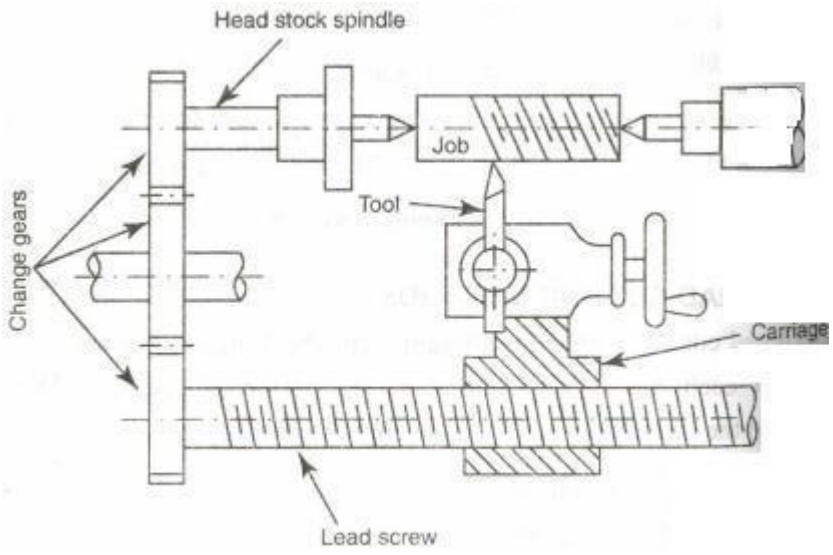
Thread cutting is done in different methods. It means, picking up a thread for each and every depth of cut called thread catching. This picking up the thread is obtained in different ways. They are

1. Reversing the machine
2. Marking the lathe parts
3. Using a chasing dial or thread indicator
4. Using thread chaser

Reversing the Machine

In this method, the tool is brought back to the initial position by reversing the carriage by means of two-way switch at the end of each cut. During reversing, the half nut is permanently engaged. This method is very tedious and requires lot of time.

Using a Chasing Dial or Thread Indicator



Thread cutting

The chasing dial is used to indicate when the half nut is closed. The dial is fitted right end of the apron.

It has a vertical shaft with a worm gear engaged with the lead screw. The top of the shaft has a revolving dial marked with lines and numbers. When the half nut is engaged, the dial turns with the lead screw.

A reference line is marked on the body of the chasing dial. For initial cut, the half nut is engaged when any line on the dial coincides with the reference marks. In the subsequent cut, the half nut is engaged when the same line coincides with the reference mark.

SPECIAL ATTACHMENTS

Generally, milling and grinding are performed on lathes by using special attachments.

2.13.1. Milling Attachment

Milling is the process of removing metal by moving the work against rotating cutter. This rotating cutter is mounted on the tool holder called arbor. Milling cutters have multipoint cutting edges. This operation is carried out in two methods depending upon the form of profiles.

1. For cutting grooves or keyways

Here, the work is held on the cross slide and milling cutter is held by a chuck using special attachment. Then the depth of cut is given by a vertical slide provided on the attachment.

2. For cutting multiple grooves and gear wheel

In this case, work is held stationary between centres. The attachment is mounted on the cross slide on the carriage which is driven by separate electric motor.

The feeding is given by the carriage and vertical movement is given by the provision made on the attachment. Similarly, a number of grooves are made on the periphery of the

work by rotating the work. For cutting gears, a universal dividing head is fitted on the rear end of the headstock spindle to divide the work equally.

Grinding Attachment

Grinding is the operation of removing metal in fine form of chips. It is done by moving the work against a rotating abrasive wheel. This abrasive wheel is known as grinding wheel. Both external and internal grinding can be cut by using special attachments on lathe. The wok is held between centres or on a chuck and rotated for grinding external surfaces. For grinding internal surfaces, a work is held on a chuck or faceplate. Then feeding is given by moving the carriage and cross slide is moved for giving depth of cut.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=fezj8G70f7c
https://www.youtube.com/watch?v=1blM3tbqYss

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-228-231

Small Thread Attachment for Internal Threading on Lathe Machine , International Research Journal of Engineering and Technology, e-ISSN: 2395-0056Volume: 06 Issue: 05 | May2019

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LECTURE HANDOUTS

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: Machining time and Power Estimation

Introduction : (Maximum 5 sentences)

- The time when a machine is actually processing something.
- *A reduction in material or removing some undesirable parts of a material.*
- To find and calculate the machining time in a machining operation.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Cutting speed
- Material to be cut
- Feed
- Depth of cut

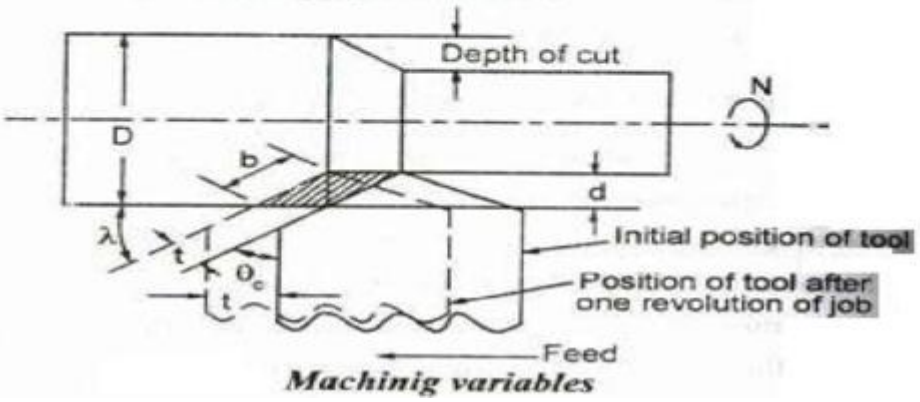
Detailed content of the Lecture:

1. *Cutting speed,* $V = \frac{\pi DN}{1000}$ *m/min.*

Where, D – Diameter of work piece in *mm*.

N – speed of rotation of work.piece in *rpm*

V – Cutting speed of work.



Machinig variables

2. *Uncut chip area,* A_c = width of chip × thickness of uncut chip.

$$= b \times t$$

If θ_c = side cutting edge angle.

$$b = \frac{d}{\cos\theta_c}$$

$$\therefore\ b \times t = f \times d$$

where, f = feed in *mm*

3. *Metal removal rate (MMR)*

$$MMR = \pi \cdot D \cdot A_c \cdot N \quad mm^3/min.$$

$$MMR = 1000\, A_c \cdot V \quad mm^3/min$$

$$\left(\because\ V = \frac{\pi DN}{1000}\right)$$

$$= 1000\, f\, D\, V \quad mm^3/min$$

4. *Machining time*

$$T_m = \frac{L}{f\,N} \text{ minutes per pass}$$

Where, L = length of travel of the tool per pass.

For turning operation

L = Length of machining surface + Length of Tool approach + Length of tool over travel

$$L = l + x + y$$

Where,

x = Length of tool approach = d $\tan\theta_c$ or d $\cot\lambda$

y = Length of tool over travel = 1 to 2 *mm*

λ = Tool approach angle = $90 - \theta_c$

For facing operation

$$L = \frac{D}{2} + x + y$$

5. *Number of passes or cuts,* $n = \dfrac{\text{Total Machining allowance}}{\text{Material removed per cut}}$

Total machining allowance = $\dfrac{D_1 - D_2}{2}$

Where,

D_1 = Initial diameter of the work piece.

D_2 = Final diameter of the work piece after machined.

6. *Total machining time,* $T_{total} = T_m \times n$

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=dje_JXy-CDo

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-244-248

Effect of Machining Parameters and Machining Time on Surface Roughness in Dry Turning Process, Procedia Engineering, Volume 100, 2015, Pages 135-140

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: Capstan lathe- tool layout

Introduction : (Maximum 5 sentences)

- Capstan are Semi-automatic lathes that help in making the Auxiliary motion quick and accurate.
- It was modified of engine lathes.
- The Tail stock is replacing with an index able multi station tool head.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

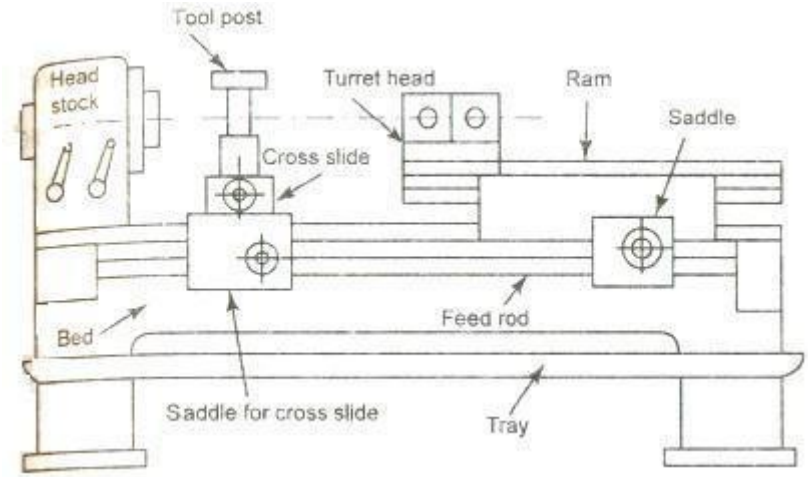
- Working principle of Capstan lathes,
- Tooling
- Designed for short continuous runs

Semi automatic lathes

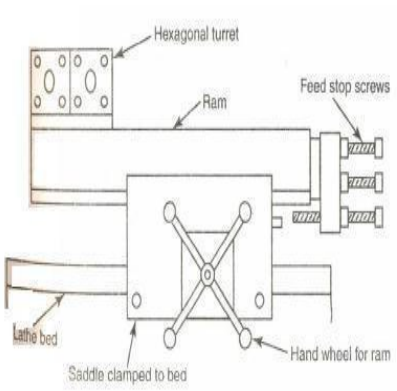
- Semi automatic lathes are production lathes with human involvement for certain operations
- Semi automatic lathes are production lathes with human involvement for certain operations
- Capstan and turret lathes with additional attachments become semi automatic lathes Also called retrofitting
- Vide range of jobs can be accommodated
- Higher production rates

The main parts of capstan and turret lathes are

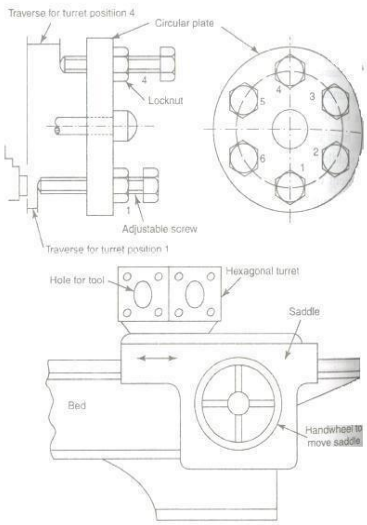
1. Bed
2. Head stock
3. Turret head and saddle
4. Cross slide.



Capstan lathe



Ram of capstan lathe



Saddle of turret lathe

Bed

Bed is the base part of the lathe. It is a box type which is made of cast iron. Guide ways on the top of the bed has been provided accurately. Cross slide and turret head are mounted on these guide ways. The bed should be strong and rigid to withstand heavy loads, force and vibrations during machining task.

Cross slide

The two types of cross slides are

1. Reach over type
2. Side hung type

3. Head stock

Headstock of capstan and turret lathe is similar to that of head of ordinary center lathe but larger and heavier in construction to house the spindle and driving mechanism. A powerful motor

of 30 to *2000rpm* speeds is fitted.

The four main types of headstock are

i) Step cone pulley driven headstock.

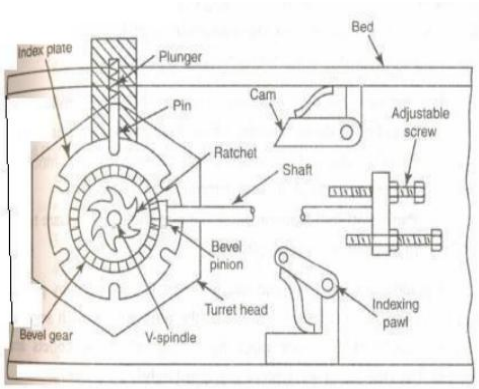
ii) Direct electric motor driven headstock.

iii) All geared headstock.

iv) Pre-selective stock.

Step cone pulley driven headstock, direct electric motor driven headstock and all geared headstock are already discussed in detail.

GENEVA MECHANISM OR INDEXING MECHANISM



WORKING PRINCIPLE OF CAPSTAN AND TURRET LATHES

The work pieces are held in collet or chucks which may be operated either hydraulically or pneumatically. A bar feeding mechanism is used for automatic feeding of bar stock or work piece. At least six tools can be held on the hexagonal turret faces, four tools in front square tool post and one tool at the rear end. Generally,

1. Drilling, boring, reaming, counter boring, turning and threading tools are mounted on the hexagonal turret head.

2. Forming, chamfering, knurling and necking tools are mounted on the front end of the square turret.

3. Parting off tool is mounted on the rear end of the square turret in inverted or reversed position.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=v2vwtY79P6M

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-239-241

THE MACHINE TOOL LABORATORY: Capstan and Turret Lathe Work

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II** **Date of Lecture:**

Topic of Lecture: turret lathes- tool layout

Introduction : (Maximum 5 sentences)

- turret lathe is one of the Semi-automatic lathes that help in making the Auxiliary motion quick and accurate.
- It was modified of engine lathes.
- The Tail stock is replacing with an index able multi station tool head.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

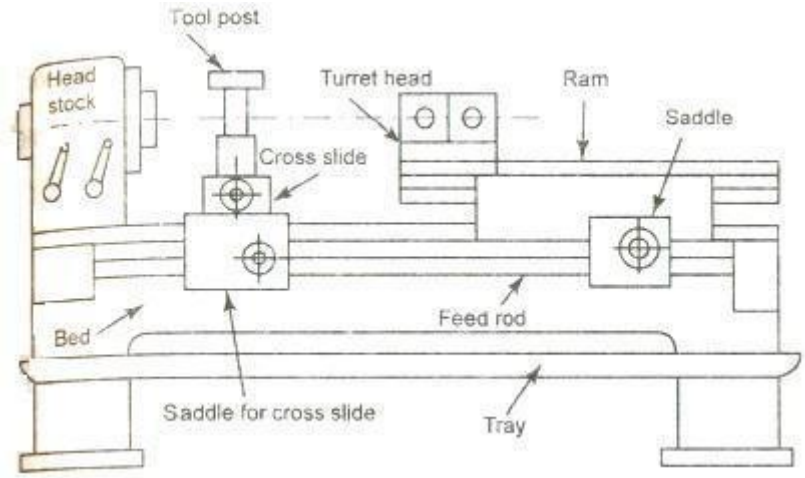
- Working principle of Capstan lathes,
- Working principle of turret lathes,
- Tooling
- Designed for short continuous runs

Semi automatic lathes

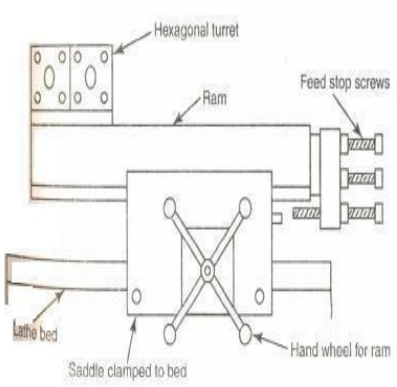
- Semi automatic lathes are production lathes with human involvement for certain operations
- Semi automatic lathes are production lathes with human involvement for certain operations
- Capstan and turret lathes with additional attachments become semi automatic lathes Also called retrofitting
- Vide range of jobs can be accommodated
- Higher production rates

The main parts of capstan and turret lathes are

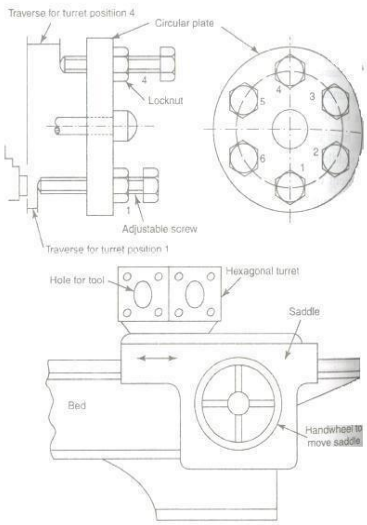
1. Bed
2. Head stock
3. Turret head and saddle
4. Cross slide.



Turret lathe



Ram of capstan lathe



Saddle of turret lathe

Bed

Bed is the base part of the lathe. It is a box type which is made of cast iron. Guide ways on the top of the bed has been provided accurately. Cross slide and turret head are mounted on these guide ways. The bed should be strong and rigid to withstand heavy loads, force and vibrations during machining task.

Cross slide

The two types of cross slides are

1. Reach over type
2. Side hung type

3. Head stock

Headstock of capstan and turret lathe is similar to that of head of ordinary center lathe but

larger and heavier in construction to house the spindle and driving mechanism. A powerful motor of 30 to *2000rpm* speeds is fitted.

The four main types of headstock are

i) Step cone pulley driven headstock.

ii) Direct electric motor driven headstock.

iii) All geared headstock.

iv) Pre-selective stock.

DIFFERENCE BETWEEN CAPSTAN AND TURRET LATHE

S.NO	*Capstan lathe*	*Turret lathe*
1.	Turret head is mounted on a ram which slides over the saddle.	Turret head is directly mounted on saddle. But it slides on the bed.
2.	The turret movement is limited	The turret moves on the entire length of the bed, without any restriction.
3.	Hence shorter workpiece can be machined.	Longer workpiece can be machined.
4.	The capstan construction does not provide rigidity due to overhanging of ram beyond the bed.	It provides rigidity and strong.
5.	So, it is very much useful in light duty applications.	It is useful in heavy duty applications.
6.	Turret head can be moved manually.	Turret head cannot be moved manually
7.	No cross-wise movement to turret	Facing and turning are usually done by cross-wise movement of turret.
8.	Overhung type of cross-slide is not used.	Overhung type of cross slide is provided for some specific operations.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=v2vwtY79P6M

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-239-241

THE MACHINE TOOL LABORATORY: Capstan and Turret Lathe Work

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: - **Swiss Type Automatic Lathes**

Introduction : (Maximum 5 sentences)

- General & single purpose machine
- manufacture of high quality fasteners

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Enhanced machines that combine high performance with complex machining capabilities
- manufacture precision turning of small parts.

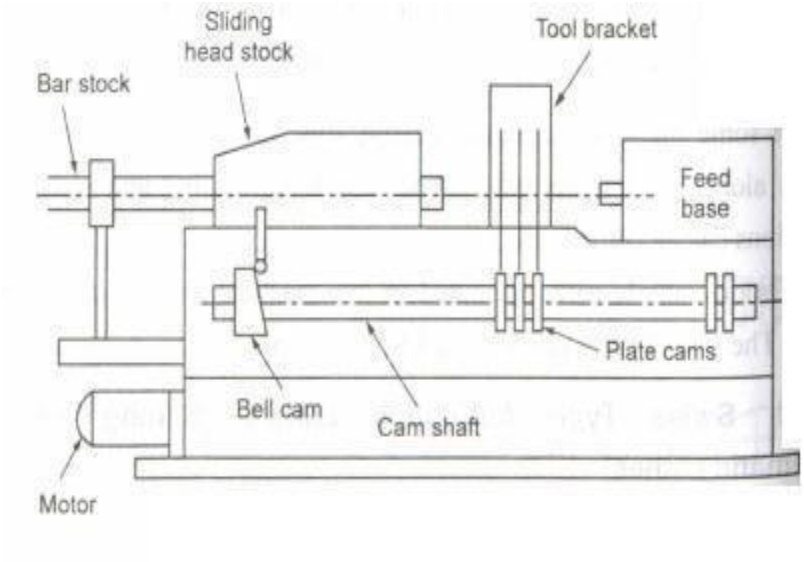
Swiss Type Automatic Lathes

This type of automatic lathe is suitable for small but long and slender parts like parts of wristwatches. There is a distinct difference between the conventional automatic lathes and Swiss type automatic lathes. ln the latter, the work is fed against the tool. The headstock carrying the bar stock moves back and forth for providing the feet movement in the longitudinal direction. Hence, this type of automatic lathe is also called a sliding head automatic lathe.

This machine is used for producing long accurate parts of small diameter (2 to 25mm). In this, the parts can be machined to an accuracy of 0.005mm to 0.0125mm.

There may be as many as five cross slides in the case of automatic lathe. However, productivity-wise, the conventional automatic lathes are superior for short work pieces. The advantage of a sliding head automatic lathe is that long slender work pieces can be machined with very good surface finish, accuracy and concentricity in sliding head automatic lathes. Further, the Swiss type automatic lathes are capable of completely machining certain types of parts which may require second and third

operations in conventional automatic machines. shows the Swiss type screw cutting machine.



It consists of four major parts:

1.The sliding headstock through which the bar stock is passed and gripped by a carbide-lined guide bush. .

2.The camshaft which controls the bar stock and cutting tool movements.

3.The tool bracket which supports five tool slides and a bush for stock.

4.Auxiliary attachments for performing various operations such as knurling, drilling, tapping, screwing, slotting, recessing etc.

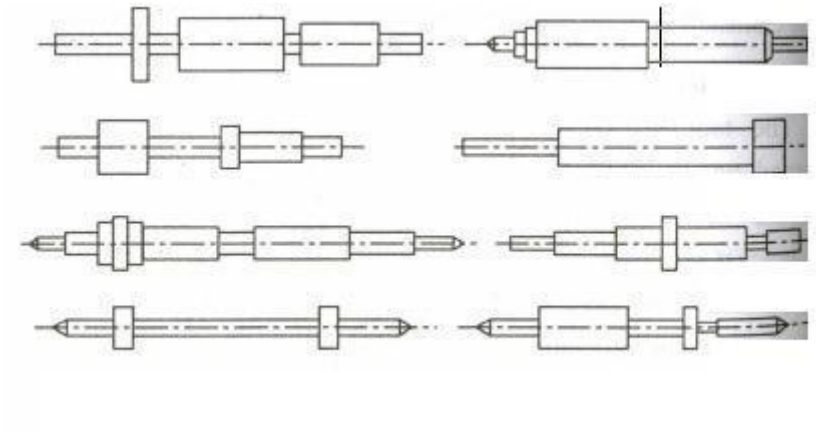
The descriptions of various parts are given below:

1.Sliding Headstock

This headstock has a collet. The bar stock is held in the collet. The headstock slides along the guide ways of the bed. A bell cam connected to the camshaft controls this sliding motion.

2.Tool bracket

The tool bracket is mounted on the bed way near the headstock. The tool bracket supports 4 or 5 tool slides. It also has a bush for supporting and guiding the bar stock. Two slides are positioned horizontally i.e. one at the front and the other at the rear. The other slides are arranged above these slides. All the slides can move back and forth.



Working principle:

The bar stock is held in the rotating spindle by a collet chuck. Headstock slides along the bed ways with the rotating bar stock. This headstock movement gives longitudinal feed to the work. All the tools in the tool slides remove material from the work piece at the same time. The tool in the feed base attachment may also do operations like drilling. After the work piece is machined, the headstock slides back the original position. One revolution of the camshaft produces one component.

Most of the turning and forming operations are done by the tools held on the (horizontal) front and rear tool slides. The vertical tool slides are mainly used for undercutting, chamfering, knurling and cutting off.

Advantages of Swiss type screw machine:

1.It is used to manufacture precision turning of small parts.

2.It has five tool slides.

3.Wide range of speeds is available.

4.It is rigid in construction.

5. Micrometer tool setting is possible.

6. Interchangeability of cams is possible.

7. Simple design of cams is enough.

8. Tolerance of 0.005 to 0.0 125mm is obtained.

9 .Numerous working stations are available

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=Dsb0Xd8NCvA

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-258-260

International Advanced Materials Research 505:31-36, Volume: 04 Issue: 11, Pg No-31-36

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LECTURE HANDOUTS

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RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: - automatic lathes

Introduction : (Maximum 5 sentences)

- Manual machine controls replaced with automatic lathes
- turret lathes to produce economically.
-

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- cutting tools, their sequence of operations
- automatically controlled cutting process

Detailed content of the Lecture:

AUTOMATIC LATHES

- Machine tools in which components are machined automatically.
- The working cycle is fully automatic that is repeated to produce duplicate parts without participation of operator.
- All movements of cutting tools, their sequence of operations, applications, feeding of raw material, parting off, un loading of finished parts all are done on machine.
- All working & idle operations are performed in definite sequence by control system adopted in automatic which is set up to suit a given work.
- Only operation reqd to be performed manually is loading of bar stock/ individual casting/ forged blanks.
- These machines are used when production requirements are too high for turret lathes to produce economically.
- Manual machine controls replaced by variousmechanisms
- Parts are fed and removed automatically
- May have single or multiple spindles
- Automatic lathes uses servo motor
- Automatic lathes Limited ranges of variety and sizes

Automatic Lathe Features

- Minimum man power utilized
- Meant for mass production
- Manual machine controls replaced by variousmechanisms
- To eliminate the amount of skilled labour.

- Mechanisms enable to follow certain prescribed frequency
- Parts are fed and removed automatically
- Minimizing the loading and unloading time
- May have single or multiple spindles
- Tool set up may be permanent
- May have horizontal or vertical spindles
- More accuracy can be obtained

Advantages

- Greater production over a given period.
- More economy in floor space.
- Improvement in accuracy.
- Floor space maintenance and inventory requirements are reduced.
- More consistently accurate work than turrets.
- More constant flow of production.
- Scrap loss is reduced by reducing operator error.
- During machine operation operator is free to operate another machine/ can inspect completed parts.

CLASSIFICATION OF AUTOMATICLATHES

Depending up on type of work machined these machines are classified as:

1. Magazine loaded Automatics:

- Machines used for producing components from separate blanks.
- Also called as automatic checking machines.

2. Automatic Bar Machines:

- designed for machining components from bar/ pipe stock.
- M/c's are used for manufacture of high quality fasteners (screws, nuts), bushings, shafts, rings, rollers, handles which are usually made of bar / pipe stock.

Depending upon number of work spindles, automatic lathes are classified as:

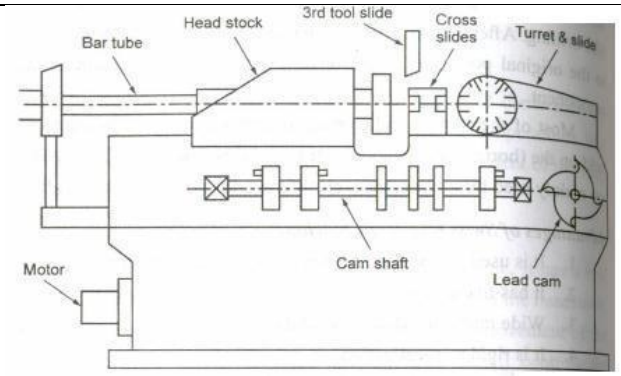
1. Single Spindle Automatics.
2. Multi Spindle Automatics.

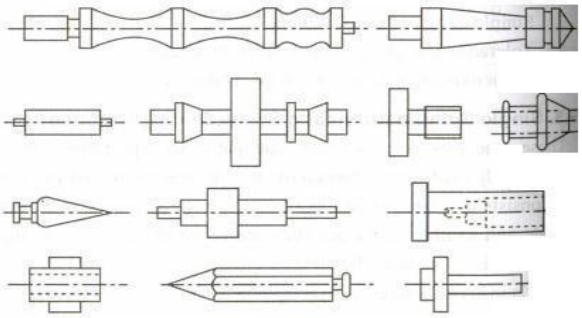
Depending upon purpose & arrangement of spindle also automatics are classified as:

1. Purpose➔ General & single purposem/c.
2. Arrangement of spindle➔ Horizontal &vertical

Single Spindle Automatic Screw Cutting Machine

These machines are essentially automatic bar type turret lathes. They are widely used for production of all sorts of small turned parts. It mainly consists of a cross slide and a turret. Two cross slides, one front cross slide and another rear cross slide are provided for cross feeding tools. An additional vertical slide is also employed in this machine. This third slide is installed above the work spindle. The turret slide is placed at the right end of the bed. It carries the turret having six tool holes. The various tools used in the machine are mounted around the turret in a vertical plane in line with the spindle. In this machine, the headstock is stationary.





- It houses the spindle which rotates in either direction. The bar stock is held in a chuck. It is advanced by a feed finger after each piece is finished and cut off. A cam shaft is mounted at the front of the machine. It carries three plate cams.
- These plate cams control the travel of cross slides. The turret head rotates about a horizontal axis. The turret slide travel is controlled by a lead cam. The lead earn gives a slow forward and fast return movement to the turret slide.
- The discs cams are used to control the cross slide. All operations such as turning, drilling, boring, threading, reaming, spot facing, knurling can be done on the machine. Special attachments are also available to perform slotting work, milling fiats, cross- drilling etc. In this machine, any type of bar stock round, square, hexagonal can be machined. These machines are made in several sizes for bar work from *60mm* diameter.

Applications:

It is used for producing small jobs, screws, stepped pins, taper pins, bolts etc.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=2fvqRCHywJA

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-235-250

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LECTURE HANDOUTS

RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **II - Turning Machines** **Date of Lecture:**

Topic of Lecture: - Multiple Spindle Automatic Lathe

Introduction : (Maximum 5 sentences)

- the ability to provide various types of operations which include boring holes, turning, chamfering, threading, grooving as well as drilling and this is done by moving the piece that is being worked on between six to eight positions in the machine.
- They are used in mass production

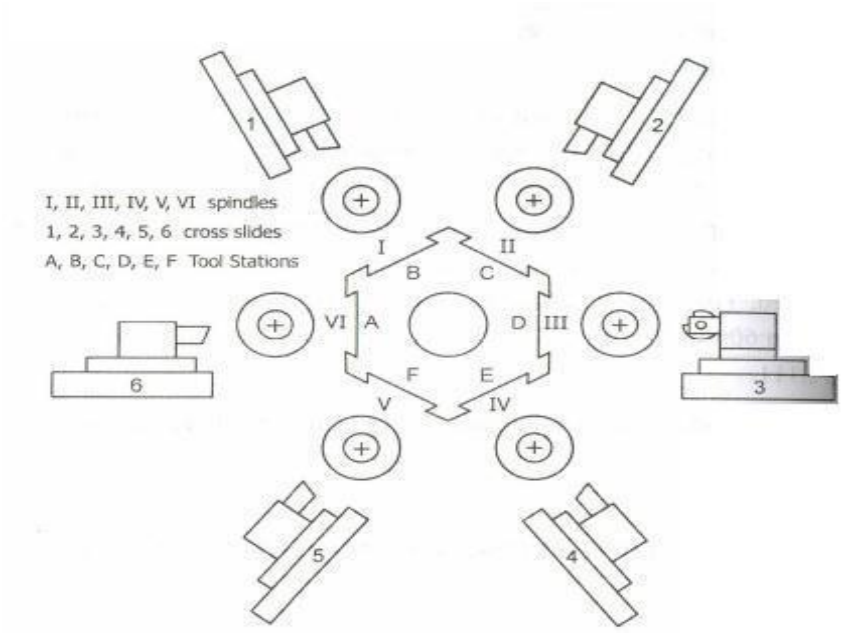
Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Multi Spindle Drill Head
- Productivity
- Energy efficiency
- Space savings

Detailed content of the Lecture:

MULTIPLE SPINDLE AUTOMATIC LATHES:

Multiple spindle automatic lathes are machines which can produce larger work pieces than single spindle automats. The principle advantage of the multi spindle automat is that it has a tool slide working on the jobs on all spindles simultaneously and hence the time for producing a piece is the time for the longest cut.



The main tool slide moves longitudinally on an extension of the spindle which provides accurate alignment with the spindle. The end tool slide is advanced and retracted by a drum cam. Each spindle position has a separate cross slide which is operated by independent cams. Cross slides are mounted directly on the headstock. One of the spindle positions is used for stock loading in the case of magazine feeding or feeding of bar stock.

2.31. Classification of Multi-Spindle Automatic Lathes

Multi-spindle automatic lathes are classified as follows.

1. According to the type of work piece (stock) used.

a. Bar type machine.

b. Chucking type machine.

2. According to the arrangement of spindle.

a. Horizontal spindle type.

b. Vertical spindle type.

3. According to the principle of operation.

a. Parallel action type.

b. Progressive action type.

Bar-Type Automatic Machine

These machines operate on bar stock, usually round. Sometimes a bar of hexagonal shape can also be used. These machines can be specified by the largest diameter of stock that can be fed through the spindles. The sizes of bars range from about 14mm diameter. The bar stock may be fed either by gravity or by rollers.

Magazine-Loading Type or Chucking Type Machine

These machines are similar to bar type machines. They handle several work pieces held in several chucks. It can be specified according to the diameter of the work that can be swung over tool slides. The maximum size of bar stock that can be used in this machine is 250mm.

Parallel Action Multi Spindle Automats

These types of automatics are otherwise called as 'multiple-flow' machine. The line diagram of machine consists of a frame with a headstock. The axes of work spindles are horizontal. These spindles are arranged in a line one above the other. The Work spindles are housed in the

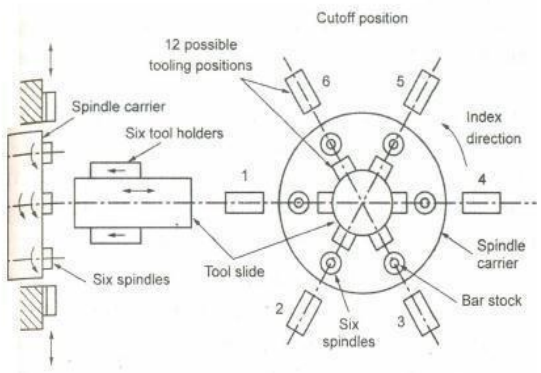
headstock. There are two cross slides, one on left hand side and the other on the right hand side. The left hand side cross slide is called as (rant tool slide. The right hand side cross slide is called as rear tool slide.

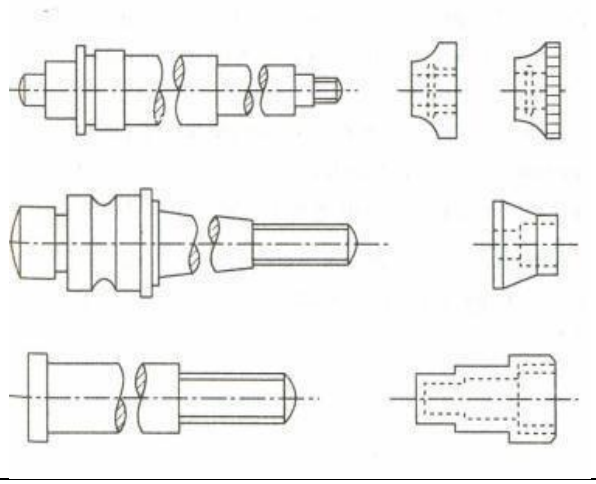
Parallel action multi spindle automatic machine

In this type of machine, the same operation is performed on each spindle. In one working cycle, each work piece is finished in each spindle. In a five-spindle machine, five components can be completed at a time. Similarly, in a eight spindle machine, eight components can be completed at a time. Hence, it is called as parallel action multi spindle machine. The production rate is very high in this machine. But only simple components can be machined since all the machining processes are done at one position.

Progressive Action Multi Spindle Automats or cutting Off Machine

In this type of machine, the work pieces are machined in stages. A six-spindle progressive action multi spindle automatic lathe The headstock is mounted on the base of the mach headstock has a spindle carrier. This carrier rotates about a horizontal axis through the centre of the machine. The working spindles mounted in the spindle carrier. Work pieces are held in the collet in the spindles. The bar stock is fed to the spindle from the rear. Cross slides are mounted in a frame above the face of the spindle carrier. These tool slides carry forming, chamfering,





Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=CFTxNLpZdmQ

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-258-260

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LECTURE HANDOUTS

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II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Shaper

Introduction : (Maximum 5 sentences)

- shaper which is having a reciprocating type of machine tool with single point cutting tool used to produce flat surface
- The flat surface may be horizontal, vertical or inclined
- They are performing specific Operations by using multipoint cutting tool.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Machining flat surface
- Single point cutting tools
- Multipoint cutting tool.

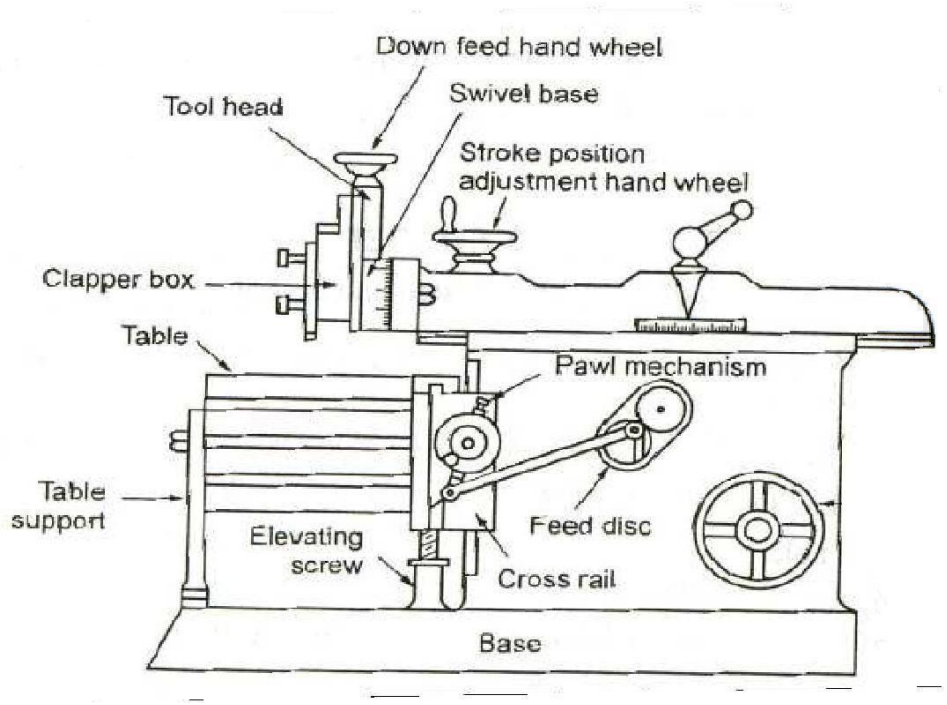
Detailed content of the Lecture:

Shaper has the three important parts such as

1. Table
2. Tool head
3. Ram

- The tool head is fitted on the front end of the ram while the job is rigidly fixed on the table. The tool is mounted on the tool post or head, the ram reciprocates along with the tool to remove the metal in the forward stroke called as cutting stroke.
- The tool does not cut the metal in the return stroke called as idle stroke. Therefore, one pass is nothing but the combination one forward and return stroke or one cutting and one idle stroke. So, we are in a position to reduce idle stroke time by increasing the speed of the return stroke. That is, the speed of cutting stroke will be lower than the speed of return stroke. This is done to reduce the time required for one pass. Hence, the overall time required will be reduced drastically.
- This quick return of the ram during idle stroke is obtained by a quick return mechanism.

At the end of each cutting stroke, the feed (depth of cut) is given.



Shaper

PRINCIPLE PARTS OF A SHAPER

The different parts of a shaper are listed and described below.

1. Base
2. Column
3. Cross rail
4. Saddle
5. Table
6. Ram
7. Tool head

SHAPER SPECIFICATIONS

Generally, the specifications of a typical shaper are listed below:

1. Maximum length of stroke.
2. Maximum crosswise movement of the table.
3. Maximum vertical adjustment of the table.
4. Type of driving mechanism.
5. Power of the motor.
6. Speed and feed available.
7. Type of shaper-plain or universal.
8. Floor space required.
9. Total weight of the shaper.
10. Ratio of cutting stroke time to return stroke time.

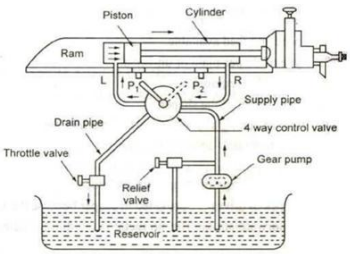
DRIVES

To convert rotary motion of motor into reciprocating motion of the tool the various types of drives are provided in shaper because the metal is removed in the forward stroke. But no metal is cut during the return stroke. Due to this, the time taken for the return stroke should be reduced by making the return stroke faster than the cutting stroke. This is achieved by some quick return mechanism.

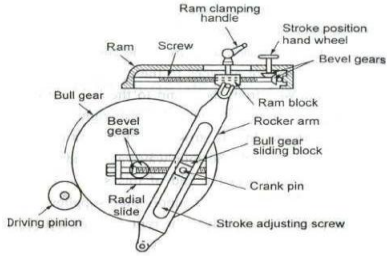
3.1.7. TYPES OF QUICK RETURN MECHANISM

The following three types of quick return mechanisms are

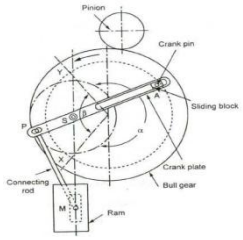
1. Hydraulic drive
2. Crank and slotted link mechanism
3. Whitworth mechanism.



Hydraulic drive



Crank and slotted lever mechanism



Whitworth quick return mechanism

$$\therefore m = \frac{Cutting\ time}{Return\ time} = \frac{\alpha}{\beta} = \frac{Cutting\ angle}{Return\ angle}$$

m varies from 2:1 to 3:2

Video Content / Details of website for further learning (if any):
https://www.youtube.com/channel/UCLy2jg5-SD84OCbiiDoOAJA

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-153-168

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LECTURE HANDOUTS

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II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Types of operations

Introduction : (Maximum 5 sentences)

- Machining horizontal surface.
- Machining vertical surface.
- Machining angular surface.
- Machining slots, grooves and keyways.
- Machining irregular surfaces.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Machining flat surface
- Single point cutting tools
- Multipoint cutting tool.

Detailed content of the Lecture:

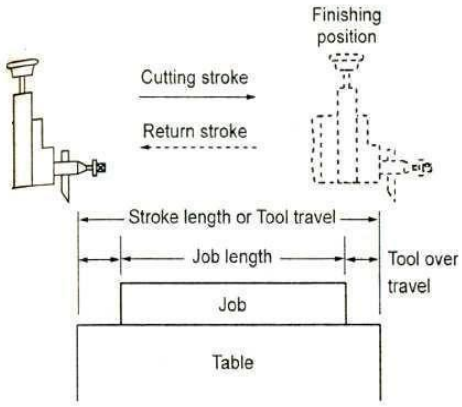
3.1.15. SHAPING OPERA TIONS

The following operations can be performed on a shaper.

1. Machining horizon tal surface.
2. Machining vertical surface.
3. Machining angular surface.
4. Machining slots, g rooves and keyways.
5. Machining irregula r surfaces.

Machining Horizontal Surface

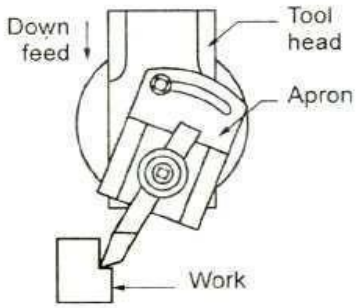
The work is held on a tab le and the tool is fitted on the tool post with minimum overhung. It should prevent the rubbing of tool on the work while returning.



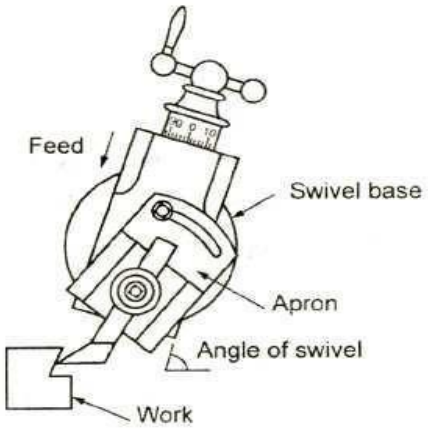
Machining horizontal surface

Machining Vertical Surface

The job is held on the table and the tool is set on the tool holder. The tool position and the stroke length are adj usted to a required dimension. Then the value o n the vertical slide dial is set at zero. The apron is swiveled to avoid rubbing of the tool on the work surface during the return stroke.

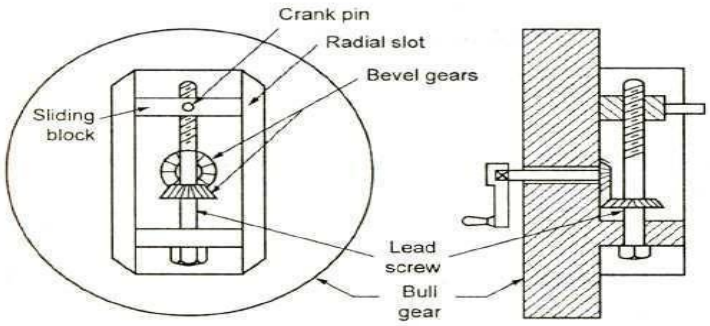


Machining Angular Surface



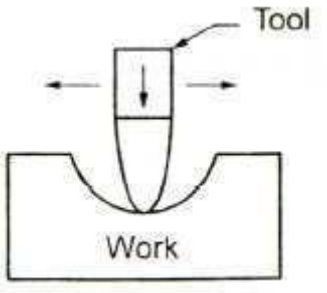
Machining Slots, Grooves and Keyways

The work is held in a vice using 'V' blocksand parallels. First a hole is drilled to a required keyway depth at th e end of the work piece. The diameter of the hole should greater than the width of ke yway. Then, the position and stroke length are adjusted. The keyway-cutting tool is set on the tool head. Finally, the external keyway is m achined with reduced speed.



Machining grooves and slots

Machining Irregular Surface



Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=0IUd5MkMOAg

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-187

Hnatovsky, C., Shvedov, V. G., Shostka, N., Rode, A. V., & Krolikowski, W. (2012). Polarization-dependent ablation of silicon using tightly focused femtosecond laser vortex pulses. Optics Letters, 37(2), 226-228.

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LECTURE HANDOUTS

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RA

II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Drilling, reaming, boring, Tapping

Introduction : (Maximum 5 sentences)

- Producing hole on the work piece by using a rotating cutter
- Operation of enlarging a hole by a single point cutting tool
- Operation of cutting internal threads in a hole by using a cutting tool.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- The operation of enlarging the hole
- produce an accurate hole
- Multipoint cutting tool.

Detailed content of the Lecture:

Drilling is the process of pr oducing hole on the work piece by using a rotating cutter called drill. The machine on which the drilling is carried out is called drilling machines. The drilling machine someti mes called drill press as the machine exerts vertical pressure to originate a hole.

CLASSIFICATION OF DRILLING MACHIENS

The drilling machines are cla ssified as follows:

1. Portable drilling machine.
2. Sensitive drilling machine.
    a. Bench type
    b. Floor type
3. Upright drilling machine
    a. Round column typ e or pillar type
    b. Box column type o r square section type.
4. Radial drilling machine
    a. Plain type
    b. Semi-universal type
    c. Universal type
5. Gang drilling machine
6. Multiple spindle drilling m achine

7. Automatic drilling machine
8. Deep hole drilling machin e

SENSITIVE DRILLI NG MACHINES

Sensitive drilling machines are lightweight, high-speed machines, which are generally benchtype drilling machines, but pillar type machines are also available.

UPRIGHT OR PILLAR DRILLING MACHINE

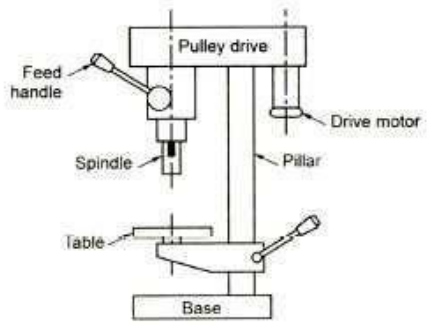
Upright drilling machine is a higher capacity version of sensitive drilling machine. It is stationary flo or mounted drilling machine.

RADIAL DRILLING MACHINE

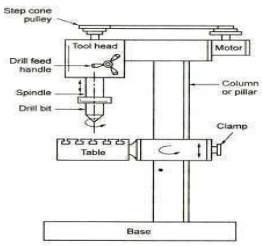
This type of machine is mounted on floor and suitable for drilling medium to large and heavy work pieces. The most significant feature of this machine i s a radial arm which can swing about a column.

MULTISPINDLE DRRILLING MACHINE

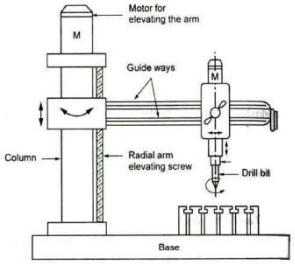
This machine is suit able for mass production. In this machine, sev eral holes of different sizes can be drilled simultaneously. It has several spindles. They ar e driven by a single motor by using a set of gears. The center distance of spindles may b e adjusted to any desired length.



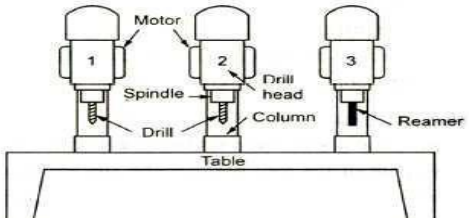
Sensitive drilling machine



Radial drilling machine



Up-right drilling

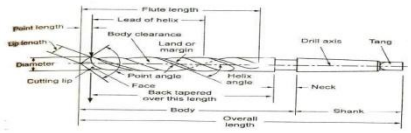


Gang drilling machine

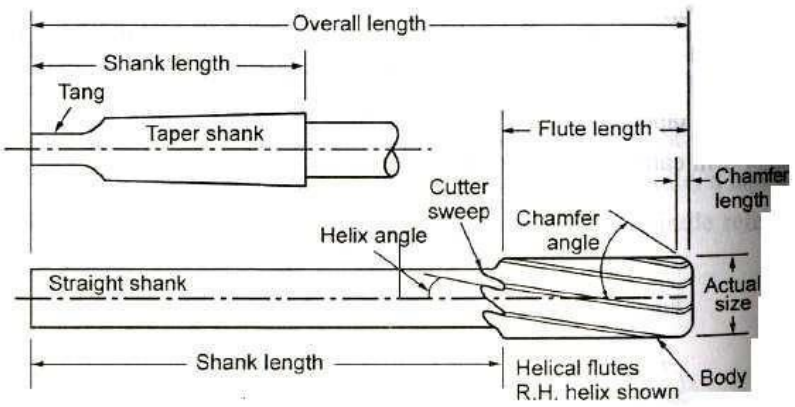
Gang drilling machine

When a number of si ngle spindles with essential speed and feed is mounted side by side on one base and hav e common worktable is known as the gang-dril ling machine. The number of spindles varies from four to six.

DRILL TOOL NOM ENCLATURE



REAMING TOOL



Reamer with helical flutes

The reamer with helical flutes provides smooth shear cutting action and provides better surface finish. The pitch of the flutes is made uneven to reduce vib ration. Small size reamers are made with straight shank whereas large size reamers are ma de with taper shank. There are different ki nds of, reamers for different applications.

Boring

Boring is the process of enlarging and locating previously drilled holes with a single point cutting tool. Th e boring machine is one of the most versatile m achine tools. Boring a small hole in a sma ll work piece can be done in a lathe. The borin g machine is designed for machining large and heavy work piece in mass production w ork of engine frame, cylinder, machine ho using etc. These machines can perform many operations like drilling, boring, counter bor ing, spot facing, internal and external thread cutting, face milling, facing turning cylind rical surfaces, gear cutting etc.

TYPES OF BORING MACHINE

The boring machines may be classified as follows:

1. Horizontal boring machine.
2. Vertical boring machine.
3. Precision boring machine.
4. Jig boring machine.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=V0MtdSr4umU

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-168-187

A.Karthik 1, R.Krishnaraj "Single Axis Semi-Automatic Drilling Machine WithPlcControl" International Journal of Innovative Research In Science, Engineering And Technology (An Iso 3297: 2007 Certified Organization) Vol. 4, Issue 3, March 2015.

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LECTURE HANDOUTS

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II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Milling operations-types of milling cutter

Introduction : (Maximum 5 sentences)

- The process of removing metal by feeding the work past against a rotating multipoint cutter
- Milling helical and spiral gear teeth
- Multi tooth rotary cutting tools

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Work holding Devices
- mass production
- Multipoint cutting tool.

Detailed content of the Lecture:

- Milling is the process of removing metal by feeding the work past against a rotating multipoint cutter. The metal is removed in the form of small chi ps.
- In milling operation, the ratio of metal removal is rapid as the cutter rotates at a high s peed and has many cutting edges.
- Thus, the jobs are machined at a faster rate than with single point tools and the surface finish is also better due to multi cutting edges.
- It is used for machining flat and irregular surface.

Principle of Operation

- The action of a milling cutter is vastly different form that of drill or lathe tool. The milling machine has a rotating cutter.
- The multi point cutter is mounted on a rotating spindle or arbor. The cutter rotates at tilt required cutting speed. The work piece is clamped on the table.
- The work piece is fed slowly past the cutter. During machining, when one cutting edge performs the cutting, the other edges will be idle. So, these edges are cooled. Also the stress on the cutting edge is not continuous.
- This gives more life 'to the cutting edge.

CLASSIFICATION OF MILLING MACHINE

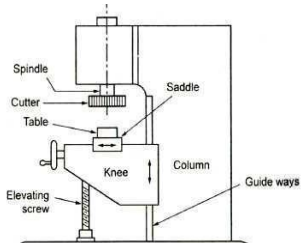
Milling machine are classified in a variety of ways. The broad classification of these machines can be done as follows.

1.Column and knee types

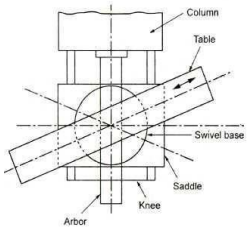
a. Plain milling machine
b. Vertical milling machine.
c. Universal milling machine.
d. Ram-type milling machine.
e. Omniversal milling machine.

2. Bed-Type milling machine

a. Simplex milling machine.
b. Duplex milling machine.
c. Triplex milling machine.



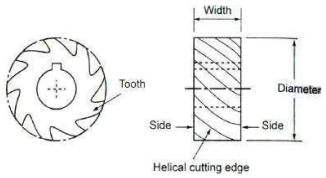
Vertical milling machine



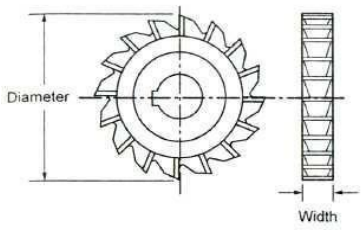
Universal Milling machine

Classification of Cutters

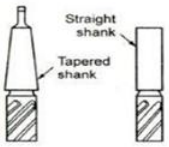
These are multi tooth rotary cutting tools generally made of high speed steels or sintered carbides. Milling cutters are classified into different ways.



Plain milling cutter



Side milling cutter



End milling cutter

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=kGws9QKhYbI

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-179-180

Research Journal of Engineering and Technology ,Milling Operation and its Optimization – A Literature Review, ISSN: 2321-581X(Online), 0976-2973(Print)

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LECTURE HANDOUTS

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RA

II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Gear cutting – forming

Introduction : (Maximum 5 sentences)

- Cutting of different types of gear
- The process of removing metal by feeding the work past against a rotating multipoint cutter
- Milling helical and spiral gear teeth
- Indexing or Dividing Heads

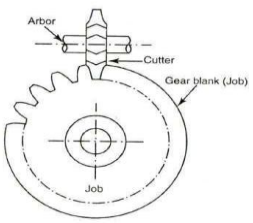
Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- The process of dividing the periphery of a job.
- Work holding Devices
- Mass production
- Multipoint cutting tool.

Detailed content of the Lecture:

Gear cutting operation

- The gear cutting operation involves cutting of different types of gear s on a milling machine. It is performed by using a form relieved cutter which is having the profile corresponding to the required tooth space of the gear.
- Equally spaced gear teeth are cut on a gear blank by holding the work on a universal dividing head and the n indexing it.



Gear cutting

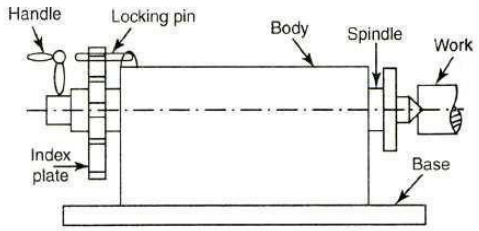
INDEXING OR DIVIDING HEADS

Indexing is the process of dividing the periphery of a job into equal number of divisions. For doing this indexing, an attachment known as dividing head is used with the milling machine. These dividing heads are of following three types:

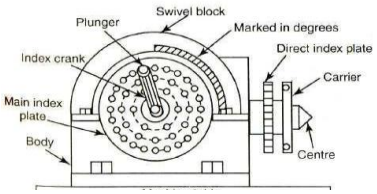
I. Plain or simple dividing head.

2. Universal dividing head.

3. Optical dividing head.



Plain or simple dividing head.



Universal dividing head

- Dividing head i s very useful device for the purpose of indexing work. The driving mechanism consists of a worm drive, index plates, sector arms, change gears and spindle. The worm drive is enclosed in a strong body.
- The base of the body has two slots which are used for mounting the dividing head with the milling machine. The worm meshes with the worm gear.
- The worm is mounted on a shaft. The crank is fitted at the other end of this shaft. The worm gear has 40 teeth and the worm is single threaded.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=39ZiVUA-JNY

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-179-181

Manufacturing of cylindrical gears by generating cutting processes: A critical synthesis of analysis methods, CIRP Annals - Manufacturing Technology 57(2):676-696 · December 2008

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LECTURE HANDOUTS

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II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Generation principle and construction of gear milling

Introduction : (Maximum 5 sentences)

- The process of removing metal by feeding the work past against a rotating multipoint cutter
- Cutting of different types of gear
- Milling helical and spiral gear teeth
- Indexing or Dividing Heads

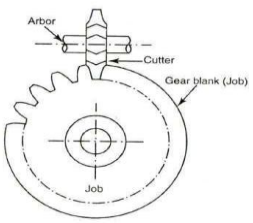
Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Mass production
- The process of dividing the periphery of a job.
- Work holding Devices
- Multipoint cutting tool.

Detailed content of the Lecture:

Gear cutting operation

- The gear cutting operation involves cutting of different types of gear s on a milling machine. It is performed by using a form relieved cutter which is having the profile corresponding to the required tooth space of the gear.
- Equally spaced gear teeth are cut on a gear blank by holding the work on a universal dividing head and the n indexing it.



Gear cutting

Construction of Gear Milling

INDEXING METH ODS

There are different methods of indexing. Selection of indexing depends upon the number of divisions required and the type of dividing head used. The common methods of indexing are

- Direct or rapid indexing.
- Plain or simple indexing.
- Differential indexing.
- Compound indexing.
- Angular indexing.

Direct or Rapid Indexing

This method of indexing is used for indexing a large number of identical pieces by very small divisions. The operation is performed on plain dividing head and universal dividing head. When universal dividing head is used, the worm and worm gear are disengaged. Indexing is done with the help of direct index plate. This index plate is fitted to the front end of the spindle nose.

Plain or Simple Indexing

This method of indexing is used for divisions that could not be indexed by direct or rapid indexing. Simple indexing can be carried out by either a plain indexing head or a universal dividing head. This method of indexing involves e use of crank, worm, worm wheel and index plate.

Compound indexing

The method of compound indexing is used when the number of divisions required on the job is outside the rang e of simple indexing. The operation involves t he use of two separate simple indexing movements.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=Uc6b1g8SHV0

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-181-183

Manufacturing of cylindrical gears by generating cutting processes: A critical synthesis of analysis methods, CIRP Annals - Manufacturing Technology 57(2):676-696 · December 2008

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II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Hobbing

Introduction : (Maximum 5 sentences)

- The process of removing metal by feeding the work past against a rotating multipoint cutter
- Cutting of different types of gear
- Milling helical and spiral gear teeth
- Indexing or Dividing Heads

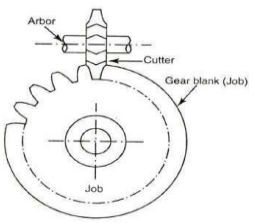
Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Mass production
- The process of dividing the periphery of a job.
- Work holding Devices
- Multipoint cutting tool.

Detailed content of the Lecture:

Gear Hobbing

- The gear Hobbing involves cutting of different types of gear s on a milling machine. It is performed by using a form relieved cutter which is having the profile corresponding to the required tooth space of the gear.
- Equally spaced gear teeth are cut on a gear blank by holding the work on a universal dividing head and the n indexing it.



Gear Hobbing

- Hobbing is a machining process for gear cutting, cutting splines, and cutting sprockets on a hobbing machine, which is a special type of milling machine.
- The teeth or splines of the gear are progressively cut into the material (a flat, cylindrical piece of metal) by a series of cuts made by a cutting tool called a hob.
- Compared to other gear forming processes it is relatively inexpensive but still quite accurate, thus it is used for a broad range of parts and quantities.
- It is the most widely used gear cutting process for creating spur and helical gears and more gears are cut by hobbing than any other process as it is relatively quick and inexpensive
- The hob is a cutting tool used to cut the teeth into the work piece. It is cylindrical in shape with helical cutting teeth. These teeth have grooves that run the length of the hob, which aid in cutting and chip removal.
- There are also special hobs designed for special gears such as the spline and sprocket gears.
- The cross-sectional shape of the hob teeth are almost the same shape as teeth of a rack gear that would be used with the finished product. There are slight changes to the shape for generating purposes, such as extending the hob's tooth length to create a clearance in the gear's roots.[8] Each hob tooth is relieved on the back side to reduce friction.
- Most hobs are single-thread hobs, but double-, and triple-thread hobs increase production rates. The downside is that they are not as accurate as single-thread hobs.
- Depending on type of gear teeth to be cut, there are custom made hobs and general purpose hobs. Custom made hobs are different from other hobs as they are suited to make gears with modified tooth profile.
- The tooth profile is modified to add strength and reduce size and gear noise

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=K785jfrsKQU

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-187-189

Machinability improvement of gear hobbing via process simulation and tool wear predictions X.

Dong, C. Liao, Y.C. Shin & H.H. Zhang ,The International Journal of Advanced Manufacturing

Technology volume 86, pages2771–2779(2016)

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LECTURE HANDOUTS

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II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Gear shaping processes

Introduction : (Maximum 5 sentences)

- Milling helical and spiral gear teeth
- The process of removing metal by feeding the work past against a rotating multipoint cutter
- Cutting of different types of gear

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

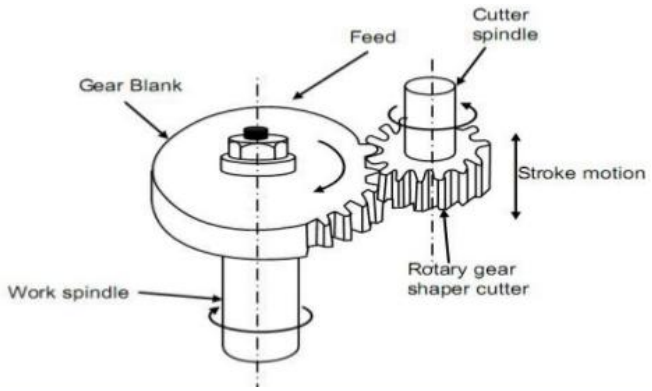
- Work holding Devices
- Mass production
- The process of dividing the periphery of a job.
- Multipoint cutting tool.

Detailed content of the Lecture:

Gear shaping is a flexible process to manufacture internal and even external gears. Especially, to manufacture internal gears or external parts with interfering contours, when gear hobbing is not possible. For these applications, gear shaping is the most chosen process.

- The types of cutters used for gear shaping can be grouped into four categories: disk, hub, shank, and helical cutters. The cutters are essentially gears that are used to form the teeth. This method of gear cutting is based on the principle that any two gears will mesh if they are of the same pitch, proper helix angle, and proper tooth depth and thickness.
- By using a gear-shaped corresponding cutter that is rotated (in relation to a blank gear) produces the gear teeth. The cutters that are rotated are timed with the workpiece. This process produces internal gears, external gears, and integral gear-pinion arrangements.
- The machine used for gear shaping generally consists of a base, column spindle, and an arbor. The gear cutter is mounted on the spindle, and the gear blank is mounted on the arbor.
- The cutter reciprocates up and down while the workpiece is gradually fed into the cutter. At the end of each cutting rotation, the spindle is retracted slightly to discourage any more cutting into the new cut teeth of the gear

- Gear shaping belongs to the generating process due to its continuous rotational movement during the operation. The workpiece and the tool form a pair of gears where the rotation speed of these partners is coupled by the number of teeth ratio. The gear profile is generated by the rolling action on the same pressure line.
- During the operation, a stroking motion of the tool is needed to ensure the cutting operation. This oscillating cutting movement (cutting stroke and return stroke) is realised by the simultaneous radial feed of the tool on the desired profile.
- During the return stroke, the tool is raised from the gear by a special raising system to prevent any scraping on the tooth flanks and to avoid significant tool damage.
- To reach the defined tooth height of the workpiece, the centre distance between the partners is adjusted continuously until the required geometry is reached.
- a wide range of shaper cutter geometries to the market,. Due to customer demands and the workpiece geometry, it is possible to use disc-type shaper cutters, shank-type shaper cutters, deep counterbore-type shaper cutters or internal hub-type shaper cutters.
- In close collaboration with our customers we choose the best fit combination out of geometry, cutting material and coating for the tool regarding its future application.



Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=hCAEG5xwMbQ

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-159-162

Advances in Gear Manufacturing, Kapil Gupta, ... Rudolph Laubscher, in Advanced Gear

,Manufacturing and Finishing, 2017

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LECTURE HANDOUTS

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RA

II / IV

Course Name with Code : 19RAC03 Manufacturing Technology

Course Faculty :

Unit : III - Shaper, Milling and Gear Cutting Machines Date of Lecture:

Topic of Lecture: Finishing of gears

Introduction : (Maximum 5 sentences)

- The surface finish and dimensional accuracy
- Improve surface finish of already made teeth
- Cutting of different types of gear

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Surface of gear teeth
- Finishing operations
- Multipoint cutting tool.

Detailed content of the Lecture:

Finishing of gears

- the surface finish and dimensional accuracy may not be accurate enough for certain applications. Several finishing operations are available, including the conventional process of shaving, and a number of abrasive operations, including grinding, honing, and lapping
- Surface of gear teeth produced by any of the generating process is not accurate and of good quality (smooth). Dimensional inaccuracies and rough surface generated so become the source of lot of noise, excessive wear, play and backlash between the pair of gears in mesh. These all result in loss of power to be transmitted and incorrect velocity ratios. This can be summarized as inefficient power transmission.
- In order to over come these problems some finishing operations are recommended for the produced gears. Sometimes poor quality of finish and dimensional inaccuracies occur due to hardening of a produced gear.
- The prepared (generated) gear is subjected to various hardening processes leading to various problems creating inaccuracies. So finishing operations are to be done at last

Gear shaving

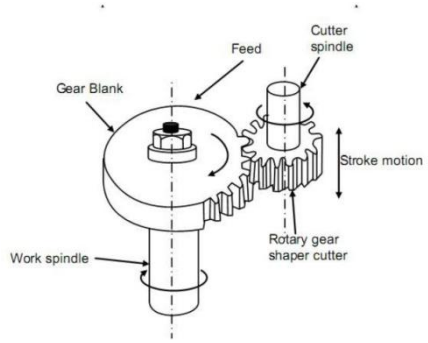
- Gear shaving is a process of finishing of gear tooth by running it at very high rpm in mesh with a gear shaving tool. A gear shaving tool is of a type of rack or pinion having hardened teeth provided with serrations.
- These serrations serve as cutting edges which do a scrapping operation on the mating faces of gear to be finished. Both are gears in mesh are pressed to make proper mating contact

Gear Grinding

- In this operation abrasive grinding wheel of a particular shapeand geometry are used for finishing of gear teeth. Gear to be finished is mounted and reciprocated under the grinding wheel. Each of the gear teeth is subjected to grinding operations this way.

Lapping of a Gear

- The process of lapping is used to improve surface finish of already made teeth. In this process the gear to be lapped is run under load in mesh with cast iron toothed laps. Abrasive paste is introduced between theteeth.
- It is mixed with oil and made to flow through the teeth. One of the mating members(either gear or lapping tool) is reciprocated axially along with the revaluations.



Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=z5E_nxEBxdE

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-159-162

Improving spur gear microgeometry and surface finish by AFF process, Journal Materials and Manufacturing Processes Volume 33, 2018 - Issue 9

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II / IV

Course Name with Code : **19RAC03 Manufacturing**

Course Faculty **Technology :**

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Abrasive processes

Introduction : (Maximum 5 sentences)

- Material removal by the action of hard, abrasive particles usually in a form of a bonded wheel. Grinding is the most important abrasive machining.
- Other abrasive processes: honing, lapping, super finishing, polishing, and buffing. – Can be used on all types of materials.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Mechanics of abrasive machining
- Abrasive machining processes
- Abrasives

Detailed content of the Lecture:

- Abrasive machining is a machining process where material is removed from a workpiece using a multitude of small abrasive particles.
- Common examples include grinding, honing, and polishing. Abrasive processes are usually expensive, but capable of tighter tolerances and better surface finish than other machining processes.
- Abrasive machining works by forcing the abrasive particles, or grains, into the surface of the workpiece so that each particle cuts away a small bit of material. Abrasive machining is similar to conventional machining, such as milling or turning, because each of the abrasive particles acts like a miniature cutting tool.
- However, unlike conventional machining the grains are much smaller than a cutting tool, and the geometry and orientation of individual grains are not well defined. As a result, abrasive machining is less power efficient and generates more heat.

- The grain size may be different based on the machining. For rough grinding, coarse abrasives are used. For fine grinding, fine grains (abrasives) are used.
- Abrasive machining processes can be divided into two categories based on how the grains are applied to the workpiece.
- In bonded abrasive processes, the particles are held together within a matrix, and their combined shape determines the geometry of the finished workpiece. For example, in grinding the particles are bonded together in a wheel. As the grinding wheel is fed into the part, its shape is transferred onto the workpiece.
- In loose abrasive processes, there is no structure connecting the grains. They may be applied without lubrication as dry powder, or they may be mixed with a lubricant to form a slurry. Since the grains can move independently, they must be forced into the workpiece with another object like a polishing cloth or a lapping plate.Common abrasive processes are listed below.

Fixed (bonded) abrasive processes

- Grinding, Honing, superfinishing
- Tape finishing, abrasive belt machining
- Abrasive sawing, Diamond wire cutting, Wire saw
- Sanding

Loose abrasive processes

- Polishing , Lapping, Abrasive flow machining (AFM)
- Hydro-erosive grinding
- Water-jet cutting, Abrasive blasting

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=5aTm1EOQhDo

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-597-600
International Journal of Abrasive Technology, 2019 Vol.9 No.3, 171-255

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Grinding wheel, specifications and selection

Introduction : (Maximum 5 sentences)

- Grinding wheel is a wheel composed of an abrasive compound and used for various grinding (abrasive cutting) and abrasive machining operations. Such wheels are used in grinding machines.
- The wheels are generally made from a composite material consisting of coarse-particle aggregate pressed and bonded together by a cementing matrix (called the bond in grinding wheel terminology) to form a solid, circular shape.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Grain size
- Wheel grade
- Grain spacing
- Wheel bond

Detailed content of the Lecture:

- Grinding wheels are made up of small abrasive particles held together by bonding material. Thus, it forms a multi-edge cutter. Abrasive is a hard material.
- It can be used to cut or wear away other materials. Small abrasive particles are used in grinding wheels

They are called abrasive grains. Abrasives may be classified into two types.

(i) Natural abrasives

(ii) Artificial abrasives.

Natural abrasives

- These are produced by uncontrolled forces of nature. These are obtained from mines. The following are the natural abrasives.
    - Sandstone or solid quartz.
    - Emery (50 to 60% crystalline Al203 + Iron oxide).
    - Corundum (75 to 90% crystalline Al203 + Iron oxide)
    - d) Diamond.

Artificial abrasives

- These are manufactured under controlled conditions in closed electric furnace in order to avoid the introduction of impurities and to achieve necessary temperature for the chemical reaction to take place.

Selection of Grinding Wheel

- Selection of a proper grinding wheel is very important for getting the best results in grinding work. A wheel may be required to perform various functions like quick removal of stock material, give a high-class surface finish and maintain close dimensional tolerances.
- A single wheel will fai1to meet all requirements. It is necessary. Therefore, that proper gram Size, bond, grade, strength, shape and size of the wheel should be selected to meet the specific requirements. The factors upon which the above selection will depend the following factors: Constant factors, Variable factors

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=ggMi0Ym6fnM

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-596

International Journal of Engineering and Technology, 2 (2) (2013) 126-133

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Types of grinding process

Introduction : (Maximum 5 sentences)

- Grinding machines fall into five categories: surface grinders, cylindrical grinders, centerless grinders, internal grinders and specials.
- Surface grinding, Cylindrical grinding, Centerless grinding, Intemal grinding, Special grinding, processes, Creep-feed grinding, Grinding wheel wear, Coded abrasives.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Grinding operation
- Grinding wheel
- Specifications

Detailed content of the Lecture:

The grinding machines may be classified according to the

1. Type of operation.

   Tool Grinders, Cut off grinders.

2. Quality of surface finish.

   Precision grinders, Rough grinders.

3. Type of surface generated.

   Cylindrical grinders, Internal grinders, Surface grinders, Tool grinders, Special purpose grinding machines, Surface finishing grinders

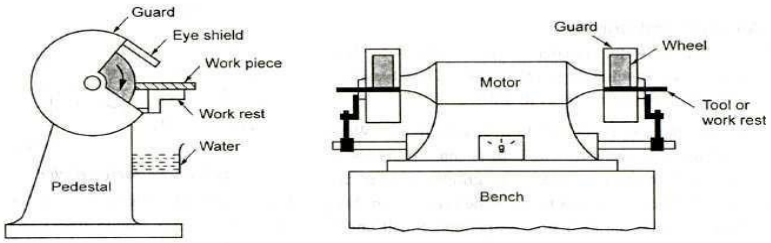
Grinding machines can probably be best classified according to the type of surfaces they are used to produce. i.e. Rough and precision grinders. They are further classified as follows.

- Rough grinders.
- Precision grinders.

- Rough grinders are mainly used for removing large amount of metal from the work piece. Therefore, the surface finish and the accuracy in dimension are not high.
- Rough grinding is used for removing projections like sprue pins from castings, grinding the projections in the forgings, finishing the weldments, sharpening of hand tool etc.
- Precision grinders are used to manufacture parts of accurate dimensions and good surface finish. The work piece and the grinding wheel are mounted rigidly but they are adjustable according to the requirement of the machining methods.
- Precision grinding is applied for grinding cylinder bores, gauges, tools, cutters, machine guide ways, threads, cylindrical pins, gears, cams etc. Normally, these parts are heat treated for improving hardness.

Floor Stand Grinder

- It is mounted on a base and consists of a horizontal spindle with grinding wheels mounted at each end of the motor shaft extensions. It is also known as pedestal grinder.
- The work is normally held by the operator in hand and pressed against the wheel to remove the material. The driving motor is placed inside the pedestal. The motor is connected to the spindle by belts. It has a guard with an eye shield for safety purpose.
- A work rest is provided for supporting the work piece while grinding. This type of grinder is used for rough grinding of tools and other small parts. It is similar to a floor grinder except for the size. It is mounted on a bench. It has two wheels and guards similar to pedestal grinder.



Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=uqBTmj5vupI

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-598-600

International Journal of Engineering Technology, Management and Applied Sciences, Volume 4, Issue 9,

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Cylindrical grinding, surface grinding

Introduction : (Maximum 5 sentences)

- Cylindrical grinder is a type of grinding machine used to shape the outside of an object. The cylindrical grinder can work on a variety of shapes, however the object must have a central axis of rotation.
- This includes but is not limited to such shapes as a cylinder, an ellipse, a cam, or a crankshaft.
- Surface grinding is used to produce a smooth finish on flat surfaces.
- It is a widely used abrasive machining process in which a spinning wheel covered in rough particles (grinding wheel) cuts chips of metallic or nonmetallic substance from a workpiece, making a face of it flat or smooth.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Grinding wheel
- Workpiece Properties
- Machining criteria

Detailed content of the Lecture:

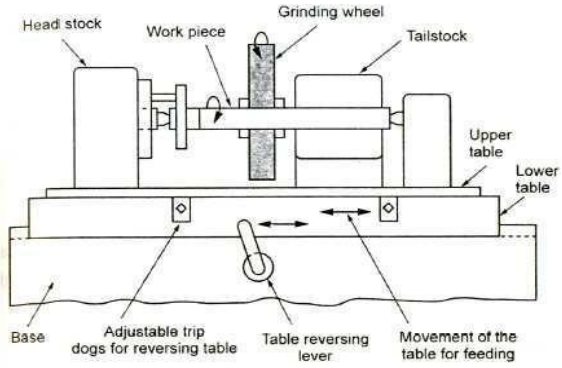
There are four movements in a cylindrical centre type grinding.

- Rotation of cylindrical work piece about its axis.
- Rotation of the grinding wheel about its axis.
- Longitudinal feed movement of the work past the wheel face.

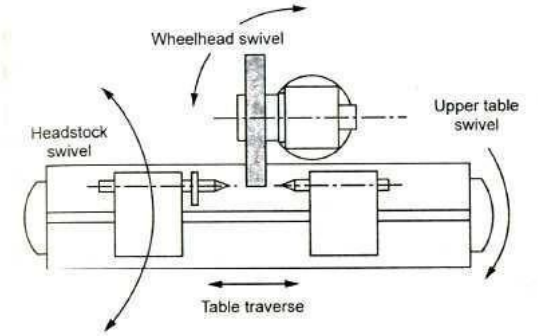
Movement of wheel into the work perpendicular to the axis of the work piece to give depth of cut.

- Types of operations in cylindrical grinding
  - Traverse grinding.
  - Plunge grinding.

Plain centre type cylindrical grinding machine:



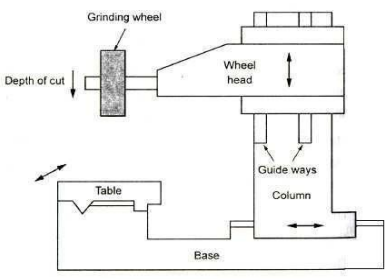
Universal grinder



- The work piece is held between centres. It is rotated by a dog or faceplate. The grinding wheel also rotates about its own axis in the opposite direction of work.
- The grinding wheel is fed by hand or automatically towards the work piece for successive cuts. In most of the cases, the work speed is selected between 20 and 30 surface speed meters per minute (s.m.p.m.).
- Wheel speed is usually selected between 1500 and 2000 s.m. p.m. The depth of cut at each reversal is from 0.025mm to 0.125mm for rough grinding. For finishing, it should be from 0.0125mm to 0.0625mm.

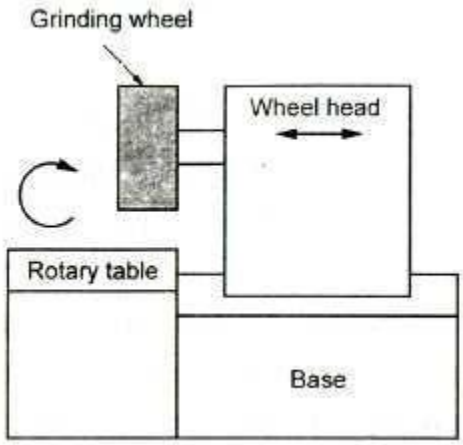
SURFACE GRINDERS

- Surface grinding machines are used to produce and finish flat and plane surfaces. By using special fixtures and form dressing devices angular and formed surfaces can also be ground.
- The various machine parts such as machine guide ways, piston rings, valves, dies, surface plates etc are finished by surface grinding.



- The work piece is clamped on the table. The trip dogs are adjusted suitably to get the correct stroke length of the table.
- The work piece reciprocates under the table. The periphery of the grinding wheel does the grinding. Cross feed is given to the work piece after every stroke.
- Depth of cut is given by lowering the wheel head. For rough grinding of work piece, the depth of cut may be from 0.02mm to 0.06mm. For finishing operation, the depth of cut may be From0.005mm to 0.0lmm.

Horizontal Spindle Rotary Table Surface Grinder



- In horizontal spindle rotary table surface grinders, the work pieces are mounted on magnetic chucks or on fixtures rotating slowly under the rotating grinding wheel in its horizontal axis.
- The circular table rotates at specific speed and the wheel can feed axially (cross-feed). The wheel head is lowered to give the required depth of cut. The periphery of the grinding wheel takes the cut. This machine is used for small and medium size works.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=GIZubRz706U
https://www.youtube.com/watch?v=npybvhWYklc

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-413-417

International Journal of Advance Engineering and Research Development, Volume 5, Issue 01, January -2018

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Centreless grinding and internal grinding

Introduction : (Maximum 5 sentences)

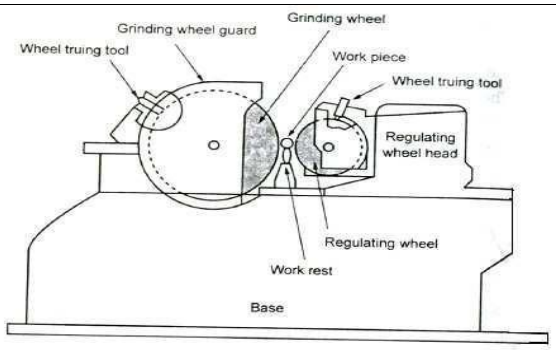
- Centreless Grinding. It is a high production process for continuously grinding cylindrical surfaces in which the workpiece is supported not by centres or chucks, but by a blade.
- Parts with the diameter as small as 0.1mm can be ground by this method
- Internal grinding refers to the grinding of bores or holes and probably one of the most difficult type of grinding.
- Requirements of internal grinding range from very rapid removal of stock to processes capable of generating size and concentricity measured in millionths of inchs.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Cylindrical surfaces
- size and concentricity
- Process Principle

Detailed content of the Lecture:

- Centreless grinding is performed on work pieces which do not have centres, such as pistons, valves, rings, tubes, balls, wrist pins, drills, bushings, shafts etc.
- Centreless grinding can be done on both external and internal cylindrical surfaces. The principle of external Centreless Grinding is shown in fig.
- The grinder has two wheels, a larger grinding wheel revolving at a high speed and a small regulating wheel revolving at a slow speed.



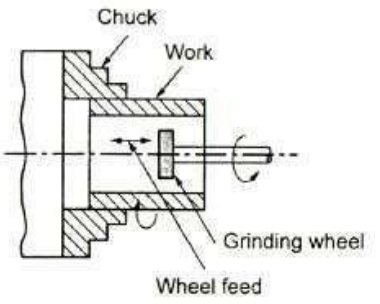
Centreless Grinding

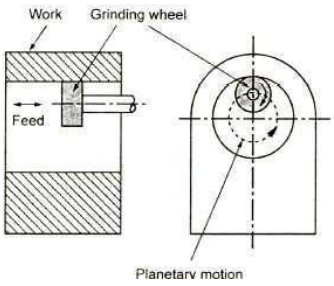
- The work is placed on the Work rest. The regulating wheel is fed forward forcing the work against grinding wheel. So, the work on work rest is pressed against the grinding wheel surface.
- By friction, the regulating wheel makes the work piece to rotate. The rotating work piece is pressed between two wheels. Work piece is placed in a floating condition between the grinding wheel and regulating wheel. So, it is called as Centreless grinding.

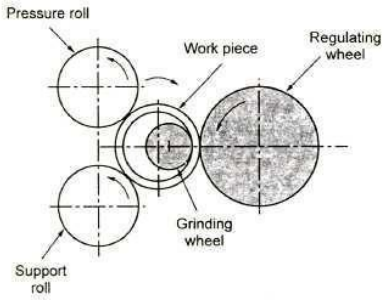
Internal grinders

- Internal grinders are used to finish straight, tapered or formed holes to the correct size, shape and finish. There are three types of internal grinders:
  (a) Chucking type.
  (b) Planetary type.
  (c) Centreless type.

Chucking type Planetary type Centreless type.







- In Chucking type, the work piece is chucked and rotated about its axis. The Work head is mounted at the left side of the machine.
- The wheel head is mounted at the right end of the machine. The grinding wheel is rotated.
- At the same time, it reciprocates back and forth through the length of the hole as shown in fig.
- These machines are used for grinding work piece which can be easily held in a chuck.

- In Planetary type, the work remains stationary and the rotation of wheel spindle gives an eccentric motion according to the diameter of the hole to be ground.
- Such type of operation is used where the work is difficult to be rotated. Therefore, in this operation, the motion of the grinding wheel is in the form of planet and hence, it is called planetary grinding.
- The external centreless grinding principle is also applied to internal grinding. In internal centreless grinding, the work is supported by three rolls.
- One is the regulating wheel, the second one is a supporting roll and the last one is pressure roll to hold the work piece against the support and regulating rolls. T
- The regularity roll is a rubber bonded wheel. This roll makes the work piece to rotate.The grinding wheel contact inside diameter of the work piece directly and reciprocates about its axis for giving the feed.
- The depth of cut is given by moving the grinding wheel in a crosswise direction. The pressure roll is mounted to swing aside to permit loading and unloading.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=NAa6xkK93V0
https://www.youtube.com/watch?v=1Z_NAIGXE8k

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-164-165

International Journal of Machine Tool Design and Research, Volume 6, Issue 2, June 1966, Pages 47-101

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LECTURE HANDOUTS

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RA

II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Typical applications, concepts of surface integrity

Introduction : (Maximum 5 sentences)

- Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. A wide variety of machines are used for grinding: Hand-cranked knife-sharpening stones
- Surface integrity is the surface condition of a workpiece after being modified by a manufacturing process. The term was coined by Michael Field and John F. Kahles in 1964. The surface integrity of a workpiece or item changes the material's properties.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

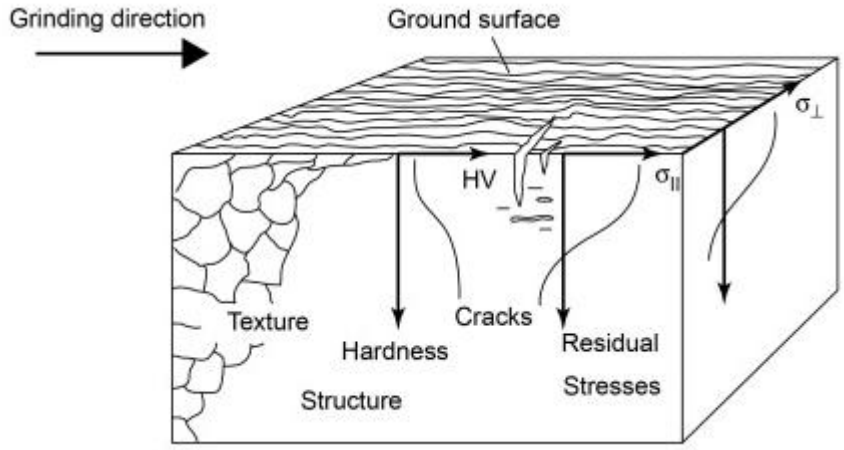
- Abrasive Machining Process
- Grinding Wheel
- Surface condition

Detailed content of the Lecture:

- Surface integrity covers the interior effects of a machining process. This includes the outermost layers whose properties differ measurably from those of the base material.
- Figure shows a principal machined surface and subsurface, and their schematic physical and technological properties: mainly the properties of machined surfaces.
- The American Standard for Surface Integrity classifies the surface alterations by the principal modes that produce them:
    - Mechanical,
    - Metallurgical,
    - Chemical,
    - Thermal, And
    - Electrical.
- This functional classification after the topics cannot differentiate between cause and effect of

the surface integrity.

- Surface integrity' is defined as the properties of a part that are influenced by physical and chemical effects of the machining process.
- Regardless of whether they are physically or chemically effected, geometrical properties are also included. Material deficits such as pores, cracks, material excesses, or residual stress-induced deflections could be such geometric properties.
- The physical properties of the surface layer can be divided into fundamental groups of physics. The function of a component is influenced geometrically by cracks and flaws, physically by mechanical stresses, and by the structure of the material.
- The subsurface structure is based on chemical effects which cause the physical properties of a material and is characterized by grain size, grain boundary, texture, dislocations, or hardness.
- Normally, this can be analyzed by using metallurgy or ceramography. Strictly, the hardness depends on the measuring method and is more a technological than a physical property.



Video Content / Details of website for further learning (if any):

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-320-322

Journal of Manufacturing and Materials Processing . 2019, 3(3), 79

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Broaching machines: Broach construction

Introduction : (Maximum 5 sentences)

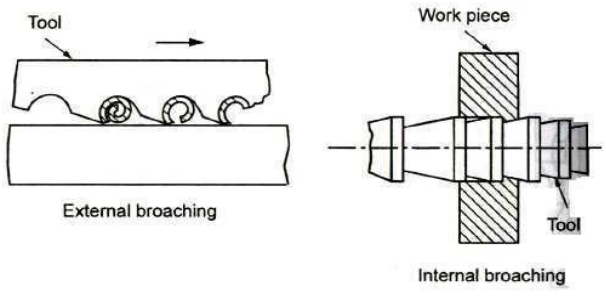
- The broaching process, similar to shaping with multiple teeth, is used to machine internal and external surfaces such as holes of circular, square, or irregular shapes, keyways and teeth of internal gears.
- A broach is a long multi-tooth cutting tool with successively deeper cuts

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Broaching Process
- Broaching Tool
- Multi-Tooth Cutting Tool

Detailed content of the Lecture:

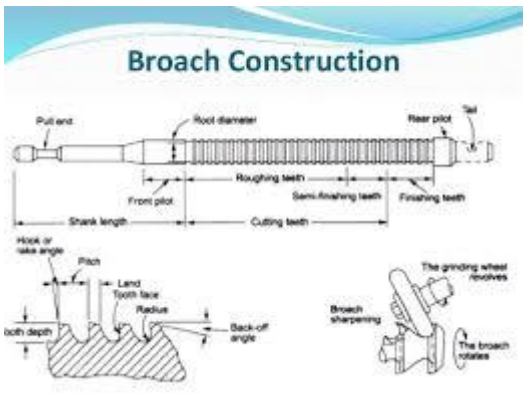
- Broaching is a process of machining a surface with a specified multipoint cutting tool called 'broach' which h as successively cutting edges in a fixed path . Each tooth removes a predetermined amount of material.
- The job is completed in one st roke of the The last tooth of the cutting tool is conforming to the desired the finished surface. It is a faster and cheaper method of macho.
- The depth of removed material is limited to 6mm or less. External and internal surface can be machined by broaching.



SPECIFICATION

Main specifications of a broaching machine are:

1. Maximum length o f stroke in mm.
2. Maximum force developed by the slide in Tonnes.



- The broach is composed of a series of teeth; each tooth is s slightly higher than the previous one. This rise per tooth is the feed.
- Roughing teeth-These teeth have the highest rise per tooth and remove bulk of the material.
- Semi-finishing teeth: These teeth have slightly smaller rise per tooth than the previous one. Hence, they remove relatively smaller amount of material when compared to the roughing teeth.
- Finishing teeth: The last set of teeth is called finishing or sizing teeth. Very little material is removed by these teeth. The necessary size is achieved by these teeth and hence, all the teeth are of the same size as that required finally.
- Rack or hook or face angle-This is ground back on the face. Its value depends upon the material to be cut. In general, it will increase as the ductility increases. This angle may vary from 12° to 15°.

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=mP42uU3K9KM

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-167-170

International Journal of Engineering Research, Vol.6., Issue.3, 2018

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LECTURE HANDOUTS

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Push, Pull Broaching

Introduction : (Maximum 5 sentences)

- Push type broaches are subjected to compressive load and hence are made shorter in length to avoid buckling.
- The general configuration of pull type broaches, which are widely used for enlarging and finishing preformed holes
- Pull Broaching Work piece is clamped to the broaching machine in stationary position and the broach is pulled through the work.
- Broaches are usually long and are held in a special head Pull broaching is mostly used for internal broaching.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Broaching machine principle
- Types of Broaches
- Tool and Work material Properties

Detailed content of the Lecture:

Broaching process

• on a press – the tool is pushed

• on a broaching machine – the tool is pulled

• Using special machine – stationary broach

- Pull Broaching Work piece is clamped to the broaching machine in stationary position and the broach is pulled through the work. Broaches are usually long and are held in a special head Pull broaching is mostly used for internal broaching.
- The broaching process, similar to shaping with multiple teeth, is used to machine internal and external surfaces such as holes of circular, square, or irregular shapes, keyways and teeth of

internal gears. A broach is a long multi-tooth cutting tool with successively deeper cuts.

- One is performed inside the surface and other is performed outside the surface. Internal broaching makes use of hole while external broaching is at outside the hole.

Push Type Broaching

- Push broach must be relatively short since it is a column in compression and will buckle and break under too heavy a load. Push broaches are often used with a simple arbor press if quantities of work are low. For medium- to high-volume production they are used in broaching machines.

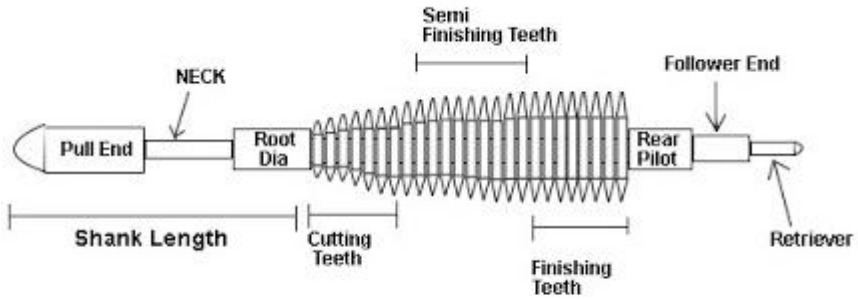
Vertical Pull Type Broaching Machine

• This type of machine are available for both pull up and pull down type of machine. • This machine is only used for internal broaching or hole broaching.

• In this machine we can mount more than one broach.

• In the pull down type the workpiece is mounted on table and the broach is lowered to pass its front pilot through the workpiece.

• In the pull up type, the only difference is that the ram is provided at the top which will carry the broach from bottom to top.



PULL TYPE BROACHING MACHINE

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=QaQ5LqFaVGU
https://www.youtube.com/watch?v=cdY0PN3Opxw

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-170-171

Strojniški vestnik - **Journal** of Mechanical Engineering 63(2017)7-8, 466-475.

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **IV - Abrasive Process and Broaching** **Date of Lecture:**

Topic of Lecture: Surface and continuous broaching machines

Introduction : (Maximum 5 sentences)

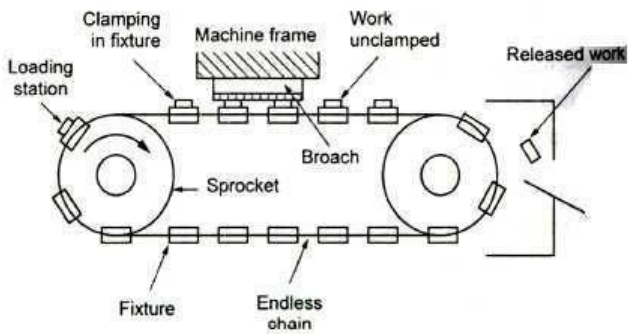
- Surface broaching is a generic term used in the broaching industry to refer to broaching any external surface or surfaces of a piece part. The converse of surface broaching is internal broaching. Surface broaching takes on many forms, and can employ several different types of machines.
- Surface broaching is fast, and typically more efficient than milling. Multiple dimensions can be cut simultaneously, and in complex configurations. In its simplest form, surface broaching can be used to cut slots and flats quickly and accurately.
- In continuous broaching the work is moved continuously and the broach is held stationary. The movement of work may be either straight horizontal or circular. The continuous broaching method is mostly used for broaching a number of similar works at the same time.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Broaching principle
- Types of Operations
- Work and tool materials properties

Detailed content of the Lecture:

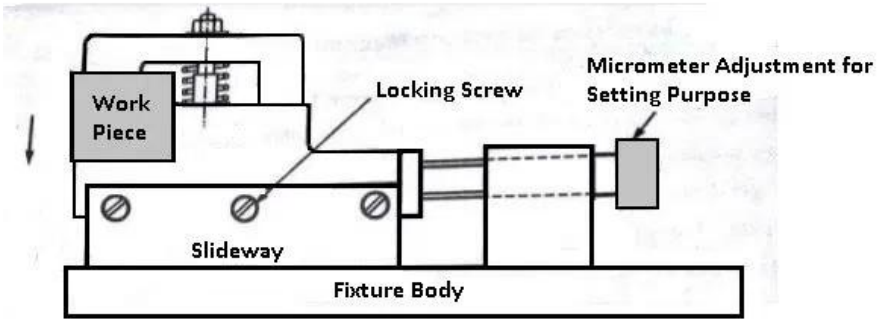
CONTINUOUS BROACHING MACHINE



- This is one type of surface broaching machine. The broaching machine has a driving unit which consists of two sprockets. They are connected by an endless chain. Fixtures are mounted at intervals on the chain for locating and holding work pieces.
- The broach tool is fixed horizontally in the frame of the machine. The rigid guiding member is arranged under the chain in the zone where the work pieces pass under the broach. When the fixture passes the loading station, the operator will drop the part in the fixture.
- The work is automatically clamped before it reaches the tunnel. The bro aching lakes place when work pieces will move under the broach. The work pieces are then automatically released by a cam. At the Unloading point, the work piece falls out the fixture.
- Continuous Broaching machine increases the productivity and hen ce, it is used for Mass production

Surface Broaching Machine

- In this machine either workpiece or broach moves across each other. • This machines are generally vertical and hydraulically operated.
- This machine is an alternative to milling machine so machine fixtures are also used to hold the workpiece.
- These machines are used for large quantities of workpiece having flat surfaces.



SURFACE BROCHING MACHINE

Video Content / Details of website for further learning (if any):
https://www.youtube.com/watch?v=il-HKMnLsyY
https://www.youtube.com/watch?v=5APSB-1l8H8

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007 Pg-171-172

Procedia CIRP, Volume 13, 2014, Pages 114-119

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LECTURE HANDOUTS

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **V - CNC Machining** **Date of Lecture:**

Topic of Lecture: Numerical Control (NC) machine tools

Introduction : (Maximum 5 sentences)

The major advantages of NC over conventional methods of machine control are as follows:

- Higher precision
- Machining of complex three-dimensional shapes
- Better quality
- Higher productivity
- Multi-operational machining
- Low operator qualification

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

- Machining.
- Machine tool
- Material Properties

Detailed content of the Lecture:

Numerical Control (NC) refers to the method of controlling the manufacturing operation by means of directly inserted coded numerical instructions into the machine tool. It is important to realize that NC is not a machining method, rather, it is a concept of machine control. Although the most popular applications of NC are in machining, NC can be applied to many other operations, including welding, sheet metalworking, riveting, etc.

Types of NC systems

Machine controls are divided into three groups,

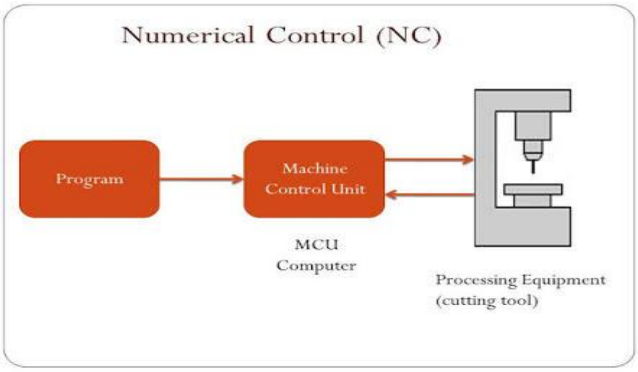
Traditional numerical control (NC);

Computer numerical control (CNC);

Distributed numerical control (DNC).

The original numerical control machines were referred to as NC machine tool. They have "hardwired" control, whereby control is accomplished through the use of punched paper (or plastic) tapes or cards. Tapes tend to wear, and become dirty, thus causing misreadings. Many other problems arise from the use of NC tapes, for example the need to manual reload the NC tapes for each new part and the lack of program editing abilities, which increases the lead time. The end of NC tapes was the result of two competing developments, CNC and DNC. Some important definitions are being described here which determine the quality of a generated surfaces. The surface parameters described here are not only responsible for aesthetic point of view but also their correctness and accuracy influence performance of the object correctly.

Controlled axes



Integrate machine tool with digital computer

- Compute Complex Cutter Paths
- Accurately Control Axes Motors

Position feedback

- Closed – Servo Motors & Position Sensors
- Open – Stepper Motors

Limited capability

- Programmed Moves
- Little Intelligence

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=1Q3iHfX75K4&list=PLD50A0FB75B98EDA3

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-441-447

Importance of Surface Preparation for Corrosion Protection of Automobiles in Journal of Surface Engineered Materials and Advanced Technology 03(01):94-105 · January 2013

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty : **V - CNC Machining**

Unit **Date of Lecture:**

Topic of Lecture: CNC types

Introduction : (Maximum 5 sentences)

- the automation of machine tools that are operated by precisely programmed commands
- CNC machining controls a range of complex machinery, such as grinders, lathes, and turning mills, all of which are used to cut, shape, and create different parts and prototypes

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

- G Codes
- M Codes

Detailed content of the Lecture:

CNC machining is the use of Computer numerically controlled machines to manufacture parts. A variety of materials can be CNC machined including metal, plastics, glass, foam, composites, and wood. Compared with machining without CNC programmable functions, CNC machining has many advantages, such as reduced machining time, smoothness of the machined surface, and multi-tasking. Therefore, CNC machining parts are the most demanded components in many industries, such as medical, aerospace, industrial, oil and gas, hydraulics, guns, and other industrial applications.

CNC Lathe Machine

CNC refers to the use of computer computing and control of the operation of the machine, through the calculation of programming to determine the direction and amplitude of the machine, most of the programming language used is G code, which can complete the lathe process quickly and accurately.

CNC Milling Machine

The CNC milling machine calculates the programming by G code only through the calculation, and can control the process operation of the milling machine through the XYZ three-axis. CNC milling machines can also be easily divided into vertical milling machines or horizontal milling machines.

CNC Plasma Cutting Machine

CNC uses ceramic torches to cut materials and is often used to cut steel and other metals. In this process, a gas (such as compressed air) is ejected from the nozzle at a high speed, and an electric arc is simultaneously generated from the nozzle to the surface to be cut, and some gases are converted into plasma. The plasma is hot enough to melt the material being cut and moves fast enough to blow away the molten metal from the slit.

The plasma cutting process involves cutting the material with plasma burning, the laser cutting machine directs the high power laser through the optics, and focuses the output beam to cut the material. A typical commercial laser cutting machine will operate through a CNC (computer numerical control) system. Three main types of laser cutting machines are commonly used: gas lasers, solid state lasers, and plasma cutters.

CNC Discharge Machine

Electrical Discharge Machining, or simply EDM, involves the use of electrical discharge or activation to create a particular shape within a particular material. The material is discharged from a particular workpiece by repeating the electrical release process between the two anodes. These anodes are isolated by a dielectric liquid that periodically receives a voltage.

In other words, EDM is a method of cutting holes, pockets and other shapes into hardened steel and imparting a surface texture to the internal cavity of the mold. The sacrificial electrode in the electrolyte bath releases a high power spark to erode very hard materials. This method is usually used to create square holes. With a wire EDM machine, a wire can be fed continuously between two spools. After charging, it cuts through hardened tool steel quickly and accurately.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=2GjIIhDE330

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-441-447

Surface properties, thermal, and mechanical characteristics of poly(vinyl alcohol)–starch-bacterial cellulose composite films, Volume135, Issue6,February 10, 2018

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty

Unit : **V - CNC MACHINING** **Date of Lecture:**

Topic of Lecture: CNC constructional details

Introduction : (Maximum 5 sentences)

- The cutting operations performed by the CNC is called CNC machining.
- The Various machining services in which CNC machine is used are known as CNC machining services.
- In CNC machine shops, programs are designed or prepared first, and then it is fed to the CNC machine. According to the program, the CNC controls the motion and speed of the machine tools.

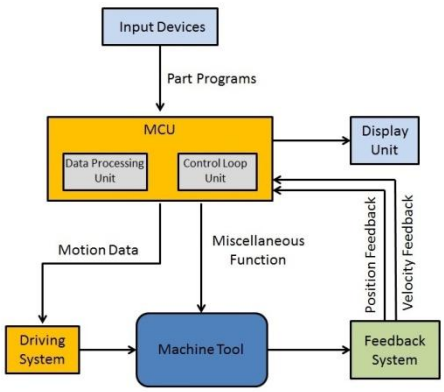
Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

- Components of conventional Machines
- Working Principles

Detailed content of the Lecture:

Block Diagram of CNC Machine



Main Parts of CNC Machine

(i) Input Devices: These are the devices which are used to input the part program in the CNC machine. There are three commonly used input devices and these are punch tape reader,

magnetic tape reader and computer

(ii) Machine Control Unit (MCU): It is the heart of the CNC machine. It performs all the controlling action of the CNC machine, the various functions performed by the MCU are

- It reads the coded instructions fed into it.
- It decodes the coded instruction.
- It implements interpolation (linear, circular and helical) to generate axis motion commands.
- It feeds the axis motion commands to the amplifier circuits for driving the axis mechanisms.
- It receives the feedback signals of position and speed for each drive axis.
- It implements the auxiliary control functions such as coolant or spindle on/off and tool change.

(iii) Machine Tool: A CNC machine tool always has a slide table and a spindle to control of the position and speed. The machine table is controlled in X and Y axis direction and the spindle is controlled in the Z axis direction.

(iv) Driving System: The driving system of a CNC machine consists of amplifier circuits, drive motors and ball lead screw. The MCU feeds the signals (i.e. of position and speed) of each axis to the amplifier circuits. The control signals are than augmented (increased) to actuate the drive motors. And the actuated drive motors rotate the ball lead screw to position the machine table.3

(v) Feedback System: This system consists of transducers that act as sensors. It is also called a measuring system. It contains position and speed transducers that continuously monitor the position and speed of the cutting tool located at any instant. The MCU receives the signals from these transducers and it uses the difference between the reference signals and feedback signals to generate the control signals for correcting the position and speed errors.

(vi) Display Unit: A monitor is used to display the programs, commands and other useful data of CNC machine.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=xknQuL01ouQ

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-445-447

Experimental analysis of Improvement of surface finishing using magnetic abrasive finishing, International Journal of Technical Research (IJTR) Vol. 6, Issue 1, Mar-Apr2017

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology**

Course Faculty :

Unit : **V - CNC Machining** **Date of Lecture:**

Topic of Lecture: CNC special featuresn

Introduction : (Maximum 5 sentences)

- Super finishing is an alternative process similar to honing.
- roughness better the surface finish
- abrasive stick moved with a reciprocating motion and pressed against the surface

Prerequisite knowledge for Complete understanding and learning of Topic:

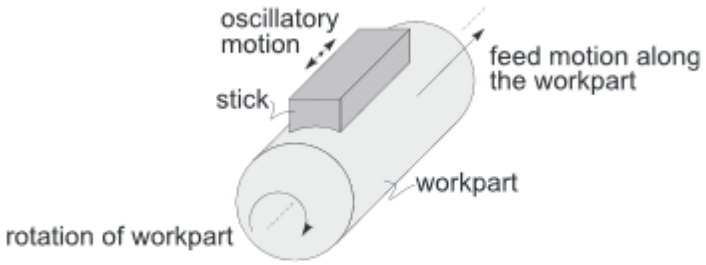
(Max. Four important topics)

- Surface roughness of the work piece.
- Surface finishing.
- Production clearance.

Detailed content of the Lecture:

Super finishing is an alternative process similar to honing. This also uses bonded abrasive stick moved with a reciprocating motion and pressed against the surface to be finished. The relative motion between the abrasive stick and the workpiece is varied so that individual grains do not retrace the same path.

Cutting fluid is used in the process for cooling of tool workpiece interface. Coolant also washes awaythe tiny chips produced in the process. The time needed for super finishing is very small. Work piece may be super finished to a roughness of the order of 0.075 µm within 50 seconds.



Schematics of the superfinishig process.

Sometimes the process of super finishing can be continuedupto 3 minutes for very fine quality of finish. Super finishing can be differentiatedfrom honing in the following ways

(a) Super finishing stroke length is comparatively shorter but frequencyis larger. It is upto 1500 stokes/minute.

(b) It requires low pressure application as compared to honing process.

(c) During the process fed is given to workpiece, the fed rate in case of super finishing operation is smaller than honing.

(d) Grit size of abrasive used in case of super finishing is smaller thanthat is used with hones.

Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=i2RlTd41EP0

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-449

Study on Advanced Super Finishing Processes, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334XPP. 13-19

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty : **V - CNC Machining**

Unit **Date of Lecture:**

Topic of Lecture: Micromachining

Introduction : (Maximum 5 sentences)

- Trend of miniaturization of products and consequently its components nowadays can be Evident in almost every production field.
- The trend of micro-miniaturization of the products and its parts has already become forceful in industry,

Prerequisite knowledge for Complete understanding and learning of Topic:

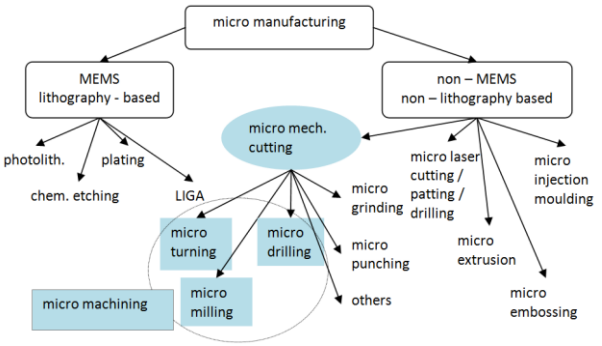
(Max. Four important topics)

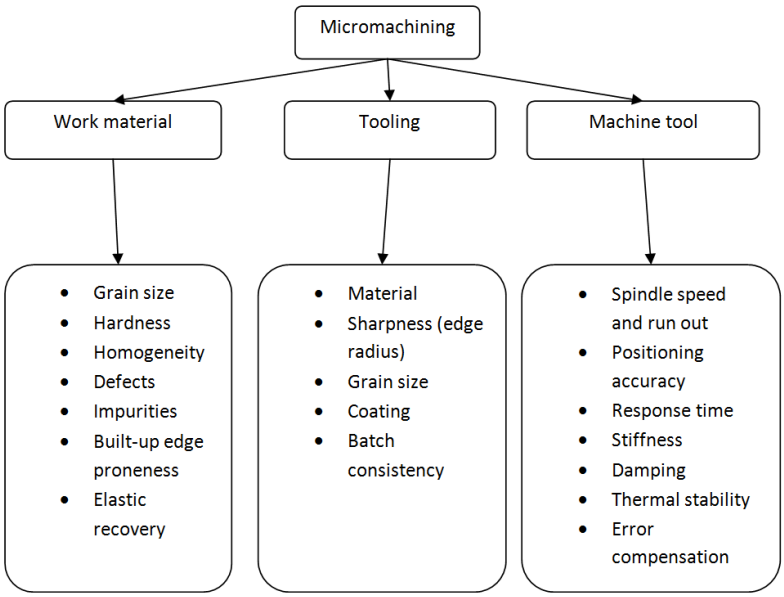
- Material Properties
- volume production

Detailed content of the Lecture:

The trend of micro-miniaturization of the products and its parts has already become forceful in industry, especially in field of micro electromechanical system (MEMS) or micro system technology (MST).

- In MEMS manufacturing techniques such as photolithography ,chemical-etching, plating and LIGA are used,
- They are very well known in semiconductors or micro electric manufacturing and used for large volume production, mainly sensors and actuators made of silicon or limited range of metals. Micromachining refers to mechanical micro cutting using geometrically determined cutting edge(s) (micro turning, micro milling and micro drilling, etc.) performed on conventional Precision machines or micro machines.
- Although micromachining techniques are similar to conventional (macro)machining manufacturing techniques, simple scaling of parameters or process model cannot be applied due to size effects





Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=EALXTht-stg

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-454-455

Micromachining, International Journal of Mechanical And Production Engineering, ISSN: 2320 - 2092, Volume-4, Issue-2, Feb.-2016

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II / IV

Course Name with Code : **19RAC03 Manufacturing Technology :**

Course Faculty

Unit : **V - CNC Machining** **Date of Lecture:**

Topic of Lecture: Wafer machining

Introduction : (Maximum 5 sentences)

- Conventional and matured semiconductor processes have long been used for producing functional electronics and mechanical devices on silicon.
- Mechanical machining process like milling can fabricate complex features very efficiently and accurately.

Prerequisite knowledge for Complete understanding and learning of Topic:

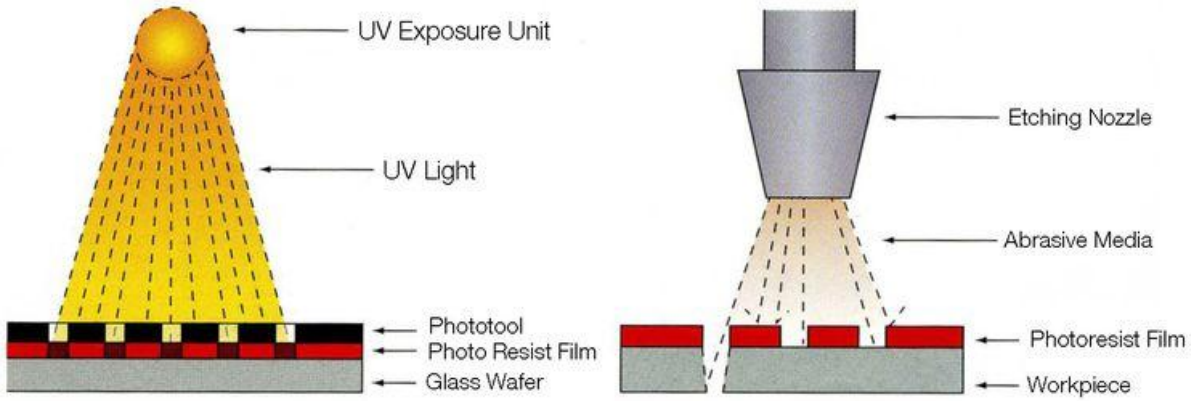
(Max. Four important topics)

- Machine tool
- Silicon workpiece and micro-end mills

Detailed content of the Lecture:

- Silicon, being a material which allows light transmission beyond visible spectrum is a good candidate for the integration of micro fluidic and optical devices.
- The lack of rapid prototyping method in particular mechanical-based micromachining process for silicon device processing is due to the brittleness property of silicon. Silicon fails or breaks without significant deformation when subjected to tension or stress.
- Influences of cutting parameters including spindle speed, feed rate and axial depth of cut on surface roughness were analyzed. Surface and subsurface characterization studies show that the primary material removal mode is ductile or partial ductile using lower feed rate.
- Conventional and matured semiconductor processes have long been used for producing functional electronics and mechanical devices on silicon. Nevertheless, mechanical machining process like milling can fabricate complex
- Machining of silicon by traditional process is extremely difficult due to itshigh brittleness.

Brittle fracture must be suppressed during machining of silicon to achieve a machined surface freeof fracture based damage



Video Content / Details of website for further learning (if any):

https://www.youtube.com/watch?v=VFBMJHdqjcs

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, Elements of Workshop Technology, Media Promoters, 2007, Pg-452-457

Silicon Wafer Processing, Dr. Seth P. Bates Applied Materials Summer, 2000

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