

USN

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



### Internal Assessment Test 3 – December 2019

Sub:	Elements of Mechanical Engineering					Sub Code:	18ME25	Branch:	EC/EE/ME			
Date:	13/12/2019	Duration:	90 min's	Max Marks:	50	Sem / Sec:	I/ I,J,K,L,M,N,O			OBE		
<u>Answer any 5 Questions</u>										MARKS	CO	RBT
1.	Explain the following lathe operations: i) Plain turning ii) Knurling iii) Taper turning by swiveling of compound rest iv) Thread cutting					[10]	CO5	L2				
2	Explain the working of Split air conditioning system. Also list the properties of ideal refrigerants.					[10]	CO2	L2				
3	Explain the following milling operations. i) Slab Milling ii) Straddle Milling iii) Gang Milling iv) Slot Milling					[10]	CO5	L2				
4	Explain the basic components of CNC with a block diagram.					[10]	CO5	L2				
5	What is a composite material? State its advantages and applications.					[10]	CO3	L1				
6	Explain any two robot configurations with a neat sketch. Mention the application of robot.					[10]	CO5	L2				
7	Explain construction and working of a vapour compression refrigeration system.					[10]	CO5	L2				

USN 

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



**Scheme of Evaluation Internal Assessment Test III – December. 2019**

Sub:	Industrial Safety	Sub Code:	18ME15	Branch:	ME, EC, EE
Date:	13/12/2019	Duration:	90 min's	Max Marks:	50
Sem / Sec:	1 <sup>st</sup> I,J,K,L,M,N,O				

<b><u>Answer any 5 question</u></b>		Split up	Max. MARKS
1.	<p>Explain the following lathe operations:            i) Plain turning ii) Knurling iii) Taper turning by swiveling of compound rest iv) Thread cutting  <b>Diagram 1 Mark each</b>  <b>Explaining 1.5 mark each ----- 2.5 mark Each operation</b></p>	<p align="center"><b>4M</b> <b>6M</b></p>	[10]
2	<p>Explain the working of Split air conditioning system. Also list the properties of ideal refrigerants.  <b>Diagram – 4 Mark</b>  <b>Working – 3 Mark</b>  <b>Stating properties – 3 mark</b></p>	<p align="center"><b>4M</b> <b>3M</b> <b>3M</b></p>	[10]
3	<p>Explain the following milling operations.            i) Slab Milling ii) Straddle Milling iii) Gang Milling iv) Slot Milling  <b>Diagram 1 Mark each</b>  <b>Explaining 1.5 mark each ----- 2.5 mark Each operation</b></p>	<p align="center"><b>4M</b> <b>6M</b></p>	[10]
4	<p>Explain the basic components of CNC with a block diagram.  <b>Block Diagram – 4 Mark</b>  <b>Explanation – 6 Mark</b></p>	<p align="center"><b>4M</b> <b>6M</b></p>	[10]
5	<p>What is a composite material? State its advantages and applications.  <b>Definition – 2 Mark</b>  <b>Advantages – 4 Mark</b>  <b>Application – 4Mark</b></p>	<p align="center"><b>2M</b> <b>4M</b> <b>4M</b></p>	[10]
6	<p>Explain any two robot configurations with a neat sketch. Mention the application of robot.  <b>Configuration diagram – 1.5 Mark each</b>  <b>Explanation – 1.5 Mark each</b>  <b>Application – 4 Mark</b></p>	<p align="center"><b>3M</b> <b>3M</b> <b>4M</b></p>	[10]
7	<p>Explain construction and working of a vapour compression refrigeration system.  <b>Diagram – 4 Mark</b>  <b>Construction – 3Mark</b>  <b>Working – 3 Mark</b></p>	<p align="center"><b>4M</b> <b>3M</b> <b>3M</b></p>	[10]

## Solution of 3<sup>rd</sup> IAT

1

### Cylindrical (plain) turning

It is an operation to produce a uniform cylindrical surface of the required diameter. Hence, the diameter of the workpiece is reduced. The workpiece is held in the chuck as shown in Fig. 9.6. A turning tool is fixed to the tool post. The lathe is started at a suitable spindle speed and the tool is brought near the axis of the workpiece using a cross slide. Using a safe depth of cut, the tool (carriage) is slowly moved parallel to the axis of the workpiece to the desired length and disengaged at the end.

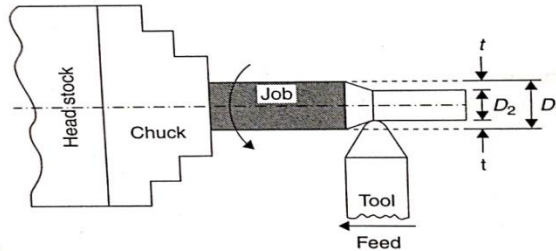


Fig. 9.6 Plain turning

### 5.3.7 Threading

Threading is the act of cutting of the required form of threaded profiles on the internal or external cylindrical surfaces of the work piece. In this process, tool of the form of thread is fixed rigidly in tool post. The carriage assembly is coupled to rotating lead screw is engaged for the movement. Gradual movement of tool takes place along the work piece length and formation of threads takes place on the work piece as shown in the Fig. 5.9.

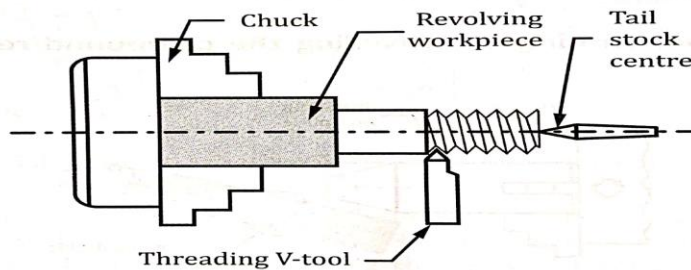


Fig. 5.9: Thread cutting operation

### Taper turning using compound slide swivelling method

Here, the workpiece is held in the chuck. A suitable cutting tool is held in the tool post. The semi-taper angle is calculated using the equation,

$$\alpha = \tan^{-1} \frac{D_1 - D_2}{L} \quad (9.2)$$

The compound slide is swivelled to an angle  $\alpha$  to the horizontal and clamped as shown in Fig. 9.14. The carriage is locked to arrest axial movement. The tool is brought near the workpiece and made to just touch it using a cross slide. The lathe is started at a suitable spindle speed and the tool is made to travel linearly at the required depth of cut at an angle  $\alpha$  to the workpiece axis by rotating the compound slide handle slowly by hand. As soon as the tool reaches the other end of the taper, it is withdrawn and set back to the next cut. The compound slide is swivelled to the right or left side of the operator depending on the direction of taper to be produced.

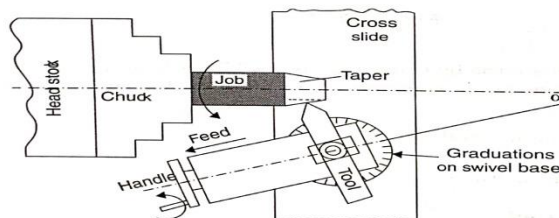


Fig. 9.14 Compound slide swivelling method

### 5.3.3 Knurling

The knurling is a process of embossing (impressing) a diamond-shaped or straight-line pattern into the surface of work piece. Knurling is essentially a roughening of the surface and is done to provide as shown in Fig. 5.5 gripping surface.

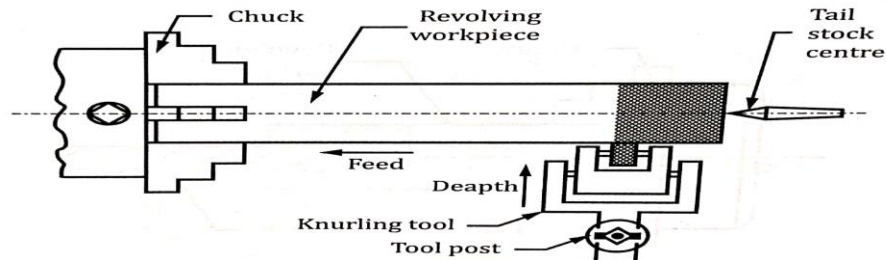


Fig. 5.5: Knurling operation

2.

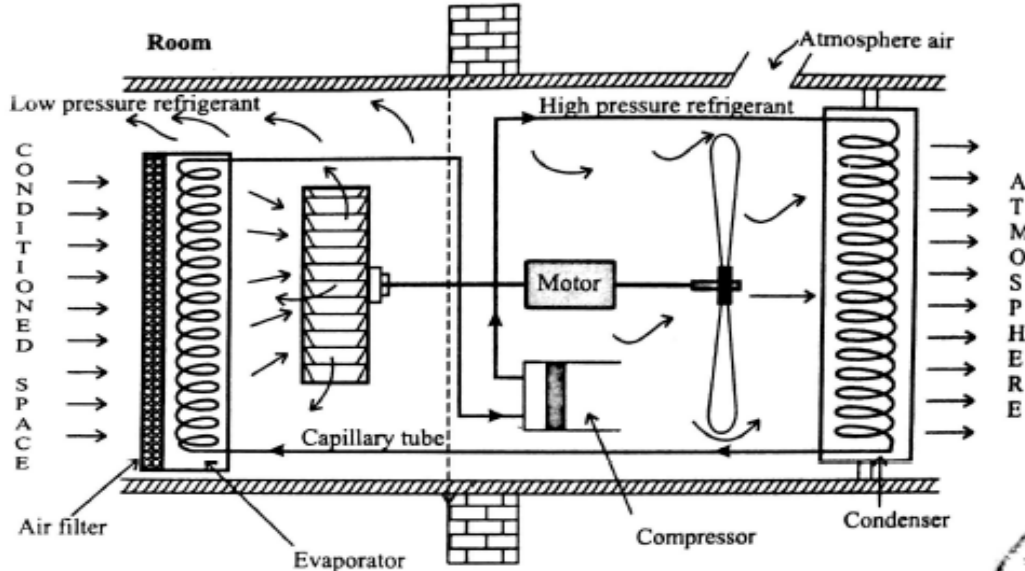


Fig. 5.6 : Air conditioner

The system consists of a **compressor, a condenser, an evaporator, a capillary tube, condenser and evaporator fans** driven by the same motor. The evaporator fan and the evaporator coils of the unit always lie inside the building or space which is to be conditioned. Condenser and the condenser fan of the unit projects outside the building or space to enable heat transfer with the atmosphere.

The high pressure refrigerant leaving the compressor enters the condenser coils. The latent heat of the refrigerant vapour is given to the surrounding atmosphere. Condensation takes place due to this heat transfer as the condenser fan draws air from outside the building and circulates it over the condenser coils. The high temperature liquid refrigerant enters the capillary tube and expands in it. Partial evaporation of the refrigerant takes place in the capillary tube reducing the pressure to evaporator pressure. The cold refrigerant enters the evaporator coils. The evaporator fan continuously draws hot air from the conditioned space and circulates it over the evaporator coils. The hot air passing through the air filter comes in contact with cold evaporator coils and exchanges its heat. The cool fresh air enters the conditioned space. As a result, complete evaporation of the refrigerant takes place which enters the compressor again. The cycle repeats again and again. Desired temperature inside the room can be adjusted by thermostatic control device.

### Straddle milling (side milling)

It is an operation of milling two parallel vertical surfaces of a workpiece (such as square and hexagonal heads of bolts simultaneously) using two side milling cutters as shown in Fig. 11.10. The distance between the cutters is adjusted by suitable spacers.

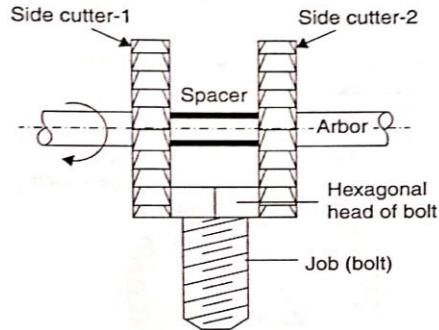


Fig. 11.10 Straddle milling

### Gang milling

It is an operation of milling a number of horizontal and vertical faces of a workpiece simultaneously at one pass using a combination of more than two different cutters as shown in Fig. 11.11. The types and sizes of cutters need not be the same as they depend on the surfaces of the job to be milled. However, they are mounted on the same arbor. Gang milling is useful in mass production.

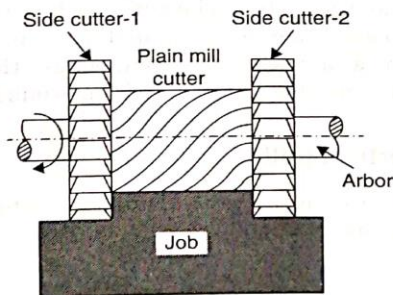


Fig. 11.11 Gang milling

### 5.10.8 Slot Milling

It is used to machine T-slot grooves in worktables, fixtures, and other holding devices. The cutter has a plain or side milling cutter mounted to the end of a narrow shank. The throat of the T-slot is first milled with a side or end milling cutter and the headspace is then milled with the T-slot milling cutter as shown in the Fig. 5.24

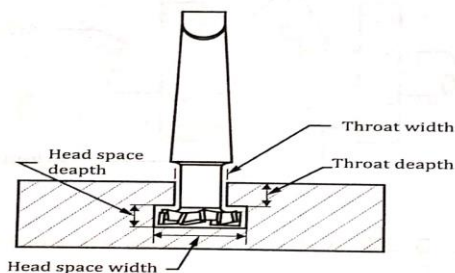


Fig. 5.24: Slot milling operation

### 5.10.1 Plain or slab Milling

It is the process employed for machining a flat surface parallel to the axis of the cutter by using a plain or slab milling cutter as shown in figure. Here the plain milling cutter is used which is rigidly fixed on the arbor and allow rotation. The work piece to be machined is fixed on the table and table is moved upwards to give required depth of cut. Table is reciprocated with respect to rotating cutter for proper feed and machining. Machining takes place from the surface of the work ice resulting behind flat machined work piece. The plain milling operation is as shown in the Fig. 5.17

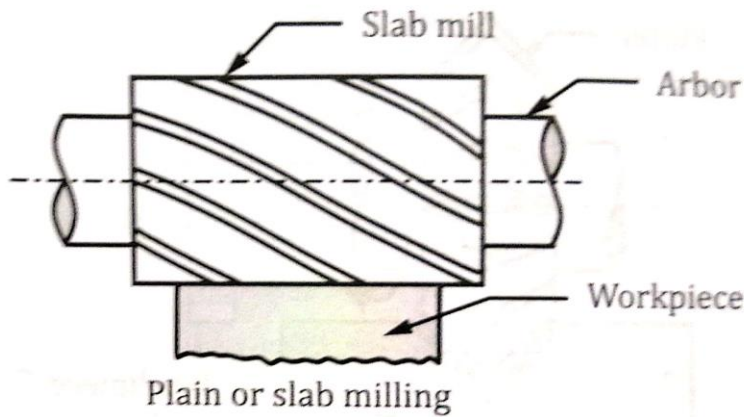
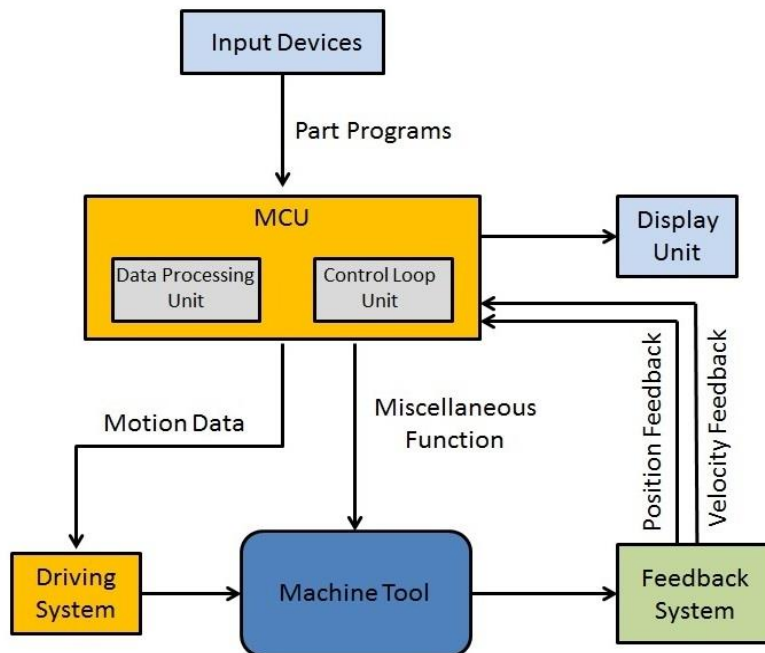


Fig. 5.17: Plain milling operation

4



The main parts of the CNC machine are

**(i) Input Devices:** These are the devices which are used to input the part program in the CNC machine. There are three commonly used input devices and these are punch tape reader, magnetic tape reader and computer via RS-232-C communication.

**(ii) Machine Control Unit (MCU):** It is the heart of the CNC machine. It performs all the controlling action of the CNC machine, the various functions performed by the MCU are It reads the coded instructions fed into it.

It decodes the coded instruction.

It implements interpolation ( linear, circular and helical ) to generate axis motion commands.

It feeds the axis motion commands to the amplifier circuits for driving the axis mechanisms.

It receives the feedback signals of position and speed for each drive axis.

It implements the auxiliary control functions such as coolant or spindle on/off and tool change.

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

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

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

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

## 5

A composite material (also called a composition material or shortened to composite, which is the common name) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure, differentiating composites from mixtures and solid solutions.

## Advantages:

**Design Flexibility** – Thermoset Composites give designers nearly unlimited flexibility in designing shapes and forms. They be molded into the most intricate components and can be made a wide range of densities and chemical formulations to have precise performance properties.

**Low cost per cubic inch** – When comparing costs based on volume, thermoset composites have lower material costs than traditional materials such as wood, engineered thermoplastics and metals. In addition, because thermoset composites have a low petroleum-based content, they are not subjected to the price fluctuations experienced in petroleum-based.

**Lower material costs** – Because thermoset composites can be precisely molded, there is little waste and therefore significantly lower overall material costs than metals products.

**Improved productivity** – Industrial Designers and Engineers are able to reduce assembly costs by combining several previously assembles parts into a single component. Also, inserts can be molded directly into the part during the molding process thereby eliminating the need for a post-process. In addition, composites do not usually require additional machining, thereby reducing work-in-process and time to market.

### Other key advantages include:

- As molded dimensional accuracy
- Tight tolerance, repeatable moldings
- Low-post mold shrinkage
- Chemical Resistance
- Consolidated Parts and Function
- Corrosion Resistance
- Design Flexibility
- Durable
- High Flexural Modulus to Carry Demanding Loads
- High Impact Strength
- High Performance at Elevated Temperatures
- Heat Resistance
- Naturally Flame Retardant
- Creep Resistance
- Mechanical Property Retention
- Superior Thermal Stability
- Lighter Weight than Metal
- Lower Costs vs. Die Cast
- Low Petrochemical content
- Better cost stability than commodities
- Lower Cost per Cubic Inch as compared to Thermoplastics
- Molded-in Color
- Molded in inserts



## Application

1. Fiberglass : Applications - Storage Tanks
2. Fiberglass : Applications - Bathtubs
3. Fiberglass : Applications – Piping Systems
4. Fiberglass : Applications – Sports Masks & Helmets
5. Laminate Floors
6. Laminate Floors
7. Bulletproof Glass
8. Bulletproof Glass
9. The layers of woven Kevlar are sewn together using Kevlar thread, while the nonwoven Spectra Shield is coated and bonded with resins such as Kraton Army Applications : Bullet Proof Vest ♣ A bulletproof vest consists of a panel, a vest- shaped sheet of advanced plastics polymers that is composed of many layers of either Kevlar, Spectra Shield ♣ Raw Materials :
10. The Manufacturing Process : 1. To make Kevlar, the polymer poly-para-phenylene terephthalamide must first be produced in the laboratory. This is done through a process known as polymerization, 2. The resultant crystalline liquid with polymers in the shape of rods is then extruded through a spinneret (a small metal plate full of tiny holes that looks like a shower head) to form Kevlar yarn. 3. The Kevlar fiber then passes through a cooling bath to help it harden. After being sprayed with water, the synthetic fiber is wound onto rolls.
11. The Kevlar manufacturer then typically sends the fiber to throwsters, who twist the yarn to make it suitable for weaving. 5. To make Kevlar cloth, the yarns are woven in the simplest pattern, plain or tabby weave, which is merely the over and under pattern of threads that interlace alternatively. Army Applications : Bullet Proof Vest
12. Its made out of an ultra-high- molecular- weight polyethylene (UHMWPE) fiber Army Applications : Spectra Shield

## 6.

### **SCARA Robot**

The SCARA acronym stands for Selective Compliance Assembly Robot Arm or Selective Compliance Articulated Robot Arm.

The robot was developed under the guidance of Hiroshi Makino, a professor at the University of Yamanashi. The arms of SCARA are flexible in the XY-axes and rigid in the Z-axis that makes it to familiarize to holes in the XY-axes.

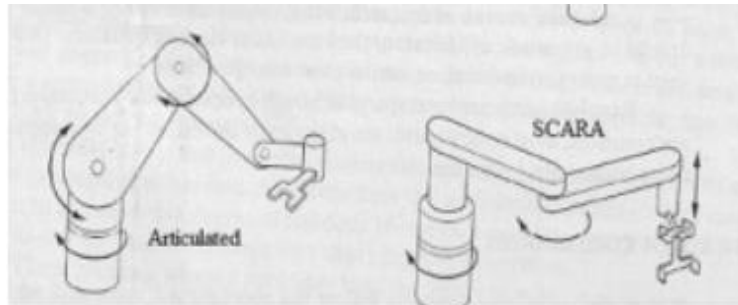
in the X-Y direction, the arm of SCARA robot will be compliant and strong in the ‘Z’ direction due to the virtue of the SCARA’s parallel-axis joint layout. Hence the term, Selective Compliant.

This robot is used for various types of assembly operations i.e. a round pin can be inserted in a round hole without binding using this. These robots are faster and cleaner than comparable robot

systems and they are based on serial architectures, that means the first motor should carry all other motors.

### **Articulated Arm (3R)**

- This is the most widely used arm configuration because of its flexibility in reaching any part of the working envelope.
- This configuration flexibility allows such complex applications as spray painting and welding to be implemented successfully.



---

#### 1 Arc Welding

Arc welding, or robot welding, became commonplace in the 1980s. One of the driving forces for switching to robot welding is improving the safety of workers from arc burn and inhaling hazardous fumes.

#### 2. Spot Welding

Spot welding joins two contacting metal surfaces by directing a large current through the spot, which melts the metal and forms the weld delivered to the spot in a very short time (approximately ten milliseconds).

#### 3. Materials Handling

Materials handling robots are utilized to move, pack and select products. They also can automate functions involved in the transferring of parts from one piece of equipment to another. Direct labor costs are reduced and much of the tedious and hazardous activities traditionally performed by human labor are eliminated.

#### 4. Machine Tending

Robotic automation for machine tending is the process of loading and unloading raw materials into machinery for processing and overseeing the machine while it does a job.

#### 5. Painting

Robotic painting is used in automotive production and many other industries as it increases the quality and consistency of the product. Cost savings are also realized through less rework.

#### 6. Picking, Packing and Palletizing

Most products are handled multiple times prior to final shipping. Robotic picking and packaging increases speed and accuracy along with lowering production costs.

## 7. Assembly

Robots routinely assemble products, eliminating tedious and tiresome tasks. Robots increase output and reduce operational costs.

## 8. Mechanical Cutting, Grinding, Deburring and Polishing

Building dexterity into robots provides a manufacturing option that is otherwise very difficult to automate. An example of this is the production of orthopaedical implants, such as knee and hip joints. Buffing and polishing a hip joint by hand can normally take 45-90 minutes while a robot can perform the same function in just a few minutes.

## 7.

It is a compression process, whose aim is to raise the refrigerant pressure, as it flows from an evaporator. The high-pressure refrigerant flows through a condenser/heat exchanger before attaining the initial low pressure and going back to the evaporator. A more detailed explanation of the steps is as explained below.

### STEP 1: COMPRESSION

The refrigerant (for example R-717) enters the compressor at low temperature and low pressure. It is in a gaseous state. Here, **compression takes place to raise the temperature and refrigerant pressure**. The refrigerant leaves the compressor and enters to the condenser. Since this process requires work, an electric motor may be used. Compressors themselves can be scroll, screw, centrifugal or reciprocating types.

### STEP 2: CONDENSATION

The condenser is essentially a heat exchanger. **Heat is transferred from the refrigerant to a flow of water**. This water goes to a cooling tower for cooling in the case of water-cooled condensation. Note that seawater and air-cooling methods may also play this role. As the refrigerant flows through the condenser, it is in a constant pressure.

One cannot afford to ignore condenser safety and performance. Specifically, pressure control is paramount for safety and efficiency reasons. There are several pressure-controlling devices to take care of this requirement

### STEP 3: THROTTLING AND EXPANSION

When the refrigerant enters the throttling valve, it expands and releases pressure. **Consequently, the temperature drops at this stage**. Because of these changes, the refrigerant leaves the throttle valve as a liquid vapor mixture, typically in proportions of around 75 % and 25 % respectively.

Throttling valves play two crucial roles in the vapor compression cycle. First, they maintain a pressure differential between low- and high-pressure sides. Second, they control the amount of liquid refrigerant entering the evaporator.

#### STEP 4: EVAPORATION

At this stage of the Vapor Compression Refrigeration Cycle, the refrigerant is at a lower temperature than its surroundings. Therefore, **it evaporates and absorbs latent heat of vaporization**. Heat extraction from the refrigerant happens at low pressure and temperature. Compressor suction effect helps maintain the low pressure.

There are different evaporator versions in the market, but the major classifications are liquid cooling and air cooling, depending whether they cool liquid or air respectively.

