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Nandikotkur Road, Venkayapalli, Kurnool – 518452

Department of Mechanical Engineering

Bridge Course
On
Machine Tools

G.PULLAIAH COLLEGE OF ENGINEERING AND TECHNOLOGY
Pasupula (V), Nandikotkur Road, Venkayapalli, Kurnool

Department of Mechanical Engineering

BRIDGE COURSE FOR THE SUBJECT "MACHINE TOOLS"

Class: III – I B.Tech-I Sem – Mechanical Engineering

Faculty in-charge: A.SREEKANTH

Machine:

A machine is a tool containing one or more parts that uses energy to perform an intended action. Machines are usually powered by chemical, thermal, or electrical means, and are often motorized.

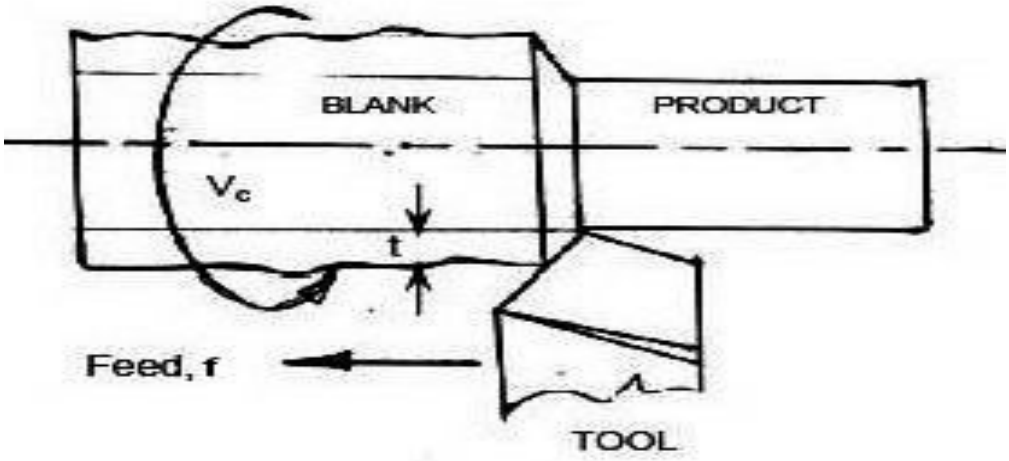
A simple machine is a device that simply transforms the direction or magnitude of a force, but a large number of more complex machines exist.

Examples include vehicles, electronic systems, molecular machines, computers, television, and radio.

Machining:

Machining is an essential process of finishing by which work pieces are produced to the desired dimensions and surface finish by gradually removing the excess material from the preformed blank in the form of chips with the help of cutting tool(s) moved past the work surface(s).

PRINCIPLE OF MACHINING:



A figure show typically illustrates the basic principle of machining. A metal rod of irregular shape, size and surface is converted into a finished product of desired dimension and surface finish by machining by proper relative motions of the tool-work pair.

PURPOSE OF MACHINING:

Most of the engineering components such as gears, bearings, clutches, tools, screws and nuts etc. need dimensional and form accuracy and good surface finish for serving their purposes. Performing

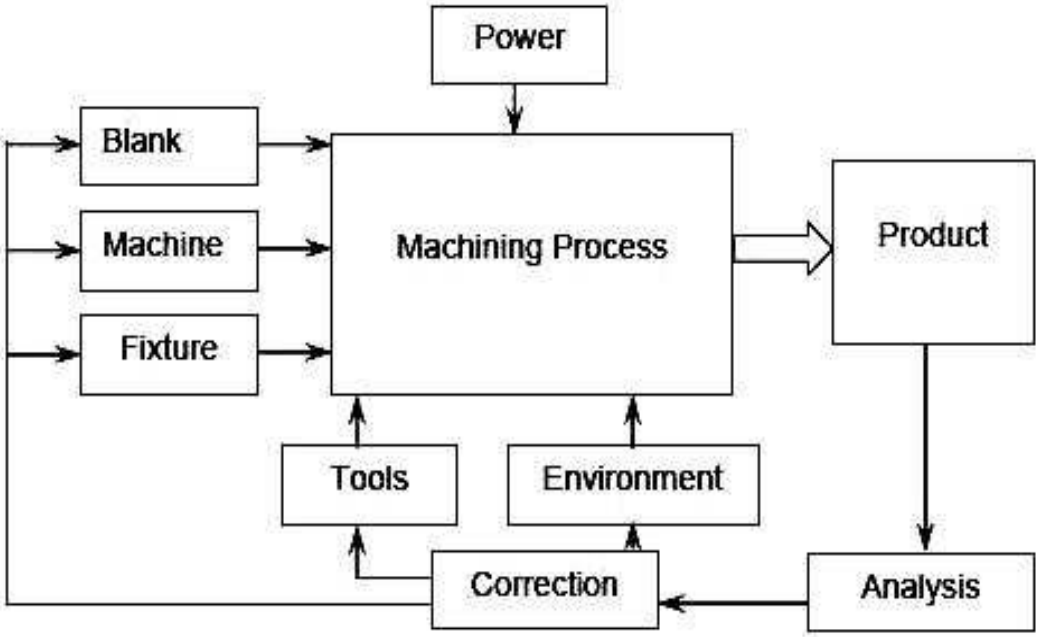
like casting, forging etc. generally cannot provide the desired accuracy and finish. For that such preformed parts, called blanks, need semi-finishing and finishing and it is done by machining and grinding. Grinding is also basically a machining process.

MACHINING TO HIGH ACCURACY AND FINISH ESSENTIALLY ENABLES A PRODUCT:

- Fulfil its functional requirements.
- Improve its performance.
- Prolong its service.

REQUIREMENTS OF MACHINING:

The essential basic requirements for machining a work are schematically illustrated in Figure



The blank and the cutting tool are properly mounted (in fixtures) and moved in a powerful device called machine tool enabling gradual removal of layer of material from the work surface resulting in its desired dimensions and surface finish. Additionally some environment called cutting fluid is generally used to ease machining by cooling and lubrication.

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The processes that have this common theme, controlled material removal, are today collectively known as subtractive manufacturing, in distinction from processes of controlled material addition, which are known as additive manufacturing. Exactly what the "controlled" part of the definition implies can vary, but it almost always implies the use of machine tools (in addition to just power tools and hand tools).

Machining is a part of the manufacture of many metal products, but it can also be used on materials such as wood, plastic, ceramic, and composites. A person who specializes in machining is called a machinist. A room, building, or company where machining is done is called a machine shop.

MACHINING OPERATIONS:

The three principal machining processes are classified as turning, drilling and milling. Other operations falling into miscellaneous categories include shaping, planing, boring, broaching and sawing.

Turning operations are operations that rotate the work piece as the primary method of moving metal against the cutting tool. Lathes are the principal machine tool used in turning.

Milling operations are operations in which the cutting tool rotates to bring cutting edges to bear against the work piece. Milling machines are the principal machine tool used in milling.

Drilling operations are operations in which holes are produced or refined by bringing a rotating cutter with cutting edges at the lower extremity into contact with the work piece. Drilling operations are done primarily in drill presses but sometimes on lathes or mills.

Miscellaneous operations are operations that strictly speaking may not be machining operations in that they may not be swarf producing operations but these operations are performed at a typical machine tool. Burnishing is an example of a miscellaneous operation. Burnishing produces no swarf but can be performed at a lathe, mill, or drill press.

BASIC MACHINING PROCESS:

Machining is any process in which a cutting tool is used to remove small chips of material from the work piece (the work piece is often called the "work"). To perform the operation, relative motion is required between the tool and the work. This relative motion is achieved in most machining operation by means of a primary motion, called "cutting speed" and a secondary motion called "feed". The shape of the tool and its penetration into the work surface, combined with these motions, produce the desired shape of the resulting work surface.

MACHINING OPERATIONS:

There are many kinds of machining operations, each of which is capable of generating a certain part geometry and surface texture.

In turning, a cutting tool with a single cutting edge is used to remove material from a rotating work piece to generate a cylindrical shape. The primary motion is provided by rotating the work piece, and the feed motion is achieved by moving the cutting tool slowly in a direction parallel to the axis of rotation of the work piece.

Drilling is used to create a round hole. It is accomplished by a rotating tool that typically has two or four helical cutting edges. The tool is fed in a direction parallel to its axis of rotation into the work piece to form the round hole.

In boring, a tool with a single bent pointed tip is advanced into a roughly made hole in a spinning work piece to slightly enlarge the hole and improve its accuracy. It is a fine finishing operation used in the final stages of product manufacture.

Reaming is one of the sizing operations that removes a small amount of metal from a hole already drilled.

In milling, a rotating tool with multiple cutting edges is moved slowly relative to the material to generate a plane or straight surface. The direction of the feed motion is perpendicular to the tool's axis of rotation. The speed motion is provided by the rotating milling cutter. The two basic forms of milling are:

THERE ARE TWO BASIC TYPES OF CUTTING TOOLS:

Single Point tool:

A single point tool has one cutting edge and is used for turning, boring and planing. During machining, the point of the tool penetrates below the original work surface of the work part. The point is sometimes rounded to a certain radius, called the nose radius.

Multiple – Cutting – Edge Tool:

Multiple-cutting-edge tools have more than one cutting edge and usually achieve their motion relative to the work part by rotating. Drilling and milling uses rotating multiple-cutting-edge tools. Although the shapes of these tools are different from a single-point tool, many elements of tool geometry are similar.

Cutting tool:

A cutting tool or cutter is any tool that is used to remove material from the work piece by means of shear deformation. Cutting may be accomplished by single-point or multipoint tools. Single-point tools are used in turning, shaping, planing and similar operations, and remove material by means of one cutting edge. Milling and drilling tools are often multipoint tools. Grinding tools are also multipoint tools.

Cutting tools must be made of a material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal-cutting process. Also, the tool must have a specific geometry, with clearance angles designed so that the cutting edge can contact the work piece without the rest of the tool dragging on the work piece surface.

Cutting tool Materials:

To produce quality product, a cutting tool must have three characteristics:

Hardness: hardness and strength at high temperatures.

Toughness: so that tools do not chip or fracture.

Wear resistance: having acceptable tool life before needing to be replaced.

Examples of machine tools are:

Broaching machine

Drill press

Gear shaper

Lathe

Milling machine

Shear (sheet metal)

Shaper

Saws

Planer

Grinding machines

Multitasking machines (MTMs)—CNC machine tools with many axes that combine turning, milling, grinding, and material handling into one highly automated machine tool

When fabricating or shaping parts, several techniques are used to remove unwanted metal

Among these are:

Electrical discharge machining

Grinding (abrasive cutting)

Multiple edge cutting tools

Single edge cutting tools

Other techniques are used to add desired material. Devices that fabricate components by selective addition of material are called rapid prototyping machines.

Construction of Machine Tool:

Frame:

The frame is a machine's fundamental element. This casting or fabricated section carries all the active and passive components – spindles, tables, and controls. Frames are made from welded steel, cast iron, or composite concrete. When constructing the frame, loads, damping, apertures, heat transfer, and noise are major design considerations.

Slides and Rails:

Guide ways are frame elements that carry the work piece table or spindles. There are two way types: box ways and roller ways.

Lead screw:

A lead screw (or lead screw), also known as a power screw[1] or translation screw,[2] is a screw used as a linkage in a machine, to translate turning motion into linear motion. Because of the large area of sliding contact between their male and female members, screw threads have larger frictional energy losses compared to other linkages. They are not typically used to carry high power, but more for

intermittent use in low power actuator and positioned mechanisms. Common applications are linear actuators, machine slides (such as in machine tools), vises, presses, and jacks

Box way:

It has high stiffness, good damping characteristics, a large surface contact area, and resistance to high cutting and shock load. The rail for this design is cast or welded onto the frame or bolted in place. Cast ways are difficult to repair and virtually impossible to replace.

Roller ways:

This way type consists of a rail and a slide, but has a rolling-element bearing between the two. Roller ways are lighter weight and operate with less friction, so they can positioned faster and with less energy. Roller ways, however, take more space and is usually more costly.

Spindles and Motors:

Electric motors are the prime movers for most machine tool functions. They mostly use 3-phase ac power supplied at 220 or 460 V. Today's spindles generally operate around 10,000 rpm or higher, range from 5-150 hp (3.7-112 kW).

Spindle motors:

A spindle is a motor-driven shaft that both positions and transmits power to a tool or holds a work piece. Spindle motors are the major motors on a machine tool, drive the spindle shafts.

Feed motors:

Positioning motors drive the ball screws that move the sides carrying spindles or worktables. Today's most popular positioning motor is technically called a dc brushless motor, more commonly known as an ac servo motor.

Linear motors:

A linear motor is essentially a "straightened out" rotary motor. The rotor is the slide and the stator is a row of windings. It is very lightweight relative to the conventional motor, but less accurate in positioning.

Spindle (tool):

In machine tools, a spindle is a rotating axis of the machine, which often has a shaft at its heart. The shaft itself is called a spindle, but also, in shop-floor practice, the word often is used metonymically to refer to the entire rotary unit, including not only the shaft itself, but its bearings and anything attached to it (chuck, etc.).

A machine tool may have several spindles, such as the headstock and tailstock spindles on a bench lathe. The main spindle is usually the biggest one. References to "the spindle" without further qualification imply the main spindle. Some machine tools that specialize in high-volume mass production have a group of 4, 6, or even more main spindles. These are called multi spindle machines. For example, gang drills and many screw machines are multi spindle machines. Although a bench lathe

has more than one spindle (counting the tailstock), it is not called a multispindle machine; it has one main spindle.

Examples of spindles include:

On a lathe (whether wood lathe or metal lathe), the spindle is the heart of the headstock.

In rotating-cutter woodworking machinery, the spindle is the part on which shaped milling cutters are mounted for cutting features (such as rebates, beads, and curves) into mouldings and similar millwork.

Similarly, in rotating-cutter metalworking machine tools (such as milling machines and drill presses); the spindle is the shaft to which the tool (such as a drill bit or milling cutter) is attached (for example, via a chuck).

Varieties of spindles include grinding spindles, electric spindles, machine tool spindles, low-speed spindles, high speed spindles, and more

Machine element:

Machine element refers to an elementary component of a machine. These elements consist of three

Basic types:

Structural components such as frame members, bearings, axles, splines, fasteners, seals, and lubricants

Mechanisms that control movement in various ways such as gear trains, belt or chain drives, linkages, cam and follower systems, including brakes and clutches, and Control components such as buttons, switches, indicators, sensors, actuators and computer controllers.

While generally not considered to be a machine element, the shape, texture and color of covers are an important part of a machine that provide a styling and operational interface between the mechanical components of a machine and its users.

Machine elements are basic mechanical parts and features used as the building blocks of most machines. Most are standardized to common sizes, but customs are also common for specialized applications.

Machine elements may be features of a part (such as screw threads or integral plain bearings) or they may be discrete parts in and of themselves such as wheels, axles, pulleys, rolling-element bearings, or gears. All of the simple machines may be described as machine elements, and many machine elements incorporate concepts of one or more simple machines. For example, a lead screw incorporates a screw thread, which is an inclined plane wrapped around a cylinder.

Many mechanical design, invention, and engineering tasks involve a knowledge of various machine elements and an intelligent and creative combining of these elements into a component or assembly that fills a need (serves an application).

Structural elements:

Shafts:

A drive shaft, driveshaft, driving shaft, propeller shaft (prop shaft), or Cardan shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them.

Couplings:

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. Couplings do not normally allow disconnection of shafts during operation, however there are torque limiting couplings which can slip or disconnect when some torque limit is exceeded.

Bearings:

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction.

Fasteners:

A fastener is a hardware device that mechanically joins or affixes two or more objects together. In general, fasteners are used to create non-permanent joints; that is, joints that can be removed or dismantled without damaging the joining components

Keys and Cotter pin:

A key is a machine element used to connect a rotating machine element to a shaft. The key prevents relative rotation between the two parts and may enable torque transmission. For a key to function, the shaft and rotating machine element must have a keyway and a key seat, which is a slot and pocket in which the key fits. The whole system is called a keyed joint. A keyed joint may allow relative axial movement between the parts.

A split pin, also known in the United States as a cotter pin or cotter key,[1] is a metal fastener with two tines that are bent during installation, similar to a staple or rivet. Typically made of thick wire with a half-circular cross section, split pins come in multiple sizes and types.

Seals:

A mechanical seal is a device that helps join systems or mechanisms together by preventing leakage (e.g. in a plumbing system), containing pressure, or excluding contamination. The effectiveness of a seal is dependent on adhesion in the case of sealants and compression in the case of gaskets.

MECHANICAL ELEMENTS:

Belt, Chain:

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts).

A chain is typically made of metal. A chain may consist of two or more links.

Those designed for lifting, such as when used with a hoist; for pulling; or for securing, such as with a bicycle lock, have links that are torus shaped, which make the chain flexible in two dimensions. Those designed for transferring power in machines have links designed to mesh with the teeth of the sprockets of the machine, and are flexible in only one dimension. They are known as roller chains, though there are also non-roller chains such as block chain.

Clutch:

A clutch is a mechanical device which engages and disengages power transmission especially from driving shaft to driven shaft.

In the simplest application, clutches connect and disconnect two rotating shafts (drive shafts or line shafts). In these devices, one shaft is typically attached to an engine or other power unit (the driving member) while the other shaft (the driven member) provides output power for work

Brake:

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system.[1] It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction.

Gear train:

A gear train is a mechanical system formed by mounting gears on a frame so that the teeth of the gears engage. Gear teeth are designed to ensure the pitch circles of engaging gears roll on each other without slipping, providing a smooth transmission of rotation from one gear to the next.

Cam and follower systems:

A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion or vice versa. It is often a part of a rotating wheel (e.g. an eccentric wheel) or shaft (e.g. a cylinder with an irregular shape) that strikes a lever at one or more points on its circular path.

A cam follower, also known as a track follower, is a specialized type of roller or needle bearing designed to follow cam lobe profiles. Cam followers come in a vast array of different configurations; however the most defining characteristic is how the cam follower mounts to its mating part; stud style cam followers use a stud while the yoke style has a hole through the middle

Linkage:

A mechanical linkage is an assembly of bodies connected to manage forces and movement. The movement of a body, or link, is studied using geometry so the link is considered to be rigid.[1] The connections between links are modelled as providing ideal movement, pure rotation or sliding for example, and are called joints.

Simple machine:

A simple machine is a mechanical device that changes the direction or magnitude of a force

Aim and objectives in manufacturing of any product:

Enhance profit rate and job opportunity

- Reduce manufacturing time
- Increase rate of production
- reduce cost of manufacturing
- raise profit and profit rate