جامعة الجوف
Jouf University

# WORKSHOP MANUAL

## ME-331

(Manufacturing Proc. 1)

# Manufacturing Processes workshop Policy and Safety

## Grading

Please see the course specification for the grading scheme and policy

## Requirements for the workshop Report

This workshop manual includes a description of each operation with questions. Students should submit the filled experiment sheets to every workshop.

# Jouf University Academic Dishonesty Policy

Student Conduct: Penalties for academic dishonesty will be severe. Academic dishonesty includes cheating, plagiarism or sabotage. Cheating includes but is not limited to: (i) unauthorized assistance in taking quizzes, tests or examinations; (ii) dependence upon the aid of sources beyond those authorized by the instructor in solving problems or carrying out other assignments; (iii) acquisition or possession without permission of tests or other academic material belonging to a member of the faculty or staff; (iv) knowingly providing any unauthorized assistance to another student on quizzes, tests or examinations.

Plagiarism includes, but is not limited to: (i) use by paraphrase or direct quotation of the published or unpublished work of another person without fully and properly crediting the author with references; (ii) unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials; or (iii) unacknowledged use of original work/material that has been produced through collaboration with others without release in writing from collaborators.

Sabotage includes but is not limited to, the unauthorized interference with, modification of, or destruction of the work or intellectual property of another member of the University community.

Other conduct that is subject to disciplinary action includes the actual or attempted theft or other abuse of computer time, including but not limited to: (i) unauthorized entry into a file to use, read or change the contents, or for any other purpose; (ii) unauthorized transfer of a file; (iii) unauthorized use of another individual's identification and password; (iv) use of computing facilities to interfere with the work of another student, faculty member or University official; (v) use of computing facilities to interfere with normal operation of the University computing system; (vi) knowingly causing a computer virus to become installed in a computer system or file.

For this class, work turned in must be original and represent an individual effort unless otherwise indicated. IF DUPLICATE COPIES OF PROJECTS OR HOMEWORKS ARE RECEIVED, AN AUTOMATIC GRADE OF ZERO WILL BE GIVEN TO ALL PARTIES INVOLVED. Code which is not your own must be referenced (e.g. when using code libraries). Persons observed cheating on tests will forfeit the test and receive a zero for that test. Names of persons involved in any of these incidents will be forwarded to the Head of the Department. Those students will be subject to sanctions as outlined in the general catalog. Sanctions may result in dismissal from the University.

I have read and I understand the Class Policies regarding Student Conduct. I agree to abide by these policies.

Signed                                        Date:

# GENERAL GUIDELINES AND SAFETY INSTRUCTIONS

**Workshop Environment and Conduct**

- Workshop must be kept clean at all times.
- Eating or drinking in the workshop is not allowed.
- Working alone in the workshop is not permitted.
- A student must be accompanied by workshop partners and/or an instructor.

**Handling Equipment**

- Strictly follow the instructions provided in the workshop manual and those given by the supervisor. If you do not understand any of the instructions make sure you ask the supervisor.
- Do not handle any equipment, device and machine without reading the safety instructions first.

**Reporting and Returning Equipment**

- Damaged equipment and dangerous workshop conditions must be reported to the supervisor.
- All equipment, devices or tools must be returned at the end of the experiment.

**Preventing Electric Shock**

- Wiring and setup should be carefully checked before turning on the power. Make sure to switch off the power before making any changes to the circuit.
- Avoid contact with live electrical circuits/wires.
- Do not try to experiment with power from the wall plug.
- Do not force connectors into the sockets.

**Fire, First Aid, and Emergency Numbers**

- Make sure you are aware of the location of fire exits, fire extinguisher, and first aid kit in your workshop.
- In case of emergency, call campus security or 911.

## Workshop Instructions

All students must be constantly aware of the safety hazards that are associated with using machines and must know all safety precautions to avoid accidents and injuries. Carelessness and ignorance are two great menaces to personal safety. Other hazards can be mechanically related to working with machines, such as proper machine maintenance and setup. Some important safety precautions to follow when using machines are:

- Know where emergency stop is before operating the machine.
- As well as compliance with the metalworking operations instructions.
- Wear the appropriate clothing, shoes, insurance glasses, remove rings and watches. See figure Instruct-1.


Figure Instruct-1: safety elements

- Always stop the machine before making adjustments.
- Do not change the spindle speeds until machine comes to a complete stop.
- Never attempt to measure work while the machine is turning.
- Turn off the machine before inspection processes.
- Fixation of the cutting tool and workpiece must be accurate and with a right manner.
- Cutting tools must not be handled during cutting
- Handle the sharp cutters, centers, and drills with care.
- Remove the chuck wrenches before operating.
- Handle heavy chucks with care.
- Keep tools overhang as short as possible.

- Coolant must be turned on during cutting process. (see next figure)

Figure Instruct-2: a cutting fluid

- Do not remove chip by hand.(see next figure)

Figure Instruct-3: removing the chip

- Use a high illuminations to get an accurate processes. (see next figure)

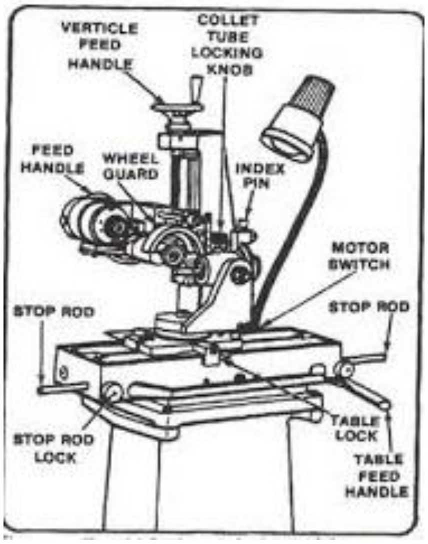


Figure Instruct-4: an illumination

# CONTENTS

# Milling Workshop

## 1- Objectives:

- Identify the types of milling machine.
- Identify the types of milling processes.
- Identify the uses of milling machine.
- Identify the parts of milling machine.
- Apply some practical milling processes.

## 2- Introduction:

It is the oldest workshop machine. It is a metalworking machine to get a final product.

## 3- Workshop prerequisites:

- Read from the text book about milling process.
- Carefully, read the workshop manual.

## 4- Classification of milling machine according to control methods:

- Manual.
- Half automatic.
- Automatic.
- Numerical control.

## 5- Types of milling machines:

- Horizontal milling machine: As in figure Mill-1, it is used in a peripheral milling.

Figure Mill-1: a horizontal milling machine

- Vertical milling machine: As in figure Mill-2, it is used in a surface (face) milling.
- Universal milling machine: As in figure Mill-3, it includes horizontal and vertical milling machine, and is used in a peripheral and surface milling. It has a machine table which can be inclined at a $45^o$ angle to produce a spiral gear.

Figure Mill-2: a vertical milling machine        Figure Mill-3: a universal milling machine

## 6- Parts of general milling machine: As in figure Mill-4.

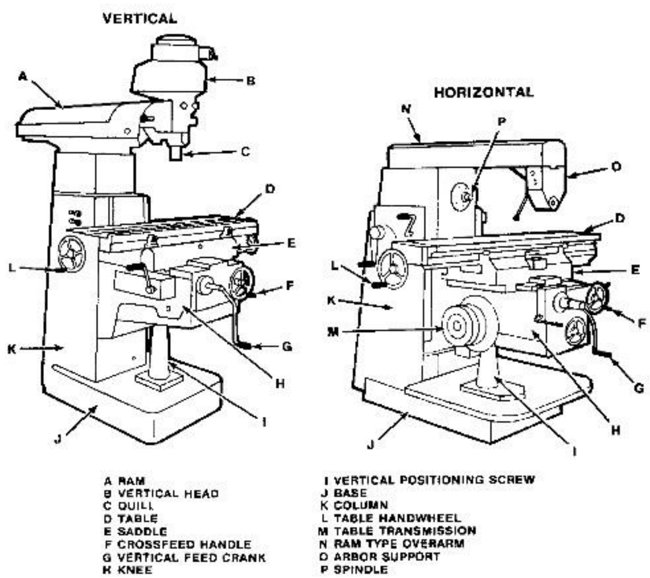


Figure Mill-4: milling machine parts

- Ram: It is the upper part of the milling machine, and, it is supported by the bracket.
- Milling cutter bracket (Support): It is a support of the arbor and prevents vibrations.
- Arbor: As in figure Mill-5. It is a shaft on which the cutting tools is hold with collets, and, it takes its movement from the main spindle.

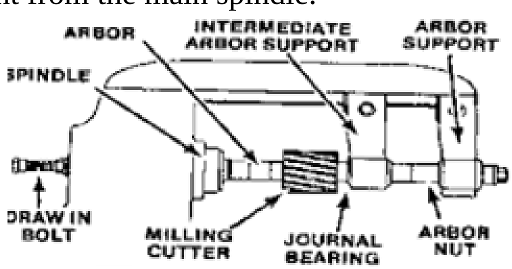


Figure Mill-5: an arbor

- Collets: It helps in the cutter fixation on arbor.
- Column: It is has the gear box and some automatic keys.
- Gearbox: It is used to change the main spindle speed.
- Automatic key: It is used to turn on main spindle and change the direction of main spindle rotation.
- Automatic machine table switch: It is used for the automatic machine movements.
- Timer switch: It is a test key.
- Cooling fluid Automatic key: It is used in coolant turn on.
- Gearbox: It changes the machine table speeds.
- Knee: It holds the machine table. It has three movements.
- Machine table: It moves in different axes.
- Pump: It is used for machine.
- Off and power switches.
- Main spindle: It takes its movement from the motor and gives it to the cutter.

## 7- Types of the milling processes: As in figure Mill-6.

- Plain milling.
- Peripheral milling (divided into up and down milling)

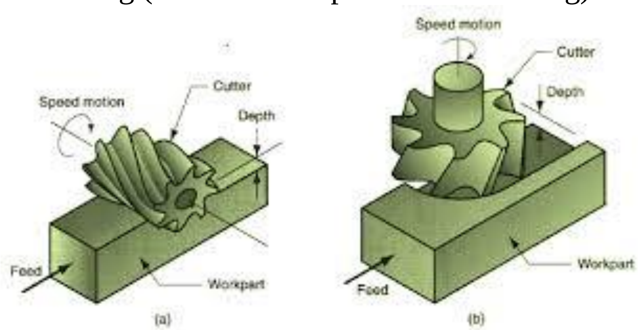


Figure Mill-6: types of milling processes

The difference between peripheral and surface milling:

In *peripheral milling:* the cutting edge (milling cutting tool) is parallel to the working area.

In *surface milling:* the cutting edge is parallel to the workpiece surface.

As in figure Mill-7, the *peripheral milling* is divided into:

- Down milling.
- Up milling.

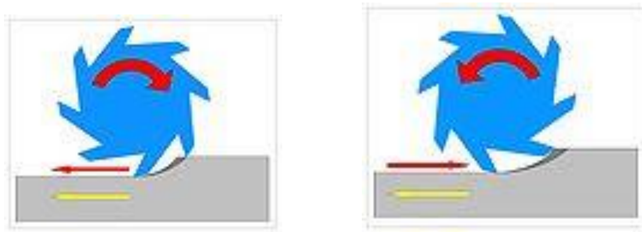

Figure Mill-7: types of peripheral milling

Table Mill-1: differences between up and down milling:

| Item | Up milling | Down Milling |
|---|---|---|
| Tool Life | Decreased | Increased |
| Machine Vibrations | Increased | Decreased |
| Surface Finishing | Bad | Good |
| Workpiece holding | Need high holding | Don't need high holding |

## 8- To save milling cutter:

Due to the high price and ease of damage, the following must be considered:

- Use a sharp cutter.
- Make sure the goodness of cutter holding before machining.
- Use the appropriate cutting speeds for each metal.
- Make sure that supply of coolant on working.
- Choose the appropriate cutter.
- Don't use cutter in hammering the column.
- Clean the cutter before storage.
- Ensure that cutter was stored in a safe place and in an individual case.

# Review Questions

1. List the different types of milling machine

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2. How milling cutter can be saved?

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3. Define :

   - Feeding:

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   - Cutting speed:

   ……………………………………………………………………………………………

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4. Illustrate the differences between up and down milling?

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# Milling Processes

**First: Surface Adjustment:**

**Steps of surface adjustment on a milling machine are as follows:**

1. Select a horizontal or vertical milling machine.
2. Adjust the cutting speed, feed and cutting depth.
3. Machine table must be away than a cutting tool position.
4. Hold a vice on a machine table in a right position.
5. Hold a workpiece with a vice (in horizontal milling machine, workpiece surface must be parallel to the cutter axis. But, in vertical milling machine, workpiece surface must be perpendicular to the cutter axis). It is possible to use a wooden part under workpiece. The wooden part must has a width lower than workpiece width to help in workpiece support and to prevent workpiece side movement due to cutting forces.
6. Select and hold a suitable milling cutting tool.
7. In a horizontal milling machine:
    a) Unscrew the bracket nut.
    b) Remove the bracket.
    c) Remove the arbor.
    d) Select a suitable arbor, and, hold it inside the main spindle.
    e) Hold collets on the arbor through arbor key, and between the collets, hold a the cutter in a right position according to the machining position. See figure Mill-8.

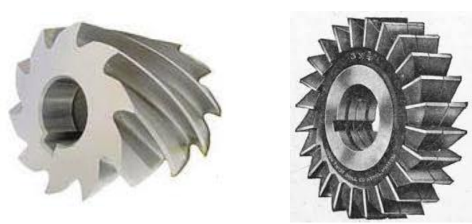


Figure Mill-8: horizontal milling cutters

8. In vertical milling machine: See figure Mill-9.
    a) Hold a suitable chuck inside the main spindle.
    b) Select and hold a suitable cutter inside the chuck.

Figure Mill-9: vertical milling cutters

9. Manually, feed the workpiece up toward the cutting tool -until reaching to a proper and close position between cutting tool and workpiece- by a suitable machine table handle.
10. Run  the machine to rotate the cutter.
11. In the beginning of operation, a slowly manual contact  between the workpiece surface and cutting tool teeth must be done.
12. Automatically and traversal, As in figure Mill-10, feed the workpiece toward the cutting tool.

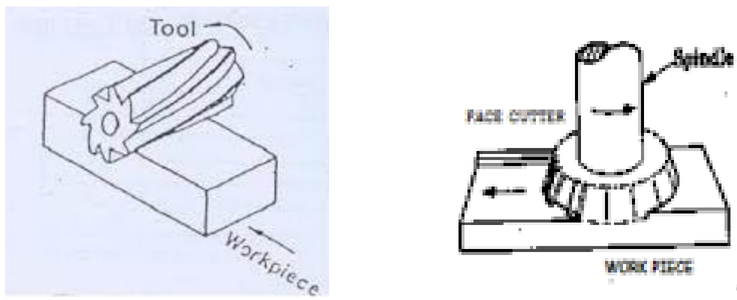



Figure Mill-10: different milling processes

13. If the depth of cut is large, previous step can be repeated.
14. After finishing, turn off power supply.
15. Machine table must be away than the milling cutter.
16. Unscrew the vice and take the final product.
17. Remove the chip.

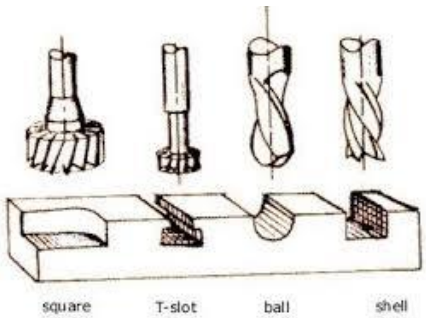
**Second: Angular Milling (Slots):** As in figure Mill-11.

Figure Mill-11: a slot process

Or angle milling, where the milling flat surfaces must be neither parallel nor perpendicular to the milling cutter axis.

**Steps of slot process** on the milling machine is similar to the surface adjustment process, but, the depth of cut is larger and the width of cut is smaller.

Select a suitable cutting tool according to the shape of slot. Slot may be takes more than one stroke according to the slot shape and depth of cut. See figure Mill-12.



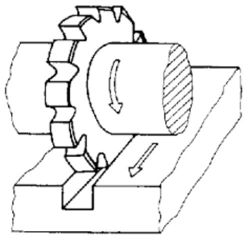



Figure Mill-12: different vertical and horizontal milling cutters

**Third: T-Slots:** As in figure Mill-13.

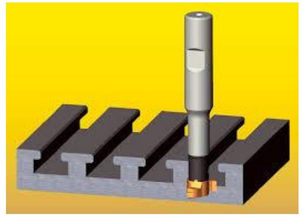


Figure Mill-13: a T-slot process

It is a type of the angular milling, where the milling flat surfaces must be perpendicular to the milling cutter axis. A side milling cutter or an end milling cutter is selected. Cutter size must be suitable to the throat width for T-slot. Select a T-slot milling cutter according to the T-slot size.

**Steps of "T" slot on a milling machine are as follows:**

1. As previously, execute the slots procedures on a vertical milling machine.
2. Turn off the machine.
3. Adjust new cutting conditions to the T-slot process.
4. Change cutting tool with a suitable T-slot cutter to execute the required T-slot. See figure Mill-14.

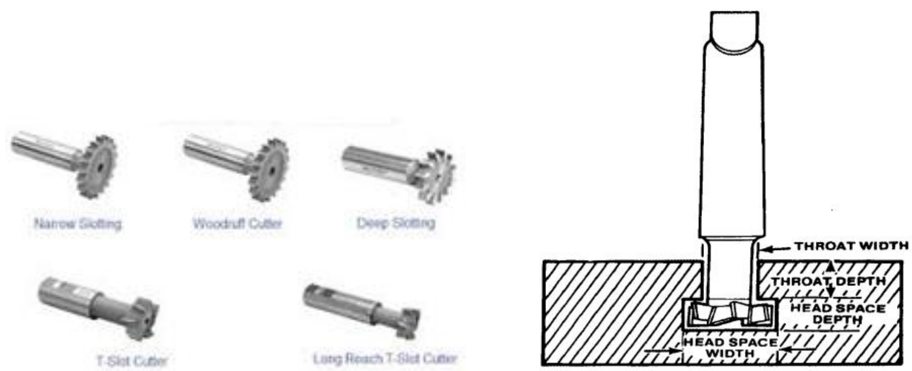



Figure Mill-14: T-slot milling process and cutters

5. Manually, feed the workpiece up toward the cutting tool -until reaching to a proper and close position between cutting tool and workpiece- by a suitable machine table handle.
6. Run the machine.
7. In the beginning of operations, a slowly manual contact between the workpiece surface and cutting tool teeth must be done.
8. Automatically and traversal, feed the workpiece toward the cutting tool.
9. After finishing T-slot, turn off power supply.
10. Machine table must be away than the milling cutter.
11. Unscrew the vice and take the final product.
12. Remove the chip.

**Fourth: "V"-Slot:** As in figure Mill-15.

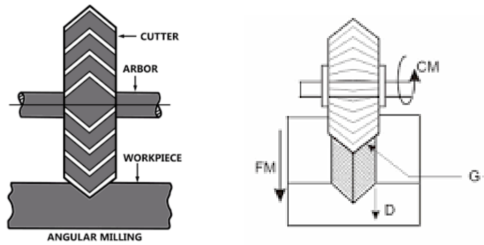



Figure Mill-15: a V-slot process

It is a type of the angular milling, where the milling flat surfaces must be parallel to the milling cutter axis.

**Steps of "V" slot on a milling machine are as follows:**

1. Select a horizontal milling machine.
2. Adjust cutting speed, feed and cutting depth.
3. Machine table must be away than the cutting tool position.
4. Hold a vice on the machine table in a right position.
5. As in figure Mill-16, hold the workpiece with the vice (workpiece surface must be parallel to the cutter axis). It is possible to use a wooden part under workpiece. The wooden part must has a width  lower than workpiece width to help in workpiece support and to prevent workpiece side movement due to cutting forces.

Figure Mill-16: hold a workpiece on a vice

6. Unscrew the bracket nut.
7. Remove the bracket.
8. Remove the arbor.
9. Select a suitable arbor, and, hold it inside the main spindle.
10. Select and hold  a suitable milling cutting tool. See figure Mill-17

Figure Mill-17: different V-milling cutters

11. Through the arbor key, hold collets on arbor, and hold a suitable cutter between these collets in a right position according to the machining position.
12. Manually, feed the workpiece up toward the cutting tool -until reaching to a proper and close position between the cutting tool and workpiece- by a suitable machine table handle.
13. Run the machine to rotate the cutter.
14. In the beginning of operation, a slowly manual contact between the workpiece surface and cutting tool teeth must be done.
15. Automatically and traversal, feed the workpiece toward the cutting tool.
16. If depth of cut is large, previous step can be repeated.
17. After finishing, turn off power supply.
18. Machine table must be away than the milling cutter.
19. Unscrew the vice and take the final product.
20. Remove the chip.

**Fifth: Dovetail Milling (Dovetail-Slot):** As in figure Mill-18.

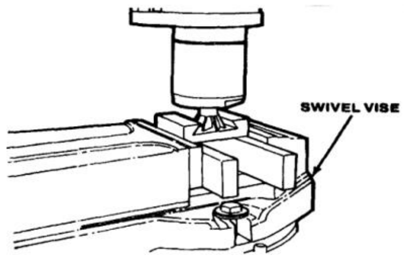



Figure Mill-18: a dovetail process

It is a type of the angular milling , where the milling flat surfaces must be perpendicular to the milling cutter axis.

**Steps of dovetail-slot on a milling machine are as follows:**

1. As previously, execute the slots procedures on a vertical milling machine.
2. Turn off power supply.
3. Adjust new cutting conditions to complete the dovetail-slot process.
4. Change the cutting tool with a suitable dovetail-slot cutter to execute the required dovetail-slot. See figure Mill-19.

Figure Mill-19: a dovetail cutter

5. Manually, feed the workpiece up toward the cutting tool -until reaching to a proper and close position between cutting tool and workpiece- by a suitable machine table handle.
6. Run the machine to rotate the cutter.
7. In the beginning of operation, a slowly manual contact between workpiece surface and cutting tool teeth must be done.
8. Automatically and traversal, feed the workpiece toward the cutting tool.
9. After finishing, turn off power supply.
10. Machine table must be away than the milling cutter.
11. Unscrew the vice and take the final product.
12. Remove the chip.

**Sixth: Sawing (Parting off):** As in figure Mill-20.

Metal slitting saw milling cutters are used to part stock on a milling machine. Workpiece is being fed against the rotation of the cutter. For greater rigidity while parting thin material such as sheet metal, the workpiece may be clamped directly to the table with the line of cut over one of the table T-slots. In this case, the workpiece should be fed with the rotation of the milling cutter (climb milling) to prevent it from being raised off the table.

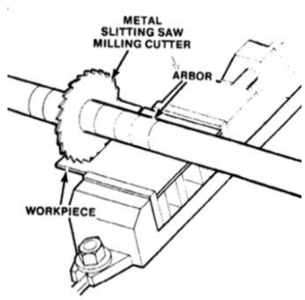



Figure Mill-20: parting off a solid stock

**Steps of sawing on a milling machine are as follows:**

1. Select a horizontal milling machine.
2. Adjust cutting speed, feed and cutting depth.
3. Machine table must be away than the cutting tool position.
4. Hold a vice on the machine table in a right position.
5. Hold the workpiece with the vice (workpiece surface must be parallel to the cutter axis). It is possible to use a wooden part under workpiece. The wooden part must has a width lower than workpiece width to help in workpiece support and to prevent workpiece side movement due to cutting forces.
6. Unscrew the bracket nut.
7. Remove the bracket.
8. Remove the arbor.
9. Select a suitable arbor, and, hold it inside the main spindle.
10. Select and hold  a suitable milling cutting tool. See figure Mill-21.

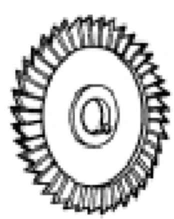



Figure Mill-21: saw cutters

11. Through arbor key, hold collets on the arbor, and between the collets, hold the cutter in a right position according to the machining position.

12. Manually, feed the workpiece up toward the cutting tool -until reaching to a proper and close position between the cutting tool and workpiece- by a suitable machine table handle.
13. Run the machine to rotate the cutter.
14. In the beginning of operation, a slowly manual contact between the workpiece surface and cutting tool teeth must be done.
15. Automatically and traversal, feed the workpiece toward the cutting tool.
16. If depth of cut is large, previous step can be repeated.
17. After finishing, turn off power supply.
18. Machine table must be away than the milling cutter.
19. Unscrew the vice and take the final product.
20. Remove he chip.

**Seventh: Straddle Milling**

As in figure Mill-22, when two or more parallel vertical surfaces are machined at a single cut, the operation is called straddle milling. Straddle milling is accomplished by mounting two side milling cutters on the same arbor, set apart at an exact spacing. Two sides of the workpiece are machined simultaneously and final width dimensions are exactly controlled.

In this process a hexagon is being cut, but the same operation may be applied to cutting squares or splines on the end of a cylindrical workpiece. The workpiece is usually mounted between centers in the indexing fixture or mounted vertically in a swivel vise. The two side milling cutters are separated by spacers, washers, and shims so that the distance between the cutting teeth of each cutter is exactly equal to the width of the workpiece area required. When cutting a square by this method, two opposite sides of the square are cut, and then the spindle of the indexing fixture or the swivel vise is rotated 90°, and the other two sides of the workpiece are straddle milled.

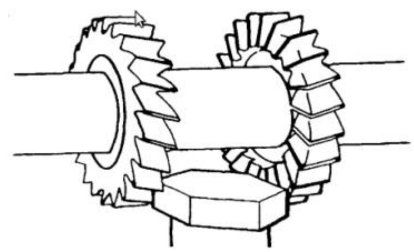


Figure Mill-22: a straddle milling

**Steps of straddle process on a milling machine** are similar to the sawing process on the milling machine.

**Eighth: Gang Milling**

As in figure Mill-23, gang milling is the term applied to an operation in which two or more milling cutters are mounted on the same arbor and used when cutting horizontal surfaces. All cutters may perform the same type of operation or each cutter may perform a different type of operation. For example, several workplaces need a slot, a flat surface, and an angular groove. The best method to cut these would be gang milling as shown in next figure. Remember to check cutters carefully for proper size.

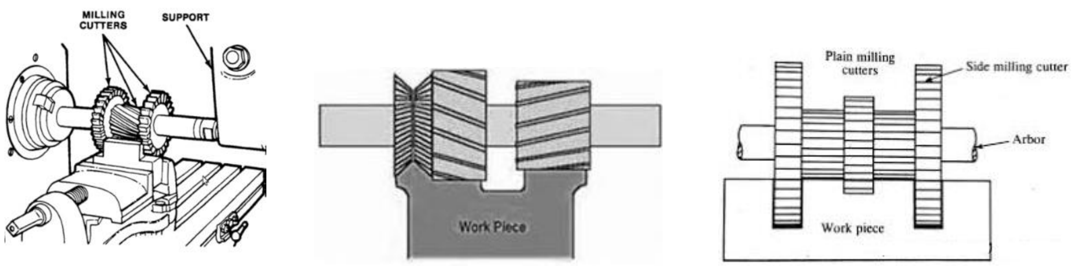



Figure Mill-23: gang cutters

**Steps of gang process on a milling machine** are similar to the sawing process on the milling machine.

# Machining Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

**Semester:…………………………** **Academic year: ………/………**

| No. | Process | Sketch of Process | Feed | Speed | Depth of Cut | Machining Time | Material Removal Rate |
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**Student name:……………………………………………**

**Student ID:……………………………………………….**

# Turning Workshop

## 1- Objectives:

- Identify the types of lathe.
- Identify the types of turning processes.
- Identify the uses of lathe.
- Identify the parts of lathe.
- Apply some practical turning processes.

## 2- Introduction:

This machine eliminates parts of the workpiece with a circular motion, and adjusted according to the drawings and specific dimensions. The raw material is formed by the cutting tool of lathes, and these cutting tools have a variety of material which must be harder than the body to be formed.

## 3- Workshop prerequisites:

- Read from the text book about turning process.
- Carefully, read the workshop manual.

## 4- Main parts of lathe:

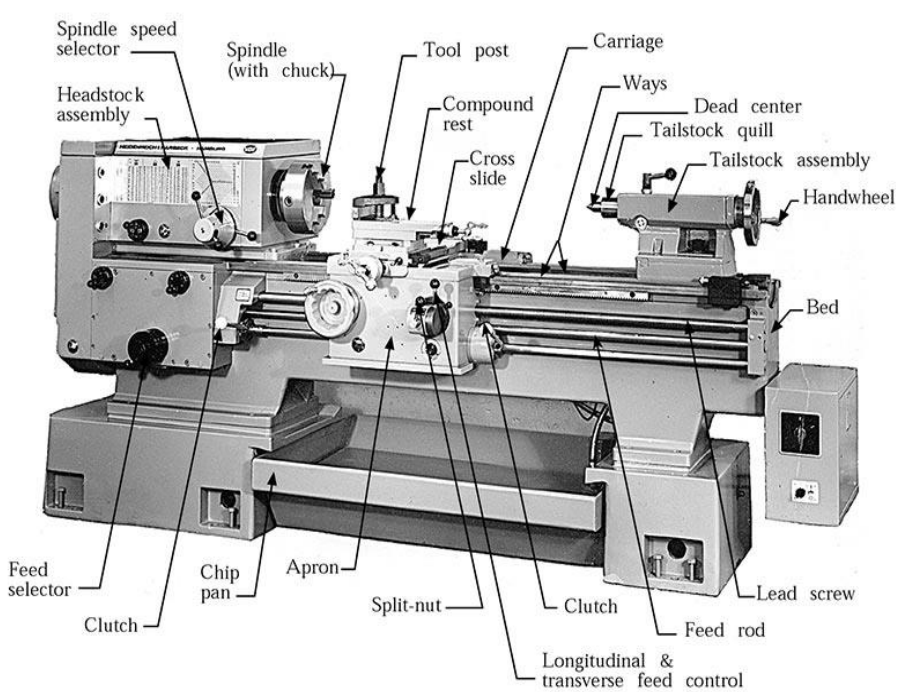


Figure Turn-1: a lathe

- Head stock: It has the main spindle and gearbox.
- Gearbox: It takes its movement from the motor, and gives these speeds to the power-screw shaft to get several speeds for the carriage. And also, it gives multiple speeds to the threading shaft.
- Tail stock: As in figure Turn-2, it is located on the lathes in opposite direction of head stock, and, it can be adjusted at any position on lathe bed with a screw.

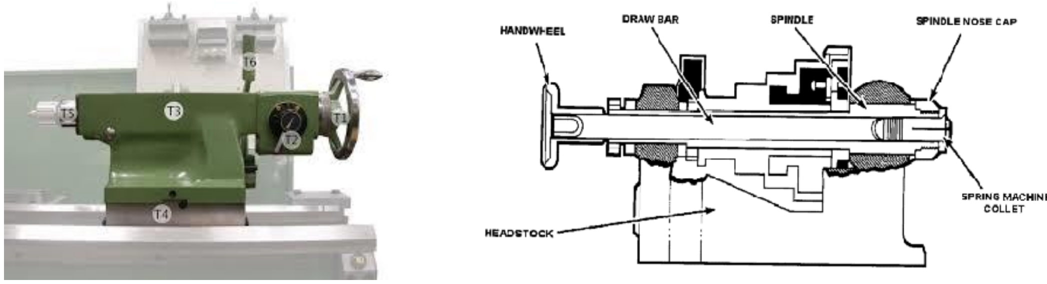


Figure Turn-2: a tailstock

- The carriage: It holds the cutting tools, and, it slides on the bed in a longitudinal direction.
- Power-screw shaft: It is a cylindrical column that extends down the bed, and takes its rotating motion from the gearbox.
- Threading shaft: It is a threaded cylindrical shaft which takes its rotating motion from the gearbox, and is used to move the carriage automatically.
- Main spindle: As in figure Turn-3, it supports the chuck and gives a rotating main cutting motion for the workpiece with different speeds.

Figure Turn-3: a chuck on the main spindle

- The turret: As in figure Turn-4, it is hold at the top of the compound rest, and is used in the cutting tool holding.

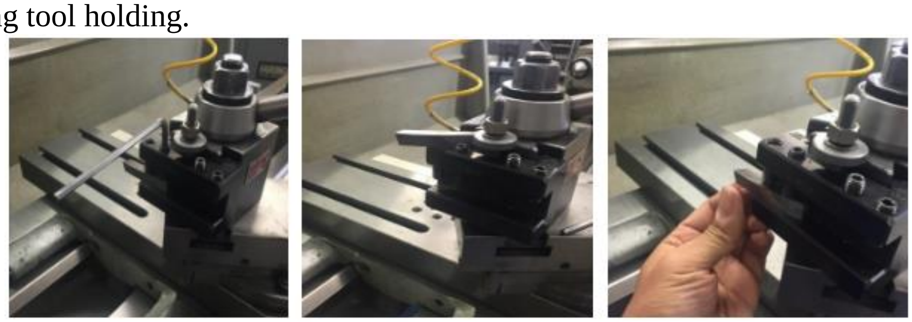

Figure Turn-4: a turret

- Compound rest: It is hold at the top surface of the cross slide. Also, It is used to get the tapered surfaces.
- Cross slide: It is located at the top of the bed and carries the compound rest. It is used in cutting tool feeding.
- Gearbox: It has a set of gears to change the speeds of chuck.
- Bed: It is made of cast iron to withstand shocks.

# **Review Questions**

1. List the different types of turning machine.

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2. list the main parts of lathe.

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# Turning Processes

**First: Longitudinal Turning:** As in figure Turn-5.


Figure Turn-5: a longitudinal turning process

**Steps of longitudinal turning on a lathe are as follows:**

1. Determine the appropriate cutting conditions (cutting speeds, feeding and cutting depth).
2. Turret must be away than the operating environment by pulling the carriage away than the chuck.
3. Select and fix a suitable chuck -according to raw material dimensions- on the main spindle. See figure Turn-6.

Figure Turn-6: a chuck

4. As in figure Turn-7, feed the raw material, and adjust an appropriate machining length with an additional length to prevent a collision between cutter and chuck.

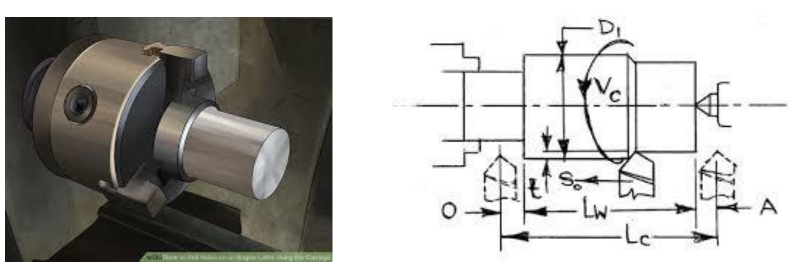


Figure Turn-7: feed the raw material with a suitable length

5. Hold the raw material with the chuck jaws in an appropriate and safe manner. See figure Turn-8.

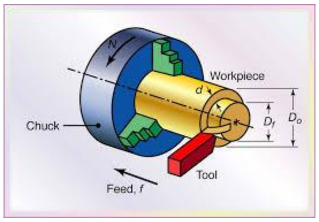

Figure Turn-8: hold the workpiece on a chuck

6. Choose an appropriate cutting tool which will be hold on turret. See figure Turn-9.

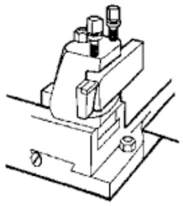

Figure Turn-9: hold the tool on a turret

7. Move the carriage to be close to the raw material face. So, use the compound rest to get a traverse movement.
8. Adjust an appropriate cutting depth. See figure Turn-10.

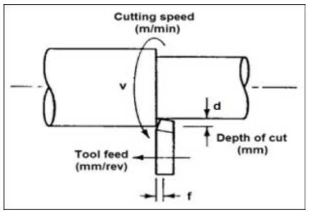

Figure Turn-10: cutting conditions

9. Run the machine to rotate the main spindle.
10. Start slow and manual contact between the cutter and raw material face
11. Manually or automatically, feed the cutting tool along the machining length.
12. Repeat steps 7 - 11 to get the desired product diameter.
13. Last cutting depth must be small to get a smooth surface.
14. During the machine turn off, workpiece surface can be inspected to verify the dimensions accuracy and surface alignment. See figure Turn-11.

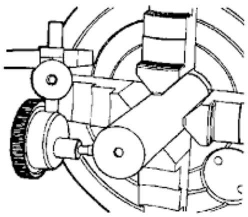

Figure Turn-11: inspection steps

15. Cutting tool must be away than the product surface to help in  product removing.
16. Close the machine.

17. Take the final product. See figure Turn-12.

Figure Turn-12: remove the final product

18. Remove the chip.

**Second: Facing:** As in figure Turn-13.

Figure Turn-13: a facing process

**Steps of facing process on a lathe are as follows:**

1. Determine the appropriate cutting conditions (cutting speeds, feeding and cutting depth).
2. Turret must be away than the operating environment by pulling the carriage away than the chuck.
3. Select and fix of a suitable chuck -according to the raw material dimensions- on the main spindle.
4. As in figure Turn-14, feed the raw material and adjust an appropriate machining length to prevent a collision between cutter and chuck.

Figure Turn-14: feed the raw material with a suitable length

5. Hold the raw material with chuck jaws in an appropriate and safe manner.
6. Choose an appropriate cutting tool which will be hold on the turret.
7. Move the carriage to be close to the raw material face.
8. As in figure Turn-15, adjust the height of cutter to be in the middle of raw material face to get a right facing process.

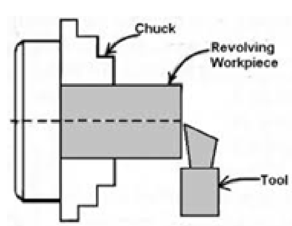


Figure Turn-15: adjust cutter at the middle of face

9. Cutting tool must be away than the workpiece.

10. Move the carriage to be close to the raw material face. So, use the compound rest to get a traverse movement.
11. Determine an appropriate cutting depth.
12. Run the machine to rotate the main spindle.
13. Start slow and manual contact between the cutter and the longitudinal raw material surface.
14. Manually or automatically, feed the cutting tool until reaching to the middle of raw material face. See figure Turn-16.

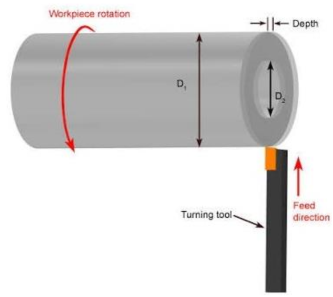


Figure Turn-16: cutting conditions in the turning process

15. Repeat steps 9 - 14 to cut the required depth of cut.
16. Last cutting depth must be small to get a smooth surface.
17. During the machine turn off, workpiece surface can be inspected to verify the surface accuracy.
18. Cutting tool must be away than the product surface to help in  product removing.
19. Close the machine.
20. Take the final product.
21. Remove the chip.

**Third: Drilling:** As in figure Turn-17.

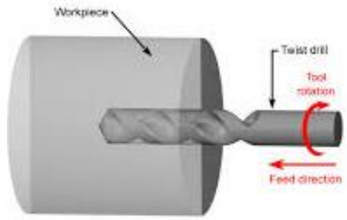


Figure Turn-17: a drilling process

**Steps of drilling process on a lathe are as follows:**

1. Determine the appropriate cutting conditions (cutting speeds, feeding and cutting depth).
2. Turret must be away than an operating environment by pulling the carriage away than the chuck.
3. Select and fix of a suitable chuck -according to the raw material dimensions- on the main spindle.
4. Centering the machined workpiece face to get an accurate machining without any deviation. As in figure Turn-18.

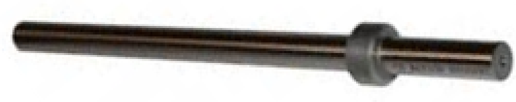

Figure Turn-18: a centered workpiece

5. Feed the raw material and adjust an appropriate machining length to prevent a collision between cutter and chuck.
6. Hold the raw material with the chuck jaws in an appropriate and safe manner.
7. Remove the center from tail stock.
8. Select an appropriate drilling tool, and hold it inside the tail stock instead of center. See figure Turn-19.

Figure Turn-19: a drilling tool inside the tailstock

9. As in figure Turn-20, move the tail stock to make the distance between the cutter and raw material face is close.
10. Run the machine to rotate the main spindle.
11. Use the tail stock handle to start slow contact between the cutter and raw material face.
12. Manually, feed the drilling tool to get the appropriate hole depth. See figure Turn-21.

Figure Turn-20: a drilling tool close to the workpiece

Figure Turn-21: a drilling tool fed inside the workpiece

13. If hole depth is large, the hole can be carried out in several stages.
14. During the machine turn off, workpiece surface can be inspected to verify the surface accuracy.
15. Cutting tool must be away than the product face to help in product removing. This can be done by dragging the drilling tool inside tail stock with a suitable handle, and then drag the tail stock.
16. Close the machine.
17. Take the final product.
18. Remove the chip.

**Fourth: Internal Turning:** As in figure Turn-22.

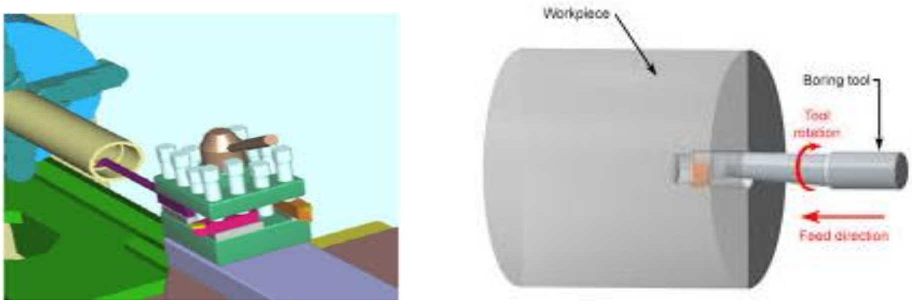


Figure Turn-22: an internal turning

**Steps of internal turning on a lathe are as follows:**

1. As in figure Turn-23, drill a suitable hole in the required surface to make an easy entry to the internal turning tool (this can be done on a drilling machine or lathe).

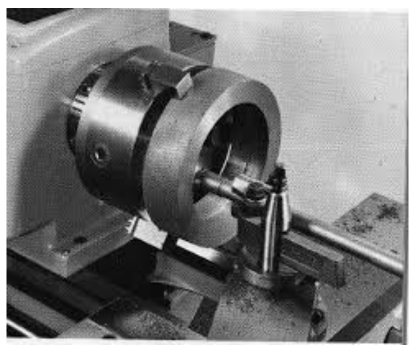

Figure Turn-23: drill a hole before an internal turning

2. Determine the appropriate cutting conditions (cutting speeds, feeding and cutting depth).
3. Turret must be away than an operating environment by pulling the carriage away than the chuck.
4. Select and fix of a suitable chuck -according to the raw material dimensions- on the main spindle.
5. Feed the raw material and adjust an appropriate machining length to prevent a collision between the cutter and chuck.
6. Hold the raw material with the chuck jaws in an appropriate and safe manner.
7. Choose the appropriate cutting tool which will be hold on the turret. See figure Turn-24.
8. Move the carriage to be close to the hole surface.
9. Adjust an appropriate cutting depth.
10. Run the machine to rotate the main spindle.
11. Start slow and manual contact between the cutter and raw material face.
12. Manually or automatically, feed the cutting tool along the machining length.
13. Repeat steps 8 - 12 to get the desired hole diameter.

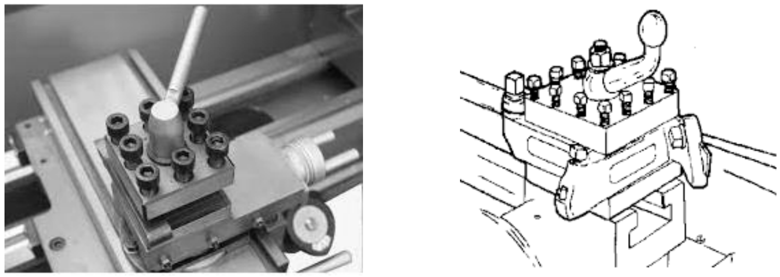

Figure Turn-24: hold tool on the turret

14. Last cutting depth must be small to get a smooth surface.
15. During the machine turn off, workpiece surface can be inspected to verify the machining accuracy.
16. Cutting tool must be away than the product surface to help in  product removing.
17. Close the machine.
18. Take the final product.
19. Remove the chip.

**Fifth: Grinding:**

Grinding is limited to the external surfaces, and it uses an attachment part to a lathe. **Steps of grinding on a lathe are as follows:**

1. Turret must be away  than an operating environment by dragging the carriage away than the chuck.
2. Remove the turret.
3. As in figure Turn-25, a grinding device -with a special electric motor- must be fixed on the carriage instead of the turret as shown in following figure.

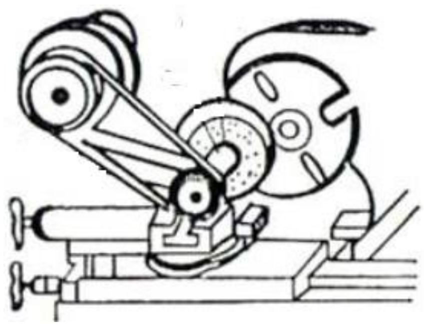

Figure Turn-25: hold a grinding wheel on the turret

4. Select and fix a suitable chuck -according to the raw material dimensions- on the main spindle.
5. Feed the raw material and adjust an appropriate length to prevent a collision between the grinding wheel and chuck.
6. As in figure Turn-26, hold the raw material with chuck jaws in an appropriate and safe manner.

Figure Turn-26: hold the raw material with the chuck

7. Manually, move the carriage to make the grinding wheel be close to the raw material face.

8. Run the machine in low speed in the same direction of main spindle rotation.
9. Start slow and manual contact between the grinding wheel and the raw material face.
10. Manually and slowly, feed the grinding wheel to make a contact with the workpiece surface.
11. Use the compound rest to get a grinding wheel traverse movement along a machined surface.
12. If it is required, gradually, feed can be increased.
13. Repeat steps 10 - 12 to get a required surface finishing.
14. When the grinding process is finished, turn off the grinding wheel motor.
15. During the machine turn off, workpiece surface can be inspected to verify the machining accuracy.
16. Grinding wheel must be away than the product surface to help in the product and grinding wheel removing.
17. Close the machine.
18. Take the final product.
19. Remove the chip.

**Sixth: Tapering:** As in figure Turn-27

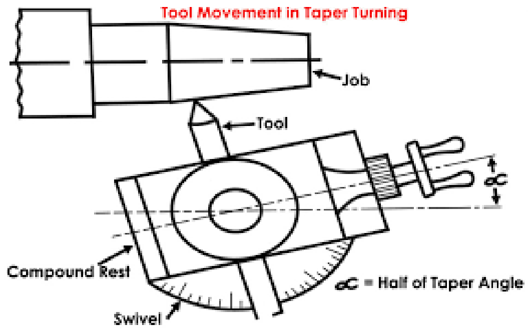


Figure Turn-27: a tapering Process

**Steps of tapering on a lathe are as follows:**

1. Determine the appropriate cutting conditions (cutting speeds, feeding and cutting depth).
2. Turret must be away than an operating environment by pulling the carriage away than the chuck.
3. Select and fix a suitable chuck -according to the raw material dimensions- on the main spindle.
4. Feed the raw material and adjust an appropriate machining length with an additional length to prevent a collision between cutter and chuck.
5. Hold the raw material with the chuck jaws in an appropriate and safe manner.
6. As in figure Turn-28, adjust the compound rest with an appropriate tapering angle, as in next figures:

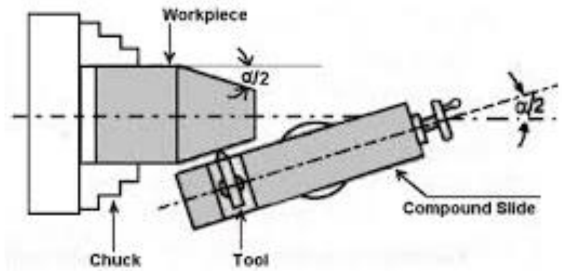


Figure Turn-28: compound rest adjustment

7. Choose an appropriate cutting tool which will be hold on the turret.
8. As in figure Turn-29, precisely , adjust the height of cutter to avoid curved sides of tapered surfaces.
9. Move the carriage to be close to the raw material face. So, use the compound rest to get a traverse movement.
10. Adjust an appropriate cutting depth (workpiece is machined to the larger diameter. See figure Turn-30).
11. Run the machine to rotate the main spindle.
12. Start slow and manual contact between the cutter and raw material face.

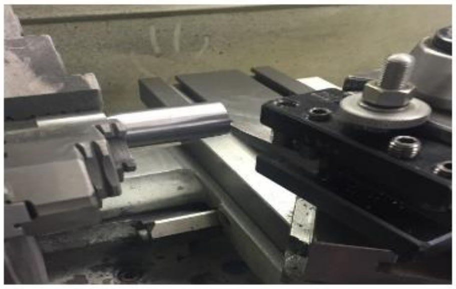

Figure Turn-29: adjust the cutter height

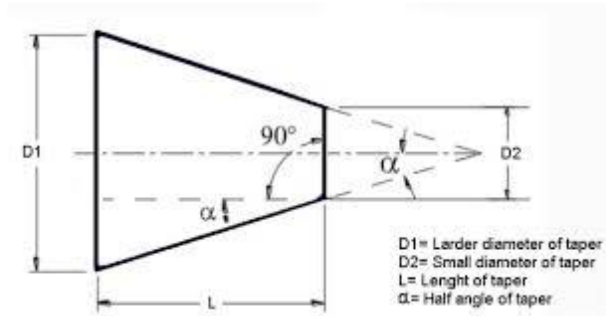


Figure Turn-30: workpiece diameters

13. Manually or automatically, feed the cutting tool along the specified machining length.
14. Repeat steps 12 - 13 to get a desired product diameter.
15. Regularly, adjust the cutter feeding for a good smooth surface
16. Cutting depths must be small to get a smooth surface and to decrease cutting forces.
17. During the machine turn off, workpiece surface can be inspected to verify the dimensions accuracy and tapering angle.
18. Cutting tool must be away than the product surface to help in  product removing.
19. Close the machine.
20. Take the final product.
21. Remove the chip.

**Sixth: Parting off:**

As in figure Turn-31, parting is the process of cutting off a piece from a stock while it is being held in the lathe. Also, it is used to cut off work after other machining operations have been completed.

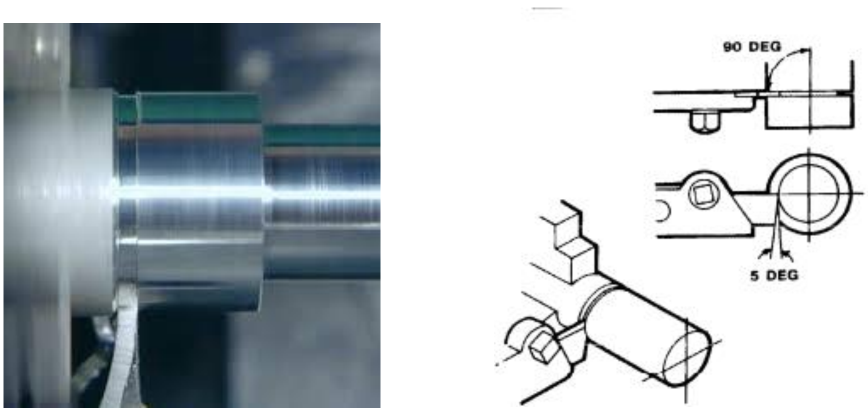


Figure Turn-31: a parting off process

**Some precautions for parting off process:**

1. As in figure Turn-32, this process uses a sharped tool with a 5° side rake and no back rake angle.

Figure Turn-32: a sharp parting off cutter

2. When parting off process, plenty of coolant must be used.
3. Length of the cutting portion of the cutter should be extend enough to be longer than the workpiece radius.
4. Work that is to be parted should be held rigidly in a chuck or collet, with the area to be parted as close to the holding device as possible.
5. Always, make the parting cut at a right angle to the centerline of the work.
6. Speeds for the parting should be about a half that used for the straight turning.

7. Feeds should be light but continuous.

8. The parting tool should be positioned at the center height of workpiece.

9. Never try to catch the cutoff part in hand; it will be hot and could burn.

**Steps of parting off  on a lathe are as follows:**

After finishing of all processes on workpiece, the follows will be start:

1. Turn off the machine.
2. Change the cutting tool with a suitable parting off tool. See figure Turn-33.

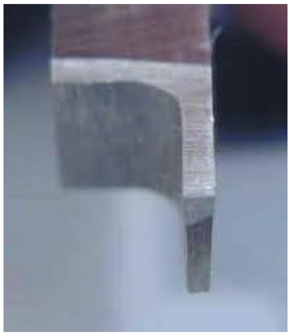

Figure Turn-33: a parting off cutter

3. Adjust the cutting tool in a right position for the workpiece surface.
4. Run the machine.
5. Slowly, feed the cutting tool toward the workpiece (use the compound rest to get a traverse movement).

**Seventh: Shoulders:**

Frequently, it will be necessary to machine work that has two or more diameters in its length. Workpiece may be mounted in a chuck or collet in straight turning. Shoulders are turned, or formed, to various shapes to suit the requirements of a particular part.

As in figure Turn-34, **steps of shoulder process on a lathe** are similar to the longitudinal turning process.

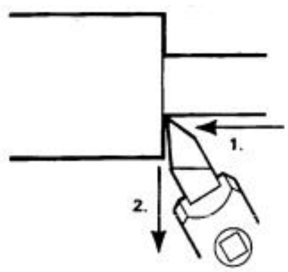


Figure Turn-34: a shoulder turning process

**Eighth: Angular Shoulders:**

Sometimes, the angular shoulders are used to eliminate the sharp corners.

As in figure Turn-35, **steps of shoulder process on a lathe** are the same manner of the square shoulders by using a side turning tool which is set at the desired angle of the shoulder.

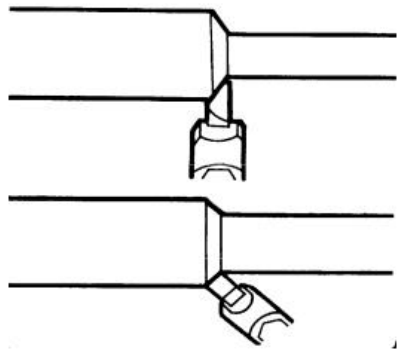

Figure Turn-35: using two tool to angular shoulders cutting processes

**Ninth: Grooves:**

Grooving (or necking) is the process of turning a groove on workpiece. The shape of the tool and the depth to which it is fed into the work govern the shape and size of the groove. The types of grooves most commonly used are square, round, and V-shaped as in figure Turn-36.

**Steps of the groove process on lathe** are similar to steps of the parting off process, but the depth of cut is smaller.

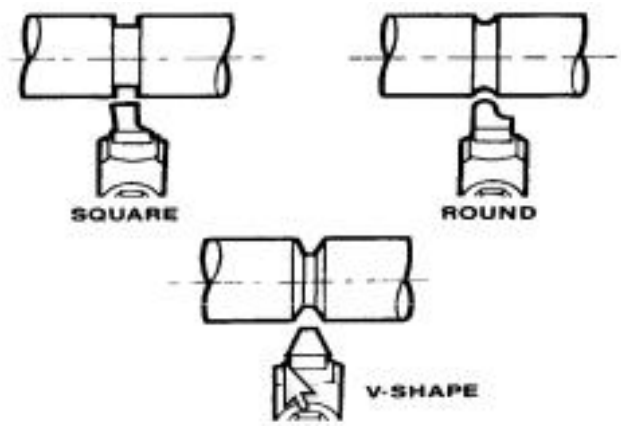


Figure Turn-36: common grooves

# Machining Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

**Semester:…………………………** **Academic year: ………/………**

| No. | Process | Sketch of Process | Feed | Speed | Depth of Cut | Machining Time | Material Removal Rate |
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# Shaping Workshop

## 1- Objectives:

- Identify the shaping machine.
- Identify the types of shaping machine.
- Identify the parts of the shaping machine.
- Apply some practical shaping processes.

## 2- Introduction:

The shaping process is an important operations which is used to make grooves and remove a layers from a surfaces. But, Shaping machines are not widely used now. Shaping produces the flat surfaces by moving a single point cutting tool in a reciprocating motion. It is used with the horizontal and vertical surfaces. This method is different from turning and milling processes in which chip is removed in longitudinal strips form. See figure Shaper-1.

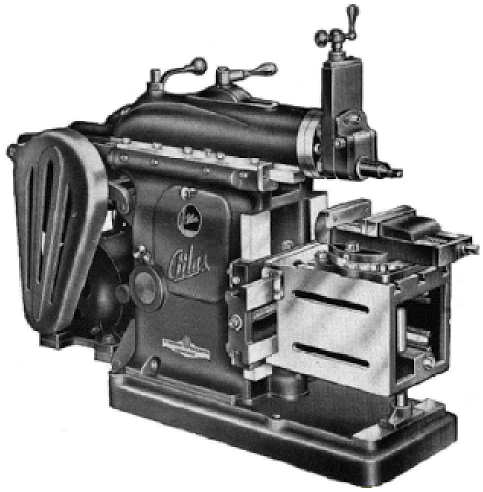
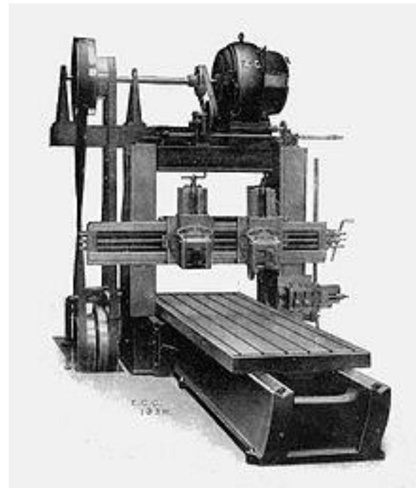

Figure Shaper-1: a shaping machine

## 3- Workshop prerequisites:

- Read from the text book about shaping process.
- Carefully, read the workshop manual.

## 4- Classification of shaping machine: As in figure Shaper-2.

- Shaper machine,
- Planer machine, and
- Vertical shaper machine.

a shaper a planer


a vertical shaper

Figure Shaper-2: types of shaping machine

## 5- Cutting tools of shaping machine:

As in figure Shaper-3, the used cutting tools in shaping processes are similar to turning cutting tools.

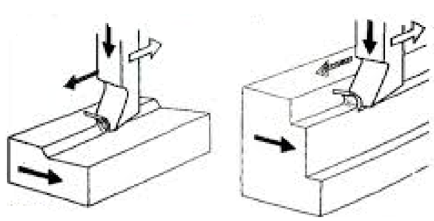


Figure Shaper-3: a shaping cutter

# Review questions:

1. List the different type of shaping machine.

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2. With sketch, describe cutting tool of shaping machine.

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# Shaping Processes

**First: Surface Adjustment (Face Shaping):**As in figure Shaper-4.

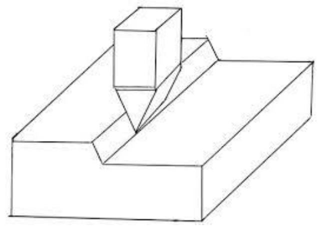

Figure Shaper-4: a face shaping process

**Steps of surface adjustment on a shaping machine are as follows:**

1. Select a shaping machine.
2. Adjust the cutting speed, feed and cutting depth.
3. Machine table must be away than the cutting tool position.
4. Hold a vice on the machine table in a right position.
5. As in figure Shaper-5, hold the workpiece with the vice (workpiece surface must be perpendicular to the cutter axis). It is possible to use a wooden part under workpiece. The wooden part must has a width lower than workpiece width to help in workpiece support and to prevent workpiece side movement due to cutting forces.

Figure Shaper-5: hold the workpiece on a vice

6. As in figure Shaper-6, select and hold a suitable cutting tool on the tool post.

Figure Shaper-6: hold the cutting tool on a tool-post

7. Manually, feed the workpiece up toward the cutting tool -until reaching to a proper and close position between cutting tool and workpiece- by a suitable machine table handle.
8. Ram distance movement must be adjusted according to the machined length.
9. Run the machine.
10. In the beginning of operation, a slowly manual contact between the workpiece surface and cutting tool teeth must be done.
11. Automatically and traversal, feed the workpiece toward the cutting tool.
12. If depth of cut is large, previous step can be repeated.
13. After finishing, turn off power supply.
14. Machine table must be away than the shaping cutting tool.
15. Unscrew the vice and take the final product.
16. Remove the chip.

**Second: Shoulders:** As in figure Shaper-7.

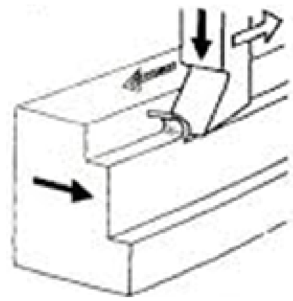

Figure Shaper-7: a shoulder in shaping process

The procedures of this process is as the previous process steps, but the cutting width is smaller than in face shaping. This process can be repeated until the required cutting depth is achieved.

# Machining Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

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# Grinding Workshop

## 1- Objectives:

- Identify the types of grinding operations.
- Apply some practical grinding processes.

## 2- Introduction:

The grinding process is defined as a fine finishing process by removing a very thin layer of metal through a tool called the grinding stone (grinding wheel). The grinding machine differs from the other operating machines because of it has thousands of cutting edges.

## 3- Workshop prerequisites:

- Read from the text book about grinding process.
- Carefully, read the workshop manual.

## 4- Grinding machine components: See figure Grind-1.


Figure Grind-1: a grinding machine

The grinding machine consists of  the follows:

- Bed with a fixture to guide and hold the workpiece**.**
- Power-driven grinding wheel spinning at the required speed. The speed is determined by the wheel's diameter and manufacturer's rating.
- Grinding head can travel across a fixed work piece, or the work piece can be moved while the grind head stays in a fixed position.

## 5- Purpose of the grinding processes:

- To get a high surface finishing.
- To get a high accuracy in dimensions.
- To grind different cutting tools.

## 6- Grinding wheel:

A grinding machine, often shortened to grinder, is any of various power tools or machine tools used for grinding, which is a type of the machining by using an abrasive wheel as a cutting tool as in figure Grind-2. Each grain of abrasive on the wheel's surface cuts a small chip from the workpiece via the shear deformation.

Figure Grind-2: a grinding wheel

## 7- Final product of grinding process:

As in figure Grind-3, grinding is used to finish the workpieces with a high surface quality (low surface roughness) and high accuracy of shape and dimension.

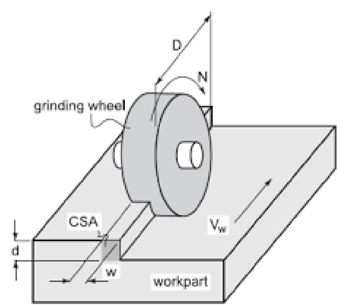


Figure Grind-3: a grinding process

# Review Questions

1. What are the grinding machine consists of?

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2. What are the grinding operations purposes?

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3. With sketch, describe the grinding wheel.

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# Grinding Processes

**First: External Grinding:**

**Steps of an external grinding on a grinding machine are as follows:**

1. Select a grinding machine.
2. Adjust cutting speed, feed and cutting depth (depth of cut must be very small).
3. Grinding wheel must be away than the machine table.
4. Hold a vice on the machine table in a right position.
5. Hold the workpiece with the vice (workpiece surface must be parallel to the cutter axis).
6. Select and hold  a suitable grinding wheel.
7. Manually, feed the grinding wheel down toward the workpiece surface -until reaching to a proper and close position between the cutting tool and workpiece- by a suitable handle.
8. Run  the machine.
9. As in figure Grind-4, In the beginning of  operation, a slowly manual contact  between the workpiece surface and cutting tool teeth must be done.

Figure Grind-4: contact between a grinding wheel and workpiece

10. As in figure Grind-5. automatically and traversal, feed the grinding wheel toward the workpiece surface.

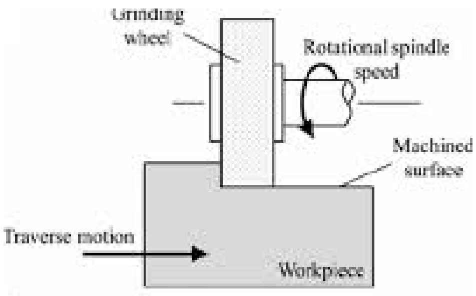


Figure Grind-5: a travers feeding

11. If depth of cut is large, previous step can be repeated.
12. After finishing, turn off power supply.
13. Grinding wheel must be away than the workpiece.
14. Unscrew the vice and take the final product.
15. Remove the chip.

# Machining Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

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# <u>Drilling Workshop</u>

## 1- Objectives:

- Identify the types of drilling operations.
- Apply some practical drilling processes.

## 2- Introduction:

The process of forming the holes in parts by two movements: the first rotary movement of the cutting tool around its axis, and the second is a movement of the transition towards the axis of cutter. Drilling is the oldest metalworking. See figure Drill-1.

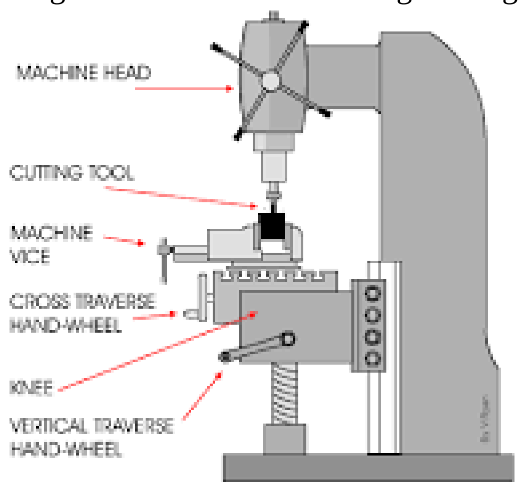


Figure Drill-1: a drilling machine

## 3- Workshop prerequisites:

- Read from the text book about drilling process.
- Carefully, read the workshop manual.

## 4- Geometry of drilling cutting tool: As in figure Drill-2.

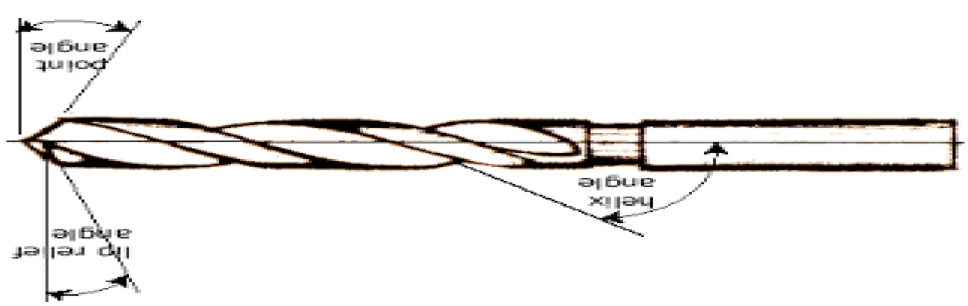


Figure Drill-2: a drilling tool Geometry

## 5- Drilling operations:

It is used to get the follows:

- Through holes.
- Blind holes.
- Help in threading.

## 6- Types of drilling machines:

a. Conventional drilling machine: As in figure Drill-3.

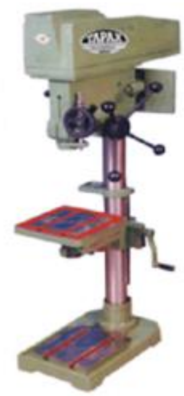

Figure Drill-3: a conventional drilling machine

Components of conventional drilling machine are:

- Gearbox.
- Manual handle for  feeding.
- Drill column.
- Machine table.
- Electric motor.

b. Tree drill: As in figure Drill-4.

Components of tree drill machine are:

- Gearbox.
- Manual handle feeding.
- Drill column.
- Base.
- Rack and pinion.
- Machine table.
- Power screw shaft.

c. Radial drill: As in figure Drill-5.

Components of radial drill machine are:

- Rule.
- The motion column.
- Manual handle for feeding.
- Electric motor.
- Machine table.
- Base.

Figure Drill-4: a tree drilling machine


Figure Drill-5: a radial drilling machine

d. Gang drill: As in figure Drill-6.

Components of radial drill machine are similar to the conventional drilling machine, but, with multiple heads and tools.

Figure Drill-6: a gang drilling machine

# Review Questions

1. With sketch, describe drilling tool geometry.

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2. What are types of drilling machines?

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# Drilling Processes

**First: Drilling a Hole:**

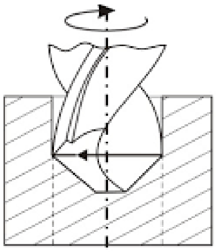

Figure Drill-7: a drilling process

**Steps of hole drilling process on a drilling machine are as follows:**

1. Choose a drilling machine.
2. Adjust cutting speed, feed and cutting depth.
3. Drilling tool must be away than the machine table.
4. Hold a vice on the machine table in a right position.
5. Centering the workpieces is a good step to prevent any wrong machining. This can be done with a small drilling tool on the drilling machine.
6. Hold the workpiece on the vice (workpiece surface must be perpendicular to the cutter axis).
7. Select and hold a suitable chuck according to the drilling tool dimensions.
8. Select and hold  a suitable drilling tool.
9. Raise machine table to a proper position to start the cutting. See figure Drill-8.

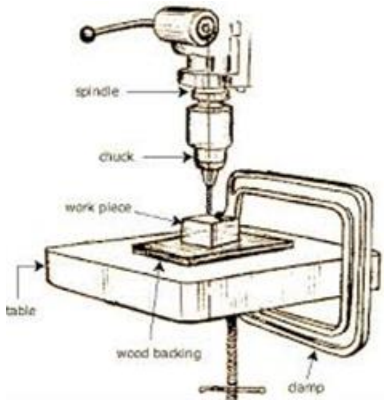


Figure Drill-8: a machine table of a drilling machine

10. Adjust the workpiece position to make the centers of required hole and drilling tool at the same line.
11. Run the machine to rotate the main spindle.

12. Manually and slowly, feed the drilling tool down toward the workpiece surface.
13. If it is necessary, increase the feed.
14. If a depth of cut is large, previous step can be repeated.
15. After finishing, turn off power supply.
16. Drilling tool must be away than the workpiece.
17. Unscrew the vice and take the final product.
18. Remove the chip.

**Second: Drilling a Large Hole:** As in figure Drill-9.

In this case, **steps of drilling large hole on a drilling machine** are the same steps of the previous process, but cutting procedures must be repeated several times. Each time, a larger drilling tool must be used to get a larger hole than a previous hole, and this must be done until the required hole diameter is get.

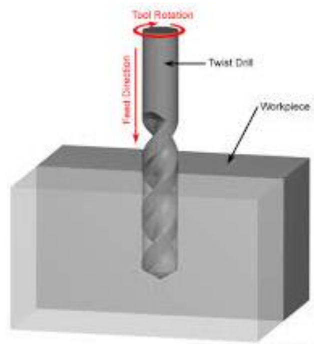


Figure Drill-9: a drilling of large and deep diameter

# Machining Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

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# Sawing Workshop

## 1- Objectives:

- Identify the types of sawing operations.
- Apply some practical sawing processes.

## 2- Introduction:

A saw is a tool consisting of a tough blade, wire, or chain with a hard toothed edge. It is used to cut through material, very often wood though sometimes metal or stone. The cut is made by placing the toothed edge against the material and moving it forcefully forth and less forcefully back or continuously forward. This force may be applied by hand, or powered by steam, water, electricity or other power source. An abrasive saw has a powered circular blade designed to cut through a metal or ceramic. See figure Saw-1.

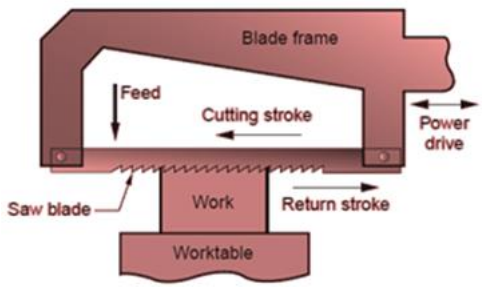


Figure Saw-1: a saw machine

## 3- Workshop prerequisites:

- Read from the text book about sawing process.
- Carefully, read the workshop manual.

## 4- Types of sawing machine:

Power hacksaw machine provides a vise for clamping the work and means for reciprocating a U-shaped frame on which is mounted a straight steel hacksaw blade that cuts when moving in one direction only. As in figure Saw-2, the saw presses down on the work during the cutting stroke.

As in figure Saw-3, a circular saw is a power-saw using a toothed or abrasive disc or blade to cut different materials using a rotary motion spinning around an arbor. Circular saws may also be loosely used for the blade itself. A circular saw is a tool for cutting many materials such as wood, masonry, plastic, or metal and may be hand-held or mounted to a machine.

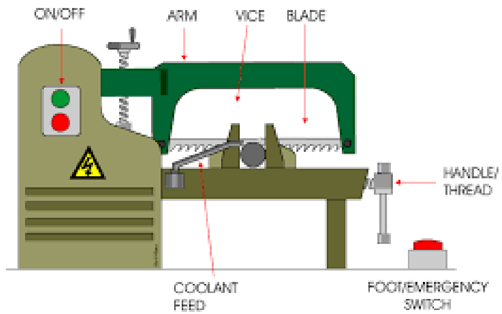


Figure Saw-2: a power hacksaw machine


Figure Saw-3: a circular saw machine

# Review Questions

1. Define a saw tool.

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2. What are types of sawing machines?

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# Sawing Process

**First: Straight Cut:**

**Steps of straight cut on a saw machine are as follows:**

1. Choose a saw machine.
2. Adjust cutting speed, feed and cutting depth.
3. Saw blade must be away than the machine table.
4. Hold workpiece on a machine table vice in a suitable position according to the machined area and blade position.
5. Select and hold a suitable blade. See figure Saw-4.

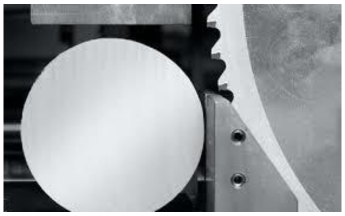

Figure Saw-4: a saw machine blade

6. Adjust a blade movement direction toward the workpiece. See figure Saw-5.

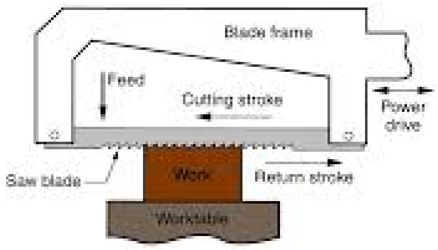


Figure Saw-5: a blade in a suitable position

7. As in figure Saw-6, close the blade to the workpiece surface.

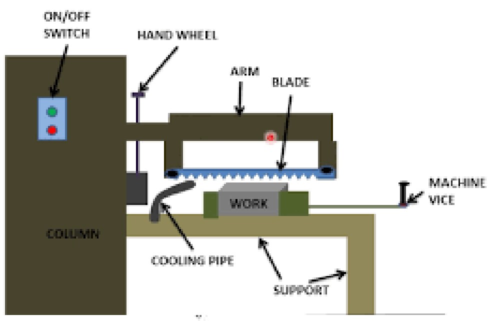


Figure Saw-6: close distance between the blade and workpiece surface

8. Run the machine. See figure Saw-7.

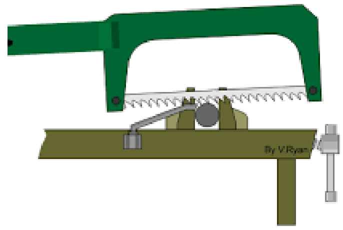

Figure Saw-7: an inclined cut during saw machine running

9. After finishing, turn off power supply.
10. Adjust a blade movement direction to away than the workpiece.
11. Run the machine to away blade than the workpiece.
12. Unscrew the vice and take the final product.
13. Remove the chip.

**Second: Inclined Cut:**

In this case, **steps of inclined cutting on a saw machine** are the same as the previous cutting process, but, vice must be inclined to a suitable angle to adjust the machined workpiece in a required angle.

# Machining Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

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# Sheet Metal working and forming Workshop

## 1- Objectives:

- Identify the types of sheet metal operations.
- Apply some practical sheet metal working and forming processes.

## 2- Introduction:

As in figure Sheet-1, sheet metal working and forming processes are those in which force is applied to a piece of sheet metal to modify its geometry rather than remove any material.

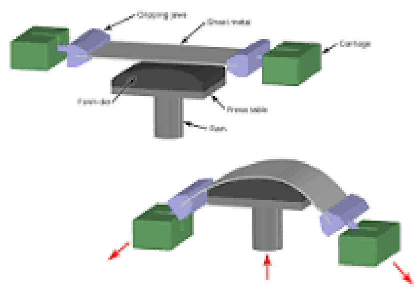

Figure Sheet-1: sheet metal working and forming processes

Sheet metal is metal formed by an industrial process into thin, flat pieces. Sheet metal is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. The used machines as in figure Sheet-2. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin sheets are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate steel or "structural steel." In most of the world, sheet metal thickness is consistently specified in millimeters. Sheet metal is available in flat pieces or coiled strips. The coils are formed by running a continuous sheet of metal through a roll slitter.

Figure Sheet-2: bending and cutting machines for sheet metal

## 3- Workshop prerequisites:

- Read from the text book about sheet metal process.
- Carefully, read the workshop manual.

# Review Questions

1. Define a sheet metal working and forming process.

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2. Name the processes of sheet metal working and forming.

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# Sheet Metal Process

**First: Manual Bending:**

It is used with sheets. **Steps of bending of a sheet-metal on a manual bender machine are as follows:**

1. As in figure Sheet-3, mark a bending place on a sheet metal.

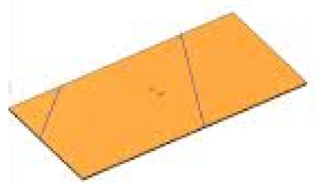

Figure Sheet-3: a marking of sheet metal

2. Lift upper manual bender part by a power screw handle (to get a distance between the two plates for a sheet-metal feeding).
3. Adjust a sheet-metal position according to the previous marking which is drawn on the sheet.
4. Down upper part of a machine by a power screw handle to hold the sheet-metal.
5. Raise a back plate by raising handle to get a desired bending.
6. Down a raising handle.
7. If the desired bending is not gotten, repeat the steps 5 and 6 until get it. See figure Sheet-4.

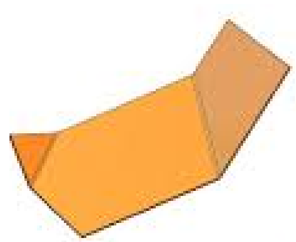

Figure Sheet-4: a bended sheet metal

8. lift upper part of the machine by a power screw handle to get the final sheet-metal.

**Second: Hydraulic Shearing Process:** As in figure Sheet-5.

It has the same steps of the previous bending, but, lift, down and cut is done by a hydraulic system.

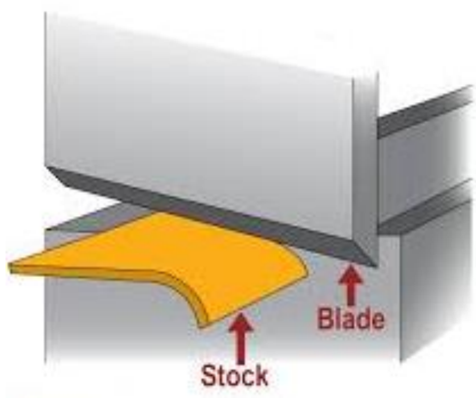


Figure Sheet-5: a hydraulic Shearing Process

As in figure Sheet-6, the hydraulic shearing process depends upon the shearing rules between the two blades.

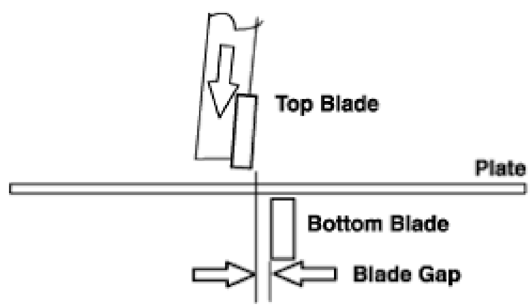


Figure Sheet-6: a shear in the hydraulic Shearing Process

# Process:………….

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# Welding Workshop

## 1- Objectives:

- Identify the types of welding processes.
- Apply some practical welding processes.

## 2- Introduction:

Welding is one of the most ancient processes used for joining metals, where the dating back thousands of years, and the oldest traces of the welding operations to the Bronze Age and Iron Age in the Middle East and Europe.

The middle Ages saw progress in method of welding, heating the metals and then moving them together until a solid weld was obtained. All these welding operations were primitive, but with the advent of the industrial revolution, the need for welding techniques developed. There was a great development in welding techniques and technology in the late $19^{th}$ and early $20^{th}$ centuries.

As in figure Weld-1, Fusion welding can be performed by raising temperature to melting. The heat required for the melting process can be obtained by gas, electric arc or by the heat released from chemical reactions. The required temperature can also be reached by the use of electrical induction.

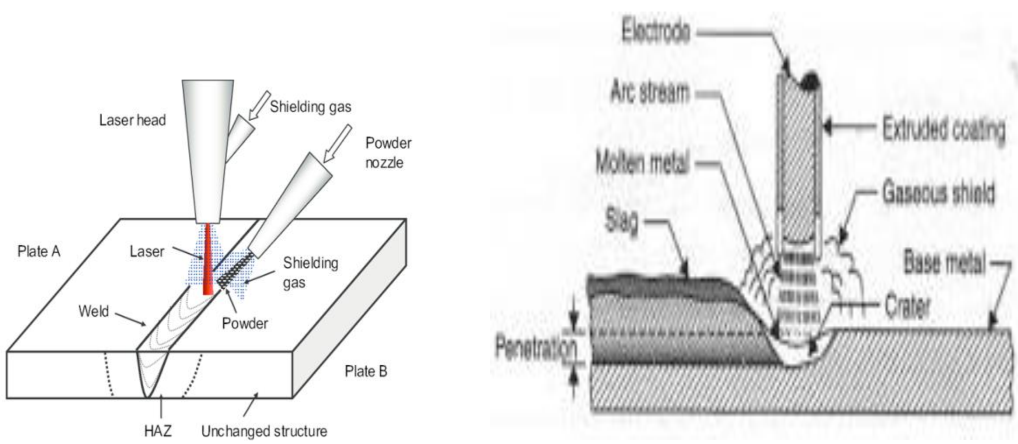


Figure Weld-1: welding as a melting process

## 3- Workshop prerequisites:

- Read from the text book about welding process.
- Carefully, read the workshop manual.

## 4- Types of connector:

The connection is divided into two types:

- Permanent connection, and
- Temporary connection.

The temporary connection is connected with screw, fastening, rivet, bolts, and joint. The permanent connection exists in gas welding or electric arc welding.

## 5- Types of welding methods:

- Electric arc welding: As in figure Weld-2.

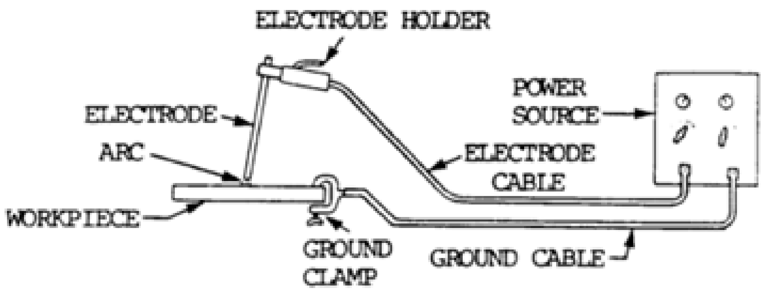


Figure Weld-2: an electrical arc welding process

Electric arc welding is one of the most important types of the joining processes at all, and is done by the heat resulted from an electric arc generated between the electrode and the welded part. In electric arc welding processes, the welding temperature may reaches 4000 ° C, which is sufficient enough to melt the metal at the welding zone or to melt a filler metal wire. A strong joint can be obtained after cooling . A generator for welding operations can produce AC and DC.

- Gas welding: as in figure Weld-3.

Figure Weld-3: a gas welding process

Gas welding is one of the most common types of welding, in which the edges of the base materials, as well as the filler material, are melted due to the generation of heat resulting from the combustion of a gas mixture (suitable gas fuel) with air or pure oxygen. The welding process is completed after the molten metal is frozen in the welding zone. The most important gases used for heating in this welding process are: acetylene, hydrogen, natural gas, kerosene, or gasoline.

- TIG or Gas Tungsten Arc Welding: As in figure Weld-4.

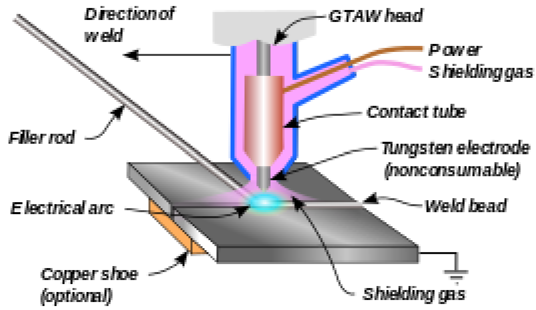


Figure Weld-4: TEG welding process

This type of welding is one of the first developments of electric arc welding. Protection of weld zone is achieved by using an inert gas such as argon, helium, or mixture gases. One type or more of which is used to isolate the welding area from the air.

- Welding of electrical resistance (spot welding): As in figure Weld-5.

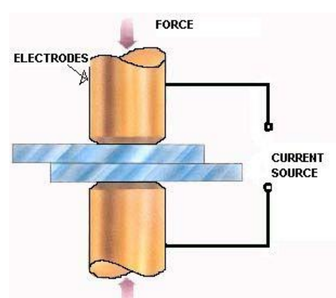


Figure Weld-5: a spot welding process

Resistance welding is a method of welding in which heat and pressure are used. A high current with low voltage is applied in a specific position for short time to generate the necessary heat for joining.

The welding process is completed at the point or place where the heat is increased by pressure by polarity.

This method of welding is easy to complete with high productivity, so it is considered an economical method compared with other welding methods. This method has the advantage of joining dissimilar metals.

This method is most suitable for welding thin sheets of ferrous and non-ferrous metals and alloys.

# Review Questions

1. Define welding process.

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2. List type of welding methods.

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3. Outline with sketch the different types of the weld joints

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4. List types of welding defects

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# Welding Processes

**First: Electrical Arc Welding:** As in figure Weld-6.

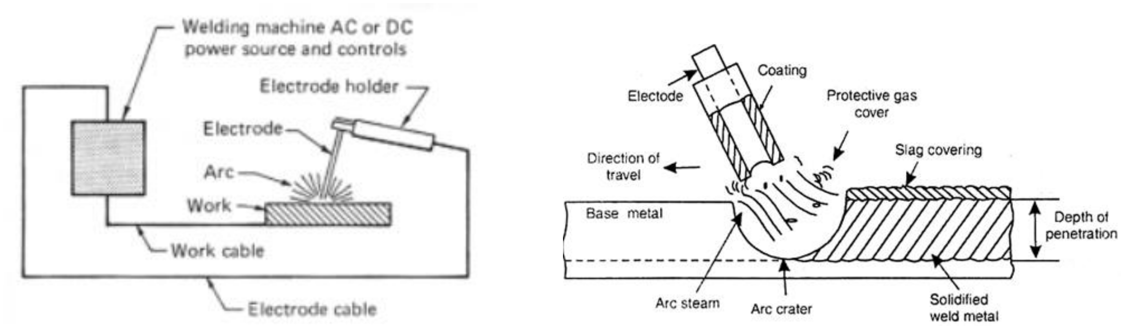


Figure Weld-6: an electrical arc welding process

**Steps of Arc Welding are as follows:**

1. Prepare parts to the welding process by using a wire brush or grinder to remove dirt, grime or rust from the area to be welded to get a good weld. Unclean conditions can lead to cracking, porosity, lack of fusion or inclusions.
2. As in figure Weld-7, current should be set up in DC positive, DC negative or AC. The correct amperage setting primarily depends on the diameter and type of electrode you select.

   As in figure Weld-8, if your amperage is too low, your electrode will be especially sticky when striking an arc, your arc will keep going out while maintaining the correct arc length or the arc will stutter.


Figure Weld-7: adjust the current

Figure Weld-8: a result of too little current

   As in figure Weld-9, if arc sounds louder than normal, your amperage might be set too high. Too much heat can also negatively affect the electrode's flux properties. See figure Weld-10.

3. Adjust length of arc as in figure Weld-11, where the optimal arc length, or distance between electrode and puddle, is the same as the diameter of the electrode.

As in figure Weld-12, holding the electrode too closely to the joint decreases welding voltage, which will create greater potential for the electrode sticking to the base material.

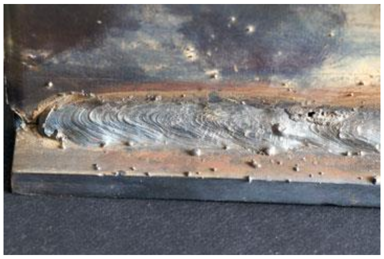

Figure Weld-9: a result of too much current

Figure Weld-10: a sign of too much current

Figure Weld-11: a length of arc

Figure Weld-12: an arc length that is too short

As in figure Weld-13, excessively long arcs (too much voltage) produce spatter, low deposition rates and often leaves porosity.

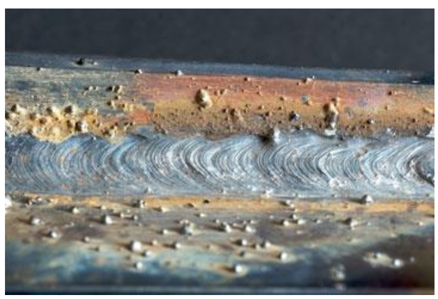

Figure Weld-13: too long of an arc length

4. As in figure Weld-14, adjust the angle of travel: the direction of travel approximately 0 to 15 degrees.
5. As in figure Weld-15, adjust the travel speed: Your travel speed should allow you to keep the arc in the leading one-third of the weld pool. Traveling too slowly produces a wide and convex bead with shallow penetration.

Figure Weld-14: angle of travel

Figure Weld-15: too slow of a travel speed

As in figure Weld-16, excessively fast travel speeds also decrease penetration and will create a thinner/undersized bead.

Figure Weld-16: traveling too fast

Steps

1. Turn on power supply.
2. Start welding stroke.
3. After finishing welding length, turn off power supply.
4. Take welded parts with suitable equipment.
5. Clean welded area.

**Second: Spot Welding:**

Resistance spot welding (RSW) is a process in which contacting metal surface points are joined by the heat obtained from resistance to electric current. It is a subset of electric resistance welding.

Work-pieces are held together under pressure exerted by electrodes. Typically the sheets are in the 0.5 to 3 mm (0.020 to 0.118 in) thickness range. The process uses two shaped copper alloy electrodes to concentrate welding current into a small "spot" and to simultaneously clamp the sheets together. Forcing a large current through the spot will melt the metal and form the weld. The attractive feature of spot welding is that a lot of energy can be delivered to the spot in a very short time (approximately 10–100 milliseconds). That permits the welding to occur without excessive heating of the remainder of the sheet.

This welding procedure can be repeated as often as necessary, depending on the workpiece size. Therefore, despite the small spot welds, a high degree of stability can be achieved.

Spot welding is generally used in sheet metalworking or, for example, for joining steel sheets in vehicle body production and vehicle production.

**Steps of Spot Welding are as follows:**

1. As in figure Weld-17, aligning the workpieces in order to join the workpieces by means of spot welding they must be precisely aligned with each other, as correction after welding is not easy.

Figure Weld-17: aligning workpieces

2. Suitable electrodes are chosen for welding the workpieces. These are mostly made of copper alloys with fractions of tungsten and molybdenum, which can withstand the high temperatures and pressures.
3. As in figure Weld-18, pressing on the electrodes.

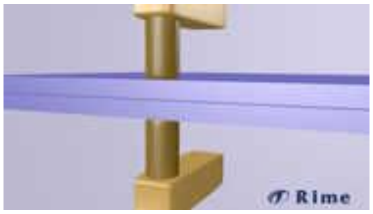

Figure Weld-18: pressing in spot welding process

4. As in figure Weld-19, the current is flowing if the electrodes have been positioned correctly, the current is switched on, which flows from one electrode to the other with a very high power. The material is heated so much that it liquefies and so both workpieces join.

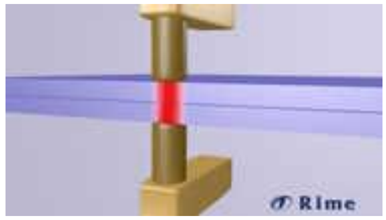


Figure Weld-19: heating in spot welding

5. The workpiece are tightly joined. The time during which the electrical current must flow through the workpieces varies, depending on the material and workpiece thickness. As in figure Weld-20, if the parts are tightly joined, the electrodes are removed in order to repeat the process at the next welding point.

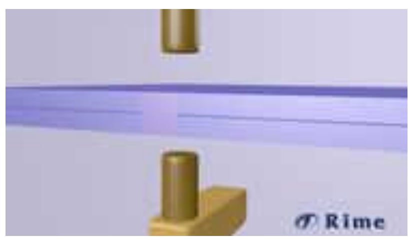


Figure Weld-20: removing electrode in spot welding process

6. After finishing welding nugget, turn off power supply.
7. Take welded parts.

# Welding Process:………….

**Sheet number:………..** **Date:………/…………/……..…**

**Semester:…………………………** **Academic year: ………/………**

| No. | Process Type | Joint type | Welding position | Current | Speed | Voltage | Thickness | Electrode |
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