CMR INSTITUTE OF TECHNOLOGY

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Internal Assesment Test - III

Sub:	Elements of Mechanical Engineering							Code:	21ME25
Date:	29 / 08 / 2022	Duration:	90 mins	Max Marks:	50	Sem:	II	Branch:	CS/CV/IS/ME

Answer Any FIVE FULL Questions

	Answer any full FIVE questions including question 1. Question number 1 is compulsory. Use of steam table is permitted.	**Marks**	OBE	
			CO	RBT
1.	A steam at 10 bar and dryness 0.98 receives 140kJ/kg at the same pressure. What is the final state and temperature of the steam?	**[10]**	C3	L1
2.	With the help of a T – h diagram explain the formation of steam from water at 0°C.	**[5+5]**	C3	L1
3.	With neat sketch explain the MIG welding process.	**[10]**	C3	L1
4	Differentiate between welding, soldering and brazing.	**[10]**	C5	L1
5.	Explain the modes of heat transfer? Explain any two heat transfer applications.	**[10]**	C3	L1
6.	Classify the robots on the basis of physical configurations. Explain the industrial application of robots specific to material handling	**[10]**	C5	L1

IAT – III Solution

1.

Enthalpy of steam with dryness 0.98

$h = h_f + h_{fg} \times 0.98$

$= 762.52 + 2014.6 \times 0.98$

$= 2736.82 \text{ kJ/kg}.$

@ 10 bar

$h_{fg} = 2014.6 \text{ kJ/kg}$

$h_f = 762.52$ "

$h_g = 2777.1$ "

$T_{sat} = 179.88^\circ C$

Enthalpy after receiving 140 kJ of heat.

$h_{final} = 2736.82 + 140 = 2876.82 \text{ kJ/kg}$

Since, $h_{final} > h_g$

$\Rightarrow$ Steam is in superheated state.

Temperature of superheat

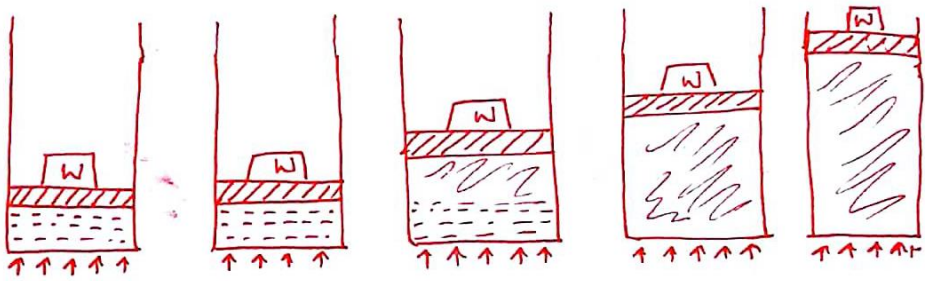
$h_{final} = h_f + h_{fg} + C(T_{sup} - T_{sat})$

$2876.82 = 762.52 + 2014.6 + 2.25(T_{sup} - 179.88)$

$\boxed{T_{sup} = 221^\circ C}$

2.

Steam formation :- (at constant pressure) from 0°c water



(A) water at 0°c

(B) water at T_{sat}

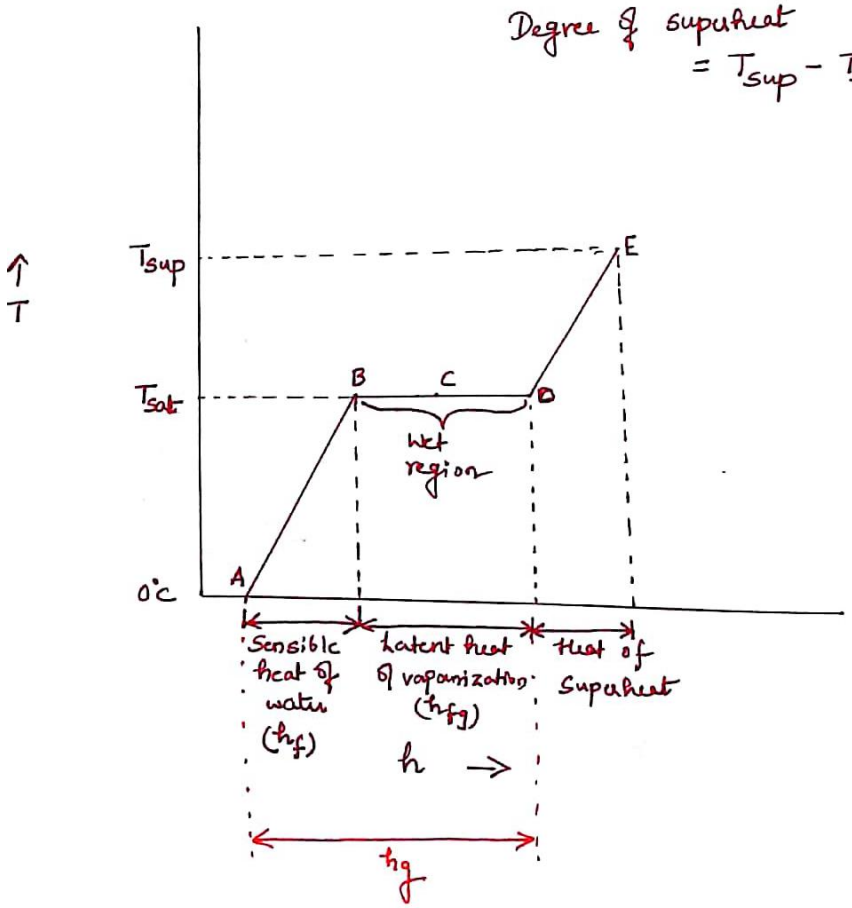
(C) Wet steam

(D) Dry saturated steam

(E) Superheat steam

T-h graph.

Degree of superheat $= T_{sup} - T_{sat}$.



$h_g = h_f + h_{fg}$

Consider a piston and cylinder arrangement having 1 kg of water at 0°C. (point A).

Let a weight 'W' be added on top of the piston to maintain the pressure constant throughout the process.

Let this water be heated. The ~~heat~~ enthalpy of the system increases and the temperature starts to rise till the saturation temperature (boiling point) of the water is reached. (Point B)

If further heat is added to the system at point B, all of the heat will be used up to change the phase of water from liquid to steam (at point D). The temperature will remains constant during this phase change.

Between the points B & D, is the wet region, where not all the water at saturation temperature is converted into dry saturated steam. The steam in this region is called as wet steam which is characterized by suspension of water molecules in the steam.

Steam at any point (C) b/w B & D is known as wet steam.

The steam at point D is called as dry saturated steam (which is completely dry and does not have any water molecules suspended in it).

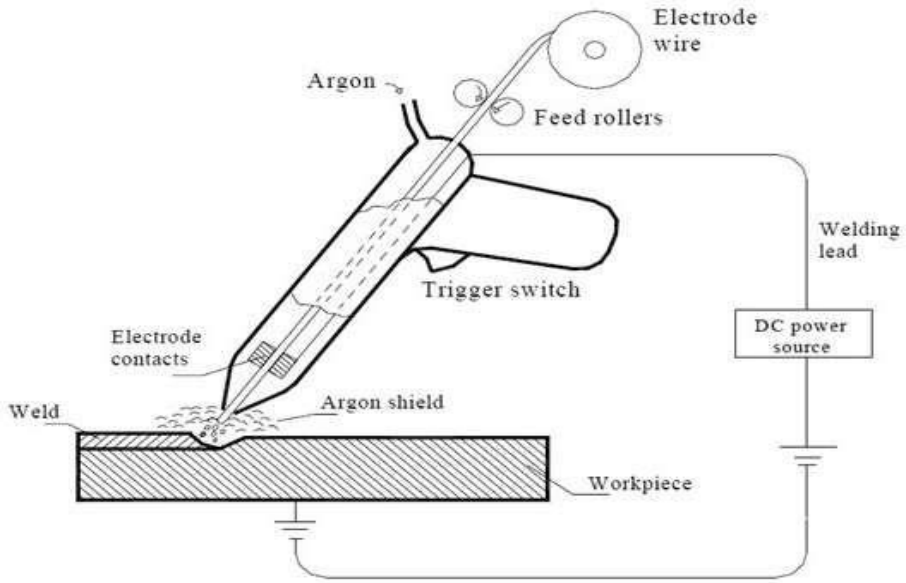
If further heat is added to dry saturated steam, the temperature of steam starts increasing.

The steam beyond point (D) is called as superheated steam (Point E).

The temperature at which superheated steam exist is called as Temperature of Superheated steam. (T_{sup}).

As the heat supplied to the system is at constant pressure, the amount of heat supplied will be equal to increase in enthalpy of the system.

3. MIG welding uses an arc of electricity that creates a short circuit amidst a constant anode and a cathode. Inert shielding gas (argon, helium, carbon dioxide) for protection of weld pool is used. The short circuit produces heat and melts the metal. After the heat is removed, the metal cools down and then solidifies, creating a new fused metal. This type of welding can be done either semi- automatically or automatically (using robotic arm).



MIG/MAG welding is a versatile technique suitable for both thin sheet and thick section components. An arc is struck between the end of a wire electrode and the workpiece, melting both of them to form a weld pool. The wire serves as both heat source (via the arc at the wire tip) and filler metal for the welding joint. The wire is fed through a copper contact tube (contact tip) which conducts welding current into the wire. The weld pool is protected from the surrounding atmosphere by a shielding gas fed through a nozzle surrounding the wire. Shielding gas selection depends on the material being welded and the application. The wire is fed from a reel by a motor drive, and the welder moves the welding torch along the joint line. Wires may be solid (simple drawn wires), or cored (composites formed from a metal sheath with a powdered flux or metal filling). Consumables are generally competitively priced compared with those for other processes. The process offers high productivity, as the wire is continuously fed.

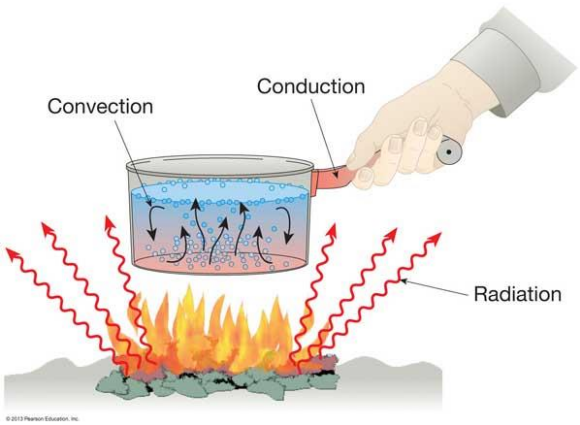
Manual MIG/MAG welding is often referred as a semi-automatic process, as the wire feed rate and arc length are controlled by the power source, but the travel speed and wire position are under manual control. The process can also be mechanized when all the process parameters are not directly controlled by a welder, but might still require manual adjustment during welding. When no manual intervention is needed during welding, the process can be referred to as automatic.

The process usually operates with the wire positively charged and connected to a power source delivering a constant voltage. Selection of wire diameter (usually between 0.6 and 1.6mm) and wire feed speed determine the welding current, as the burn-off rate of the wire will form an equilibrium with the feed speed.

4.

Welding	Brazing	Soldering
(i) High temperature process	(i) Medium temperature process	(i) Low temperature process.
(ii) Filler metal is optional	(ii) Filler metal is essential & called spelter.	(ii) Filler metal is required & called Solder.
(iii) Filler metal has same composition as the base metal.	(iii) Filler metal is of different composition	(iii) Filler metal is of different composition.
(iv) M.P of filler metal is same as the base metal.	(iv) M.P of filler metal is greater than 450°C but lesser than M.P of base metal.	(iv) M.P of solder (filler metal) is lesser than 450°C & also lesser than M.P of base metal
(v) Electrode is essential	(v) No electrode	(v) No electrode.
(vi) Similar metals can be welded (except in some special cases)	(vi) Both similar & dissimilar metals can be brazed.	(vi) Both similar & dissimilar metals can be soldered.
(vii) Poor surface finish	(vii) Good surface finish.	(vii) Poor surface finish.
(viii) Weld defects after welding.	(viii) No defects.	(viii) Less defects than welding.
(ix) High cost	(ix) Medium cost	(ix) Low cost.
(x) Flux used is Sodium carbonate	(x) Flux used is Borax.	(x) Flux used is chlorides of zinc

5. **Conduction** - Heat conduction is a process in which heat is transferred from the hotter part to the colder part in a body without involving any actual movement of the molecules of the body. Heat transfer takes place from one molecule to another molecule as a result of the vibratory motion of the molecules.

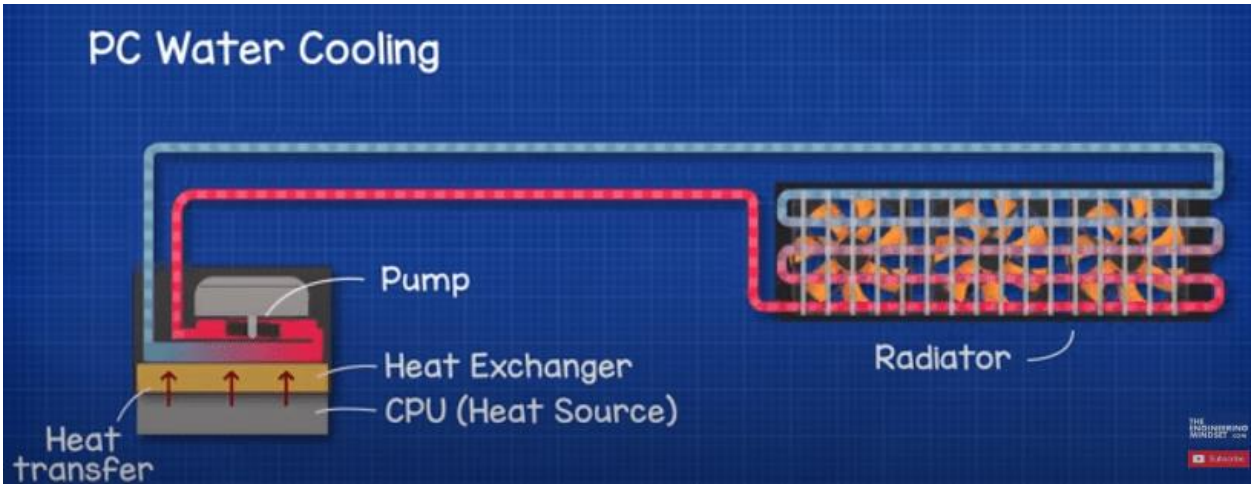


Convection - In this process, heat is transferred in the liquid and gases from a region of higher temperature to a region of lower temperature. Convection heat transfer occurs partly due to the actual movement of molecules or due to the mass transfer.

Radiation - It is the process in which heat is transferred from one body to another body without involving the molecules of the medium. Radiation heat transfer does not depend on the medium.

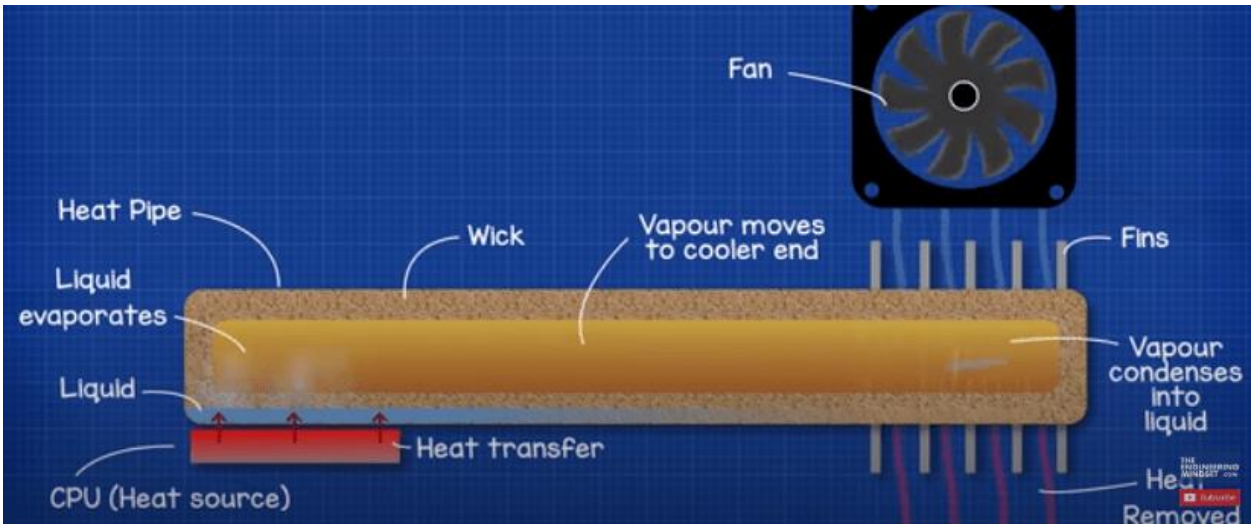
Applications:

- **Liquid or Water Cooling:** a small pump which cycles water between the heat exchanger of the CPU, known as the water block, and the radiator, which is a heat exchanger with some fans. gain the fans will blow air across the heat exchanger and remove the unwanted heat from the water, so the water picks up the unwanted heat from the chip, carries this to the radiator and then flows through the heat exchanger of the radiator. As it flows through, the fans blow air across the outside which removes the unwanted heat. The water therefore leaves cooler and returns to the chip to pick up more heat.



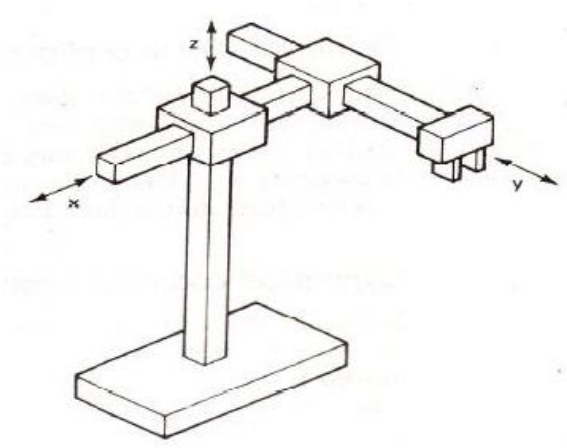
- **Heat pipes** – found usually in laptops, between processor and fan. Inside this is a small amount of liquid and a wick. The heat of the processor is absorbed into the pipe and this heat causes the liquid inside to boil and evaporate, the vapour moves towards the opposite end which is cooler because the fan is blowing air across the surface and this

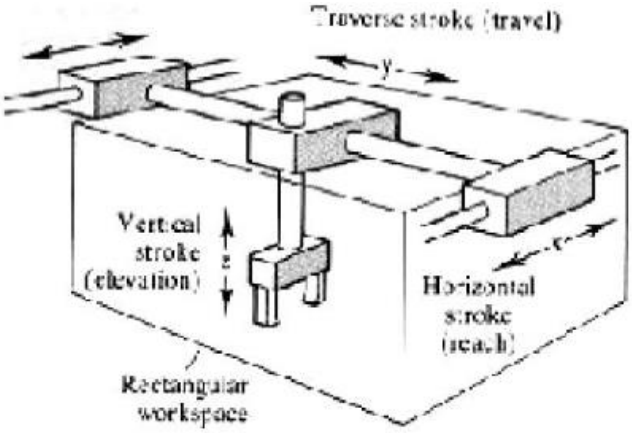
removes the heat from the heat pipe. This removal of heat causes the vapour to condense back into a liquid and this liquid flows back along the wick to pickup more heat, and so the cycle repeats.



6. **Classification based on Physical configurations**
   Possess five distinct design configurations:
   A. Rectangular (Or Cartesian)
   B. Cylindirical (Or Post-Type)
   C. Spherical (Or Polar)
   D. Jointed Arm (Articulated Or Revolute)
   E. Scara (Selective Complaince Assembly Robot Arm)

   A. **Cartesian / Rectangular configuration**





Notation: [LOO]: Linear, Orthogonal, Orthogonal
Cartesian configuration is also called as **Rectilinear or Rectangular** configuration as the joints allow only translational or linear relative motion between the adjacent links of the joint. A robot using such a configuration is called as X-Y-Z robot. Other names are xyz robot or Rectilinear

robot or **Gantry robot**. Any point in X, Y and Z coordinate system can be reached using this configuration. By appropriate movements of these slides, the robot is capable of moving its arm at any point within its three dimensional rectangular spaced work space.

Features:

i) Operate within a **rectangular** work volume

ii) Three prismatic joints are used.

iii) The position is specified by X, Y and Z locations.

iv) Easy to visualize motion

v) Easy to program the motions

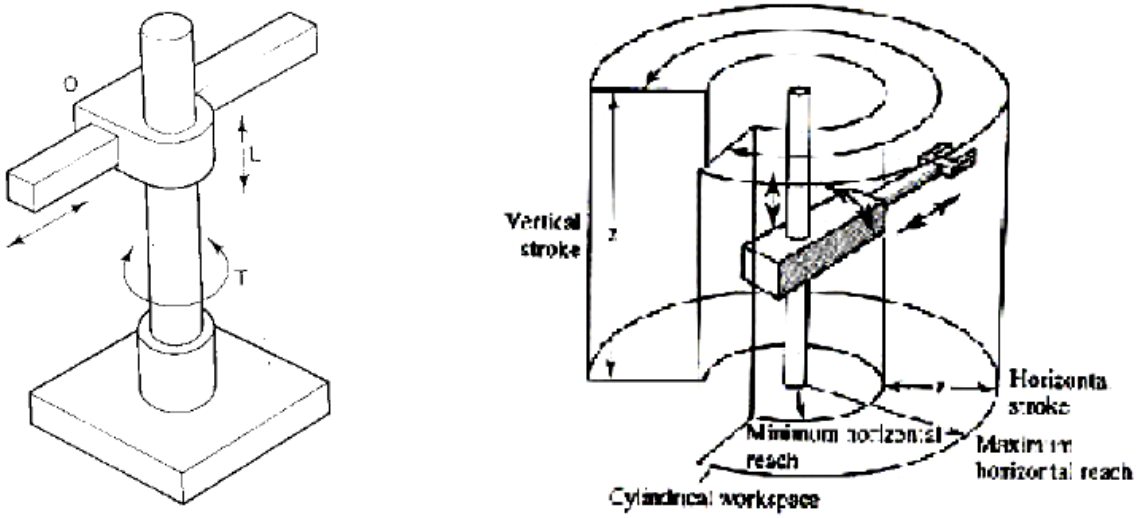
vi) Adapted in gantry crane and CNC milling machines.

vii) Gantry type can handle heavy loads.

viii) Addition axes can be incorporated to the wrist action.

ix) Difficult to protect the sliding axes from contaminants such as dust and moisture as it is open.

B. Cylindrical / Post-Type configuration:



Notation: [TLO]: Twisting, Linear and Orthogonal

This also has 3 degrees of freedom, 2 prismatic and 1 revolute joints. It moves linearly along X and Y axes and rotaion about at its base i.e. Z- axis. The robot body is a vertical column that swivels about a vertical axis. The arm consists of several orthogonal slides which allow the arm to be moved up or down and in and out with respect to the body. This is illustrated schematically in figure.

Features:

i) Operate within a **cylindrical** work volume

ii) 2 prismatic and 1 revolute joints.

iii) Postion is specified by Y value (height) extension of arm X axis and angle of rotation of Z axis (□)

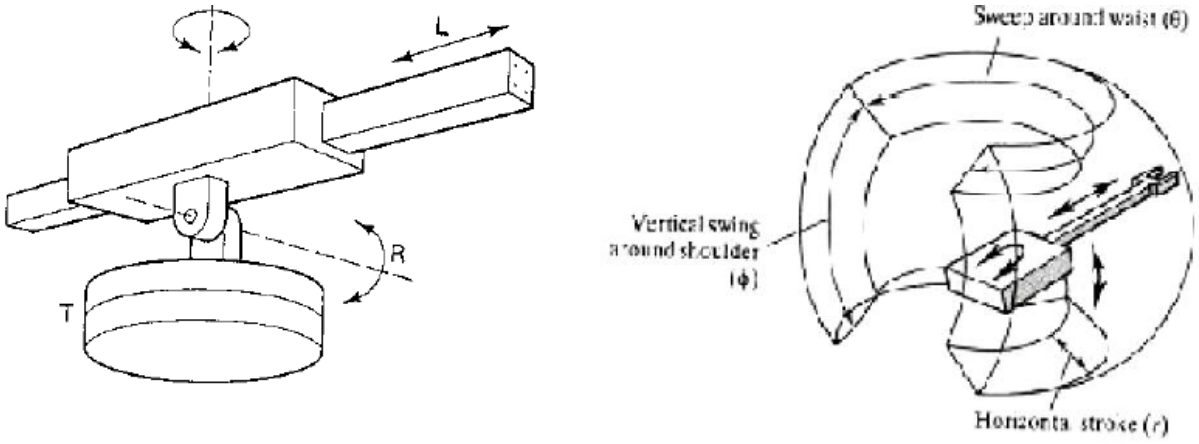
iv) Recommended for pick and place operation such as machine loading and unloading.

v) Lower repeatability and accuracy

vi) Require more sophisticated control

vii) Rigid structure & high lift-carrying capacity

C. Spherical / Polar configuration:



Notation: [**LTR**]: Linear, Twisting and Rotational joint
This configuration also called as Polar coordinate configuration. It goes by the name "spherical coordinate" also because the workspace within which it can move its arm is a partial sphere as shown in figure. The robot has a rotary base and a pivot that can be used to raise and lower a telescoping arm.

Features:

i) Operate within a **spherical** work volume

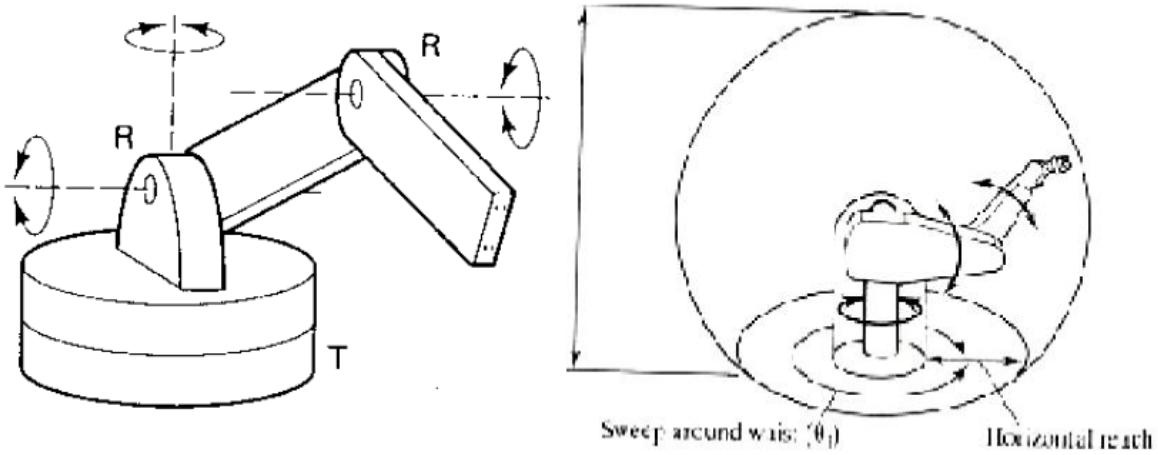
ii) Has 1 prismatic and 2 revolute axes.

iii) First motion is a base rotation, Second motion correspond to an elbow rotation and Third motion is radial or in-out motion

iv) Elbow rotation and arm reach limit the design of full spherical motion.

v) Rarely used in industries but common in automated cranes.

D. Revolute / Articulate / Jointed-arm configuration:



Notation: [**TRR**]: Twisting, Rotational and Rotational joint

It is combination of cylindrical and articulated configurations. This is similar in appearance to the human arm, as shown in fig. the arm consists of several straight members connected by joints

which are analogous to the human shoulder, elbow, and wrist. The robot arm is mounted to a base which can be rotated to provide the robot with the capacity to work within a quasi-spherical space.

Features:

i) Operate within a **quasi-spherical** work volume.

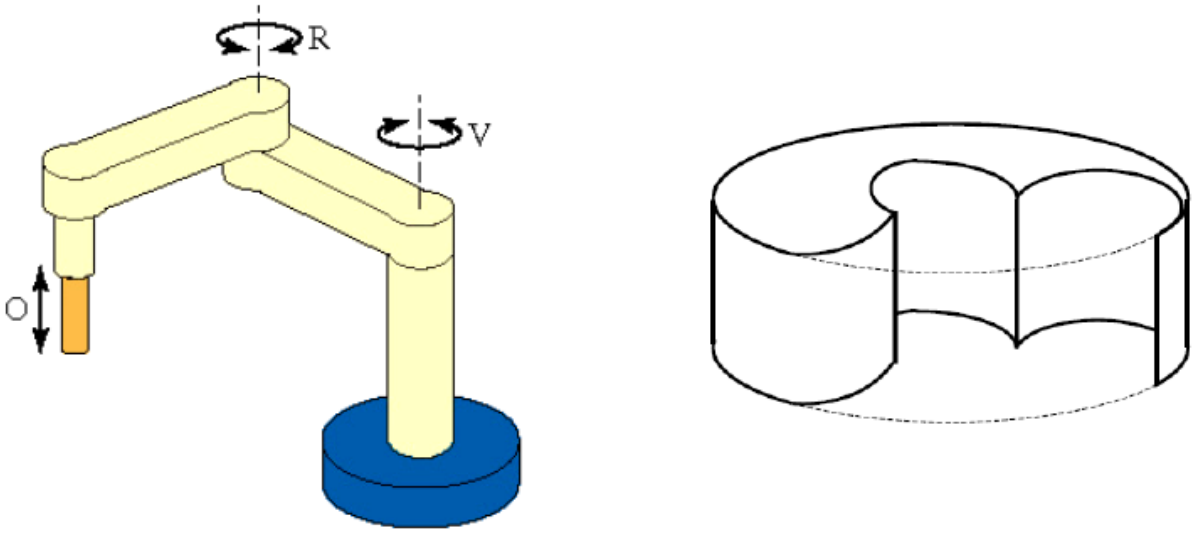
ii) All 3 are revolute joints.

iii) Can reach above, below and around obstacles.

iv) Joints can be sealed easily.

v) Difficult to calculate angular motion of the axis for a given top or end motion.

E. SCARA (Selective Compliance Assembly Robot Arm)



Notation: [**VRO**]: Revolving, Rotational and Orthogonal joint

This configuration consists of 1 prismatic and 2 revolute joint. The important features being the relative motion of all the links at the joints are about vertical axes.

SCARA stands for Selective Compliance Assembly Robot Arm. This joint is similar to jointed-arm robot except that vertical axes are used for shoulder and elbow joints to be compliant in horizontal direction for vertical insertion tasks.

Features:

i) Work volume is **cylindrical** in nature

ii) Most common in assembly robot

iii) Arm consists of two horizontal revolute joints at the wrist and elbow and a one prismatic joint

iv) Can reach at any point within horizontal planar defined by two concentric circles

v) Most assembly operations involve building up assembly by placing parts on top of a partially complete assembly

vi) Floor area is small compare to work area

vii) Rectilinear motion requires complex control of the revolute joints