Course Code: 23CE0101 **R23**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR
(AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road – 517583
QUESTION BANK

Subject with Code: Basic Civil & Mechanical Engineering (23CE0101)
Course & Branch: B.Tech – Common to All Branches

Year & Sem: I-B.Tech & I-Sem **Regulation:** R23

UNIT –I

1 **Answer All the Following Questions**

a. **Define Strength & Brittleness of a material** **[L1] [CO1] [2M]**

Strength: It is the properties of material which opposes the deformation or breakdown of material in presence of external forces or load. It should always be high.

Brittleness: Brittleness of a material indicates that how easily it gets fractured when subjected to external load. Generally brittle material will fracture without significant stress.

b. **List out the factors affect the conductivity of the metals** **[L1] [CO1] [2M]**

- Metals are composed of free (valance) electrons that contribute to its electrical conductivity. The more valance electrons, better electrical conductivity Ex: Cupper, Aluminum.
- As the temperature of a metal increases, the motion and number of valance electrons also increases that results in an increase in electrical conductivity.
- When an impurity is introduced into a metal, it disrupt the flow of electrons and reduce the electrical conductivity.
  Ex: Pure Gold is an excellent electrical conductor, but addition of cupper or silver decrease electrical conductivity.

c. **How do you classify the metals?** **[L1] [CO1] [2M]**

Metals can be divided into two main groups:

Ferrous metal: If a metal contains iron it is known as a ferrous metal.

Ex: Carbon steel, alloy steel, stainless steel

Non Ferrous metals: Metals that do not contain iron are known as non-ferrous metals

Ex: Aluminum, titanium, copper, brass, zinc, bronze, magnesium

d. **What are smart materials and mention examples** **[L1] [CO1] [2M]**

Smart materials are the materials that have one or more properties that can be significantly changed by external sources such as stress, moisture, electric or magnetic fields, light, temperature.

Ex: Conductive polymers, Colour changing liquid crystals and Motion control gels.

e. **Write the applications of composite materials?** **[L1] [CO1] [2M]**

Major applications of composites are

Aerospace Engineering : Propeller blades and wings

Defense sector: Fiber-reinforced polymer composites (FRPs) are used in military aircraft, UAVs, naval vessels, and weapons.

Agricultural Sector: Bio-composite materials can be used to create support structures for crops

Automotive sector: Polymer matrix composite (PMC) are used in the preparation of exterior body

Dental Composites: are used to restore tooth structure

Wind Energy sector: Wind turbine blades and nacelles are manufactured from composite

2 **Illustrate the role of Mechanical Engineering in Industries and society.** **[L2] [CO1] [10M]**

Mechanical engineering plays a vital role in various industries and society

- ***Product Design and Development***: Mechanical engineers often design products and systems, ranging from consumer goods like smartphones and automobiles to industrial machinery and aerospace equipment.
- ***Manufacturing and Production***: They develop manufacturing processes, select appropriate materials, and design tools and machines for efficient and cost-effective production.
- ***Quality Control***: Mechanical engineers develop and implement quality control and assurance processes to maintain consistent product quality and safety standards.
- ***Energy and Power Generation***: Mechanical engineers are instrumental in designing, maintaining, and optimizing power plants for increasing efficiency and reducing environmental impacts.
- ***Aerospace and Defense***: In this sector, mechanical engineers design aircraft, spacecraft, and defense systems.
- ***Automotive Industry***: Mechanical engineers significantly design vehicles for safety, performance, manufacturing and fuel efficiency.
- ***Biomedical Engineering***: Mechanical engineers contribute to developing medical devices, prosthetics, and healthcare equipment.
- ***Robotics and Automation***: Mechanical engineers design robots and automated systems and reduce human intervention.
- ***Material Science***: Understanding the properties and behavior of materials is crucial in various industries.

3 **Discuss about various advanced technologies in Automotive, Aerospace and marine sectors.** **[L2] [CO1] [10M]**

Automotive Sector: The technologies are used for making vehicles safer, more efficient, and more connected.

- ***Autonomous Driving*:** Autonomous driving technologies are being developed to improve safety and convenience of passengers
- ***3D Printing***: This technology allows manufacturers to prepare three dimensional objects which are more suitable for the design and testing phases of vehicle production.
- ***Advanced Materials*:** Lightweight materials like carbon fiber, aluminum, and composites are being used to reduce the weight of vehicles, which improves fuel efficiency and performance.
- ***Alternative Fuels*:** Hydrogen fuel cell vehicles are being developed, offering zero-emission transportation with fast refueling times.

Ex: H2 vehicles

Aerospace Sector: The aerospace sector is a highly advanced and technologically driven industry around designing, developing, producing, and operating aircraft, spacecraft, satellites, and related systems.

The key technologies that have played a significant role in the aerospace sector are

- **Advanced Materials**: The use of lightweight and high-strength materials such as carbon composites, titanium, and advanced alloys is critical for improving fuel efficiency and structural integrity in aerospace applications.
- **Aircraft Design and Simulation Tools**: Computer-aided design (CAD) and simulation software enable aerospace engineers to design and optimize aircraft and spacecraft efficiently, reducing development time and costs.
- **Aerodynamics and Fluid Dynamics**: Computational Fluid Dynamics (CFD) is used to model and analyse airflow around aircraft, allowing for the development of more efficient and aerodynamic designs.

Marine Sector: The marine sector encompasses a wide range of technologies and innovations in various maritime operations, from ship design and construction to navigation, safety, and environmental protection.

The key technologies in the marine sector:

a) Ship Design and Construction Technologies:

- **CAD/CAM:** These tools are used to design and build ships, optimize hull shapes, and ensure structural integrity.
- **Materials Science:** Development of advanced materials, including lightweight composites and corrosion-resistant alloys, for ship construction.

b) Navigation and Positioning Technologies:

GPS (Global Positioning System) Provides accurate global positioning for navigation and location-based services.

c) Safety and Security Technologies:

- **CCTV (Closed-Circuit Television):** Monitors ship areas for safety and security.

d) Underwater Exploration and Research: AUVs (Autonomous Underwater Vehicles), and advanced sonar systems are used for underwater exploration, mapping, and scientific research.

e) Cruise Ship Innovations: Enhanced on board entertainment systems, eco-friendly designs, and digital passenger experiences are transforming the cruise industry.

4 **Explain about various essential mechanical properties for the materials.** **[L2] [CO1] [10M]**

The important properties of the material are

Strength: It is the properties of material which opposes the deformation or breakdown of material in presence of external forces or load.

Toughness: It is the ability of a material to absorb the energy and gets plastically deformed without fracturing.

Hardness: It is the ability of the material to resist to permanent shape change due to external stress.

Hardenability: It is the ability of the material to attain the hardness by heat treatment processing.

Brittleness: Brittleness of a material indicates that it gets fractured when subjected to external load.

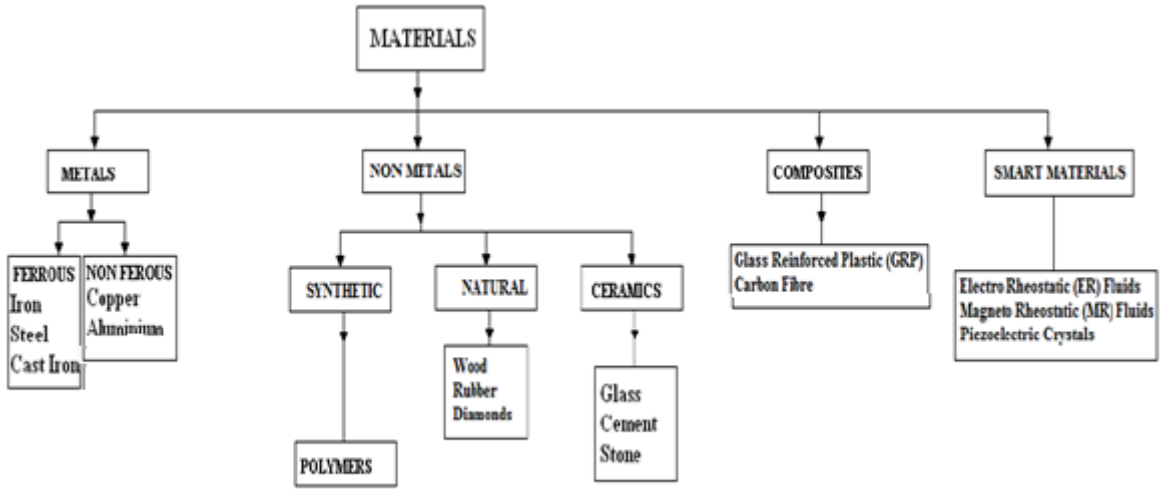
Malleability: It is a property of solid materials that a material gets deformed under compressive stress.

Ductility: Ductility is a property of a solid material that a material gets deformed under tensile stress.

Resilience: Resilience is the ability of material to absorb energy when it is deformed elastically by applying stress and release energy when stress is removed.
Fatigue: Fatigue is the weak of material caused by the repeated loading of the material.
Elasticity: It is the ability of material to resume to its normal shape after being stretched or compressed.
Plasticity: It is the ability of material to undergo some permanent deformation without rupture.
Stiffness: Stiffness is the resistance of material to elastic deformation or deflection.
Cohesion: It is the property of solid body by virtue of which they resist from being broken into fragment.
Impact strength: The impact strength is the ability of a metal to resist suddenly applied loads.

5 **a)** **Draw the flow chart classifying engineering materials.** **[L4] [CO1] [5M]**

The Engineering materials are classified as follows.



b) **Differentiate between metals and Nonmetals.** **[L4] [CO1] [5M]**

Property	Metals	Non-metals
Physical state at room temperature	Solids (except Hg)	Mostly gas or solid
Luster	Metallic	Dull or non-metallic
Electrical Conductivity	Good electrical conductivity	Poor electrical conductivity
Thermal Conductivity	Good conductors of heat	Poor conductors of heat
Density	Generally high	Generally low
Malleability and ductility	Malleable and ductile	Brittle and not malleable or ductile
Reactivity	Generally reactive	Generally non-reactive or less reactive
Oxidation state	Metals usually have a positive oxidation state	Non-metals usually have a negative oxidation state
Corrosion resistance	More prone to corrosion	Have resistance to corrosion
Cost	Metals can be expensive	Non-metals are not that expensive

6 a) List out various properties of the metals. **[L1] [CO1] [5M]**

Properties of Metals

- **Hard and have a high tensile strength** – Carbon is the only non-metal with very high tensile strength.
- **Good conductors of heat and electricity** – Graphite is a good conductor of heat and Electricity.
- **Malleable,** i.e., can be beaten into thin sheets
- **Ductile,** i.e., can be drawn into thin wires
- **High melting and boiling points**
- **Dense** (except alkali metals). Osmium – highest density, and lithium – least density
- **Lustrous** – Metals have the quality of reflecting light from their surface and can be Polished, e.g., gold, silver and copper.
- **Silver-grey in colour** (except gold and copper) – Metals usually have a silver or grey colour.

b) Distinguish between ferrous and Nonferrous materials **[L4] [CO1] [5M]**

Ferrous Metals	Non-Ferrous Metals
Ferrous indicates the presence of iron in a bivalent state.	Non-ferrous metals do not contain any iron.
As ferrous contains iron, it shows magnetic feature.	Non-ferrous metals don't show any magnetic feature which means it's non-magnetic.
Ferrous metals are less resistant to corrosion.	Non-ferrous metals are more resistant to corrosion
One special feature of ferrous metals is it possesses high tensile strength and durability.	One special feature of non-ferrous metals is their malleability.
Ferrous metals can be oxidized.	Non-ferrous metals cannot be oxidized.
Some ferrous metals are- vehicle scrap metal, demolition site scrap metal, metal offcuts from manufacturing industries.	Some non-ferrous metals are-aluminum and aluminum alloys, copper, brass, lead, zinc, stainless steel, electronic cable etc
Ferrous metals are used - cutlery, kitchen equipment, ball bearings etc.	Non-ferrous metals are used- water pipes, electrical wire, decorative goods, soft solder etc.
Ferrous metal includes mild steel, carbon steel, stainless steel, cast iron and wrought iron.	Non-ferrous metals are used where their difference from ferrous metals can provide an advantage.
Ferrous metals make up the most recycled materials in the world	As per the recycling goes, many non-ferrous materials are relatively scarce.

7 a) List out various properties of Ceramic materials. **[L1] [CO1] [5M]**

- Harder and more brittle than metals
- Good thermal and electrical insulators
- Nonmagnetic
- Oxidation-resistant
- High elastic modulus
- Low ductility

- High dimensional stability
- Good wear resistance
- High resistance to corrosion and chemical attack
- High weather resistance
- High working temperature
- High compressive strength
- Medium machinability

b) **Elucidate the ceramic applications.** **[L2] [CO1] [5M]**

Aerospace: Ceramics make up some high-temperature components such as turbine blades, heat shields, and nose cones.

Biomedical: Ceramics show up in medical implants due to their biocompatibility, strength, and wear resistance.

Electronics: Electronic devices receive ceramic components because of the material's electrical insulation properties and ability to dissipate heat.

Energy: Ceramic materials are important to energy applications such as fuel cells, solar panels, and thermal insulation due to their thermal stability and temperature resistance.

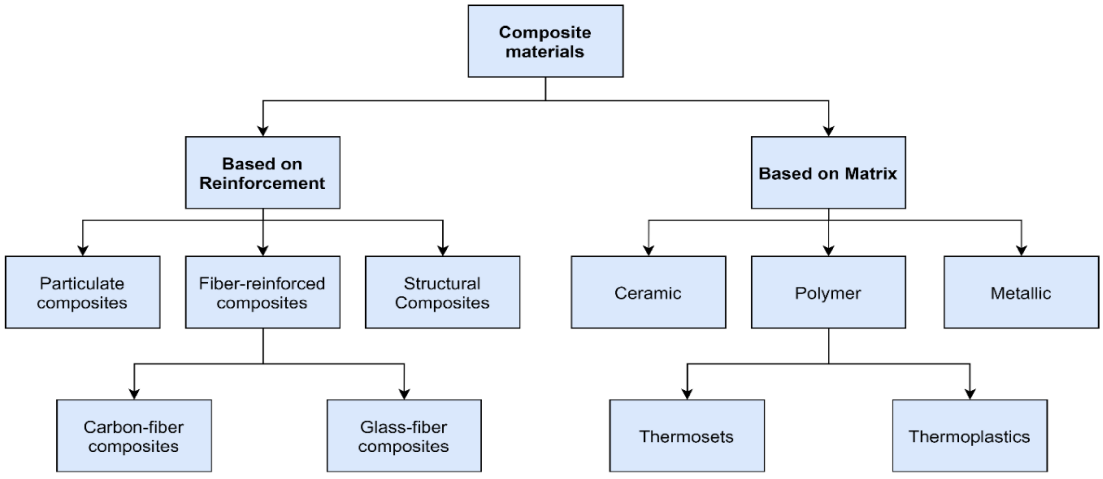
8 **What is composite? How do you classify the composites? Explain in detail** **[L2] [CO1] [10M]**

Composite materials are materials that are made by combining two or more distinct components with different properties to create a material that exhibits unique and often superior properties compared to its individual components.

These components can be classified into two main categories: Matrix and Reinforcement.

a. Matrix:

- The matrix is the continuous phase in composite material and serves as a binder or host for the reinforcement material.
- The matrix material can be a polymer, metal, ceramic, or even another composite material. The choice of matrix material depends on the desired properties and application of the composite.



b. Reinforcement:

- The reinforcement is the component of a composite material that is embedded within the matrix. It enhances the material's mechanical, thermal, or other properties.
- Reinforcements can take various forms, including fibers, particles, flakes, or sheets.

Common reinforcement materials include carbon fibers, glass fibers, aramid fibers, natural fibers (such as bamboo or hemp), and various types of particles or whiskers.

9 a) The most preferable material for the Automotive Industry is Composites. Justify **[L5] [CO1] [5M]**

Yes, the most preferable material for automotive industry is composites, because the automotive material should consists of the following properties, which composites have.

- High Strength to Weight Ratio
- Light in weight
- Fire Resistance
- Lower Electrical and thermal conductivity
- Chemical & Weathering Resistance
- Can be manufactured in variety of aesthetic colors
- Longer life
- Complex designs can also be manufactured easily with composites.

b) Identify numerous applications of Composites. **[L3] [CO1] [5M]**

As the composites are light in weight, high strength and low corrosion characteristics, the following components can be prepared in various sectors.

Aerospace engineering: Engine blades, Propellers/rotors, Wings

Defense Sector: Fiber-reinforced polymer composites (FRPs) are used for military aircraft, Naval vessels, and weapons.

Aeronautical Sector: Landing-gear hatch and rotor blades for helicopters.

Agricultural Sector: Support structures for crops are lightweight, biodegradable, and can provide sufficient support to growing plants without causing harm to the environment.

Automotive sector: Polymer matrix composite (PMC) are used for tires and various belts and hoses

Sports Sector: Bicycles, skis and surfboards, golf clubs and tennis rackets.

Dental Composites: Tooth structure

Wind Energy sector: Wind turbine blades and nacelles are manufactured from composite materials

Carbon fiber-reinforced composite materials: They are used to make aircraft and spacecraft parts, racing car bodies, golf club shafts, bicycle frames, fishing rods, automobile springs and sailboat masts

10 Name the types of smart materials and explain them. **[L2] [CO1] [10M]**

Smart materials, also called intelligent or responsive materials, are materials that have one or more properties that can be changed in a controlled by external such as stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds.

Types of smart materials:

- **Piezoelectric materials** are materials that produce a voltage when stress is applied.
- **Shape-memory materials** in which large deformation can be induced and recovered through temperature changes or stress changes.
- **Photovoltaic materials** convert light to electrical current.
- **Magnetostrictive materials** exhibit a change in shape under the influence of magnetic field
- **Temperature-responsive materials** which undergo changes upon temperature.
- **Chromogenic systems** change color in response to electrical, optical or thermal changes.

- **Photomechanical materials** change shape under exposure to light.
- **Self-healing materials** have the intrinsic ability to repair damage due to normal usage, thus expanding the material's lifetime.
- **Smart self-healing** coatings heal without human intervention.
- **Thermoelectric materials** are used to build devices that convert temperature differences into electricity and vice versa

11 a) List out various important applications of smart materials. [L1] [CO1] [5M]

Electronics: The use of smart materials aids in the manufacturing of batteries that recharge faster thanks to materials that increase their energy storage capacity.
Textiles: Smart textiles allow the textile product to respond or react to the wearer or the environment in the fiber, yarn, fabric, dye or finish state
Construction: Smart materials have applications in the design of smart buildings. Smart materials are used for vibration control, noise mitigation, safety and performance.
Aerospace industry: Main application direction of smart material is to realize self-perception, self-diagnosis, and adaptive and self-healing functions.
Space crafts: Coatings such as ceramics are particularly effective in protecting aircraft from heat and solar radiation.
Automotive: Smart materials used to make different parts of vehicles for durability, safety, comfort
Biotechnology: Smart materials in medical implants automatically adjust according to patients' health status, or diagnostic devices that automatically adjust according to clinical situations.

b) Discuss about the important properties of Nonferrous metals [L2] [CO1] [5M]

Metals that do not contain iron are known as non-ferrous metals.
Ex: Aluminum, titanium, copper, brass, zinc, bronze, magnesium, etc
Properties of non-ferrous metals

- Easy to fabricate (including machinability, casting, and welding)
- High corrosion resistance.
- Good thermal and electrical conductivity.
- Low density.
- Non-magnetic.
- Colorful

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UNIT –II

1 **Answer All the Following Questions**

a. **Name the steps involved in making a casting process** **[L1] [CO2] [2M]**

Steps involved in making a casting are

(i)Pattern making (ii) Sand mixing and preparation (iii) Core making

(iv)Melting (v) Pouring (vi) Finishing (vii) testing (viii) Heat treatment (ix) Re-testing

b. **What are the factors on which machining depends?** **[L1] [CO2] [2M]**

Factors affecting machining are

(i)Casting metal (ii) Machining method (iii) Casting method (iv) Shape and size of casting (v) Amount of finishing required.

C **List out the functions of additive manufacturing.** **[L1] [CO2] [2M]**

Functions of additive manufacturing. Are

- To increase effective communication.
- To decrease development time.
- Decreasing delivery time
- To decrease costly mistakes.
- To minimize sustaining engineering changes.
- To extend product lifetime

d. **How do you classify the heat engines?** **[L1] [CO2] [2M]**

The heat engines are broadly classified according to the place of combustion of the fuel as follows

Internal Combustion Engines The combustion of the fuel takes place inside the engine cylinder Ex: Petrol Engines, Diesel engines, Gas turbines etc.,

External Combustion Engines: The combustion of the fuel takes place outside the engine cylinder. Ex: Locomotives, Power generation plants.

e. **List out the components of Hybrid Electric vehicle?** **[L1] [CO2] [2M]**

Electric and hybrid vehicles (EVs and HEVs) use a combination of technologies to provide efficient and environmentally friendly transportation.

Electric Motor(s), Battery Pack, Internal Combustion Engine (ICE), Generator, Power Electronics:

Regenerative Braking System, Charging Port (EVs), On board Charger (EVs):

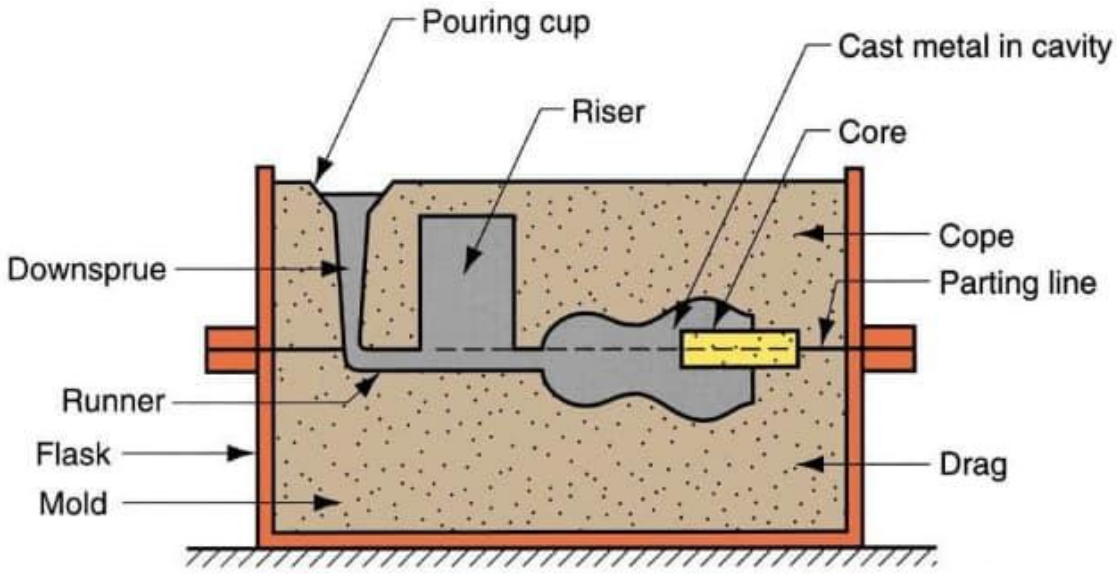
2 **Explain the working principle of casting with a neat sketch. And also mention its merits & demerits** **[L2] [CO2] [10M]**

Casting is a manufacturing process in which molten metal is poured into a specially designed cavity. When metal cools down and becomes solid it takes the shape of cavity. This cooled solid metal is called casting. After this casting of desired shape and size is removed from the cavity.

Ex: casting materials are metals combination of two or more materials.

Process for the preparation of casting.

- Material is melted
- Heated to proper temperature
- Treated to modify its chemical makeup
- Molten material is poured into a mold
- Solidifies
- Remove and cleaning, finishing and inspection operations.



Merits:

- Economical for large production quantities
- Good dimensional accuracy
- Better surface finish
- Thin sections can also be produced easily
- Good strength and smaller grain size to casting

Demerits

- Limited to metals with low melting points
- Part geometry must allow removal from cavity
- Chances of porosity due to air or gases during the process

3 a) How do you classify the forming process and explain them. [L2] [CO2] [5M]

Forming is a manufacturing process that uses mechanical forces to change a material's shape and size without adding or removing of material.

There are four forming processes: Forging, Rolling, Extrusion, and Drawing.

- **Forging:**

  Forging involves shaping a piece of metal by applying localized compressive force using hammers, presses, or dies. It creates strong, durable, precisely shaped metal parts, such as tools, gears, and crankshafts.

- **Rolling:**

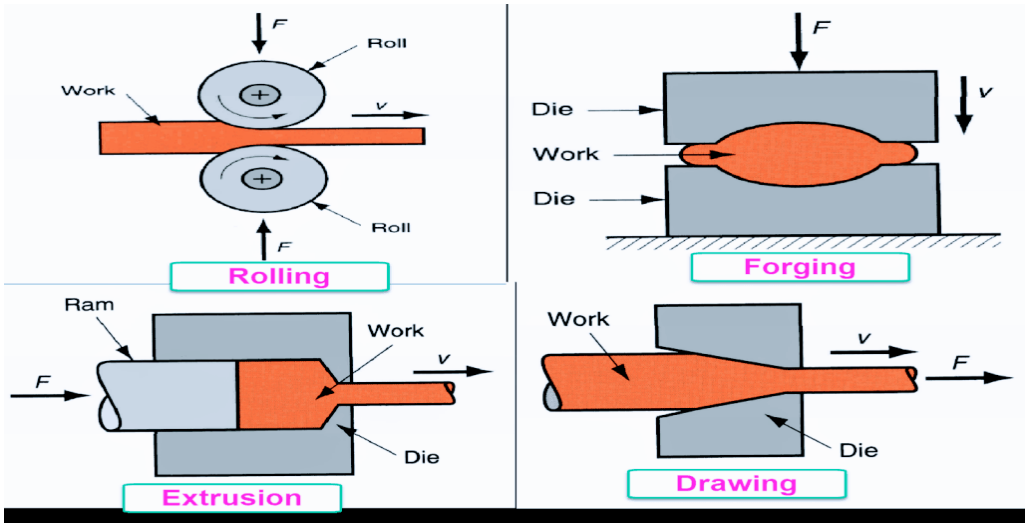
  Rolling is a forming process that reduces the thickness of materials like metal sheets or foil while maintaining their length. It is common to produce sheet metal for roofing and packaging materials.

- **Extrusion:**

  Extrusion involves forcing a material, often metal or plastic, through a die to create a continuous profile or shape. This process is used in manufacturing items like pipes, tubing, and complex cross-sections

- **Drawing:**

  Drawing involves pulling a material through a die to reduce its cross-section while maintaining its length. It is used to create products like wires, tubes, and cups.



b) **Mention the merits and demerits of forming process** **[L2] [CO2] [5M]**

***Merits*:**

- No raw material wastes
- Better mechanical properties
- Faster production rate
- Automation
- Reduced labour
- Greater thermal efficiency
- Better working conditions

***Demerits*:**

- Tolerances may vary significantly
- Thickness limitations
- High manufacturing costs
- Shorter tool life
- Poor surface finish

4 **Elucidate various joining processes along with its merits and demerits** **[L2] [CO2] [10M]**

Joining is one of the manufacturing processes by which two or more materials can be permanently or temporarily joined or assembled together with or without the application of external element in order to form a single unit.

Joining Processes are widely classified

1. Welding
2. Brazing
3. Soldering
4. Riveting

Welding: It is a metal joining processes in which two or more parts are joined at their contacting surfaces by suitable application of heat or/and pressure.

Brazing is a process that joins two or more metal surfaces by letting molten metal flow into the joint with a filler metal

Soldering is a process used for joining metal parts to form a mechanical or electrical bond. It typically

uses a low melting point metal alloy (solder) which is melted and applied to the metal parts to be joined

Riveting is a semi-permanent and non-thermal joining method that involves using a mechanical fastener/rivet to join sheet metal parts.

Merits:

- No thermal structural transformation of work pieces
- High strength capacity
- Mobility of material after joining
- Easy to control quality
- No emission or pollution
- Can be used for joining different materials

Demerits

- More stress concentration at the point of joining
- More chances of corrosion at the point of joining
- Due to more stress concentration, the joining may lead for hole formation.
- The joint may loose due to vibrations

5 **Discuss the functions of various elements of CNC machine with a neat sketch. Also mention its advantages and disadvantages.** **[L2] [CO2] [10M]**

CNC (Computer Numerical Control) Machines are automated machines, which uses programs to automatically execute a series of machining operations.

A CNC machine consists of following elements:

Input Device

A series of coded instructions required to produce a part. The coded instructions are composed of letters, numbers and symbols. The part program to be entered into the CNC control as an input.

Machine Control Unit:

The machine control unit (MCU) is the heart of a CNC system.

Functions:

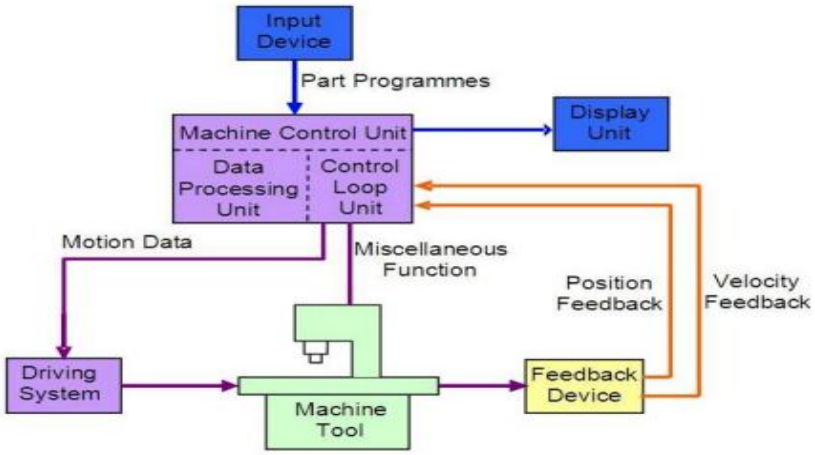
- Read and decode the coded instructions.
- Implement interpolations to generate axis motion commands.
- Feed the axis motion commands to the machine.
- Receive the feedback signals of position and speed for each drive axis.

Machine Tool

The CNC machine tool receives the commands from machine control unit. The machine table is controlled in the X and Y axes, while the spindle runs along the Z axis.

Feed Back System:

- It uses position and speed transducers to continuously monitor the position at which the cutting tool is located at any particular instant.
- The MCU uses the difference between reference signals and feedback signals to generate the control signals for correcting position and speed errors



Drive System:

- Drives are used to provide controlled motion to CNC elements
- A drive system consists of amplifier circuits, drive motors, and ball lead-screws.
- The MCU feeds the control signals (position and speed) of each axis to the amplifier circuits.
- The control signals are augmented to actuate drive motors which in turn rotate the ball lead-screws to position the machine table.

Advantages:

- Flexible with accuracy
- Reduce scrap
- Reduce tool cost
- Easy machine adjustment
- Reduce lead time and inventory
- Accommodate design change
- Rapid in programming and reduce paper work
- Less skilled operator is sufficient
- Multi-tasking is possible

Disadvantages:

- Chances of part programming mistakes
- Lesser choice of speed and feed
- More breakdown problems
- Relatively high initial cost of equipment
- Need special maintainace

6 a) Illustrate the functions of Additive manufacturing. [L2] [CO2] [5M]

In the additive manufacturing instead of removing material to create a part, the process adds material in successive patterns to create the desired shape.

Functions

- Increase effective communication.
- Decrease development time.
- Decreasing delivery time
- Decrease costly mistakes.
- Minimize sustaining engineering changes.
- Extend product lifetime

b) **Differentiate between traditional Manufacturing and smart manufacturing** **[L2] [CO2] [5M]**

	Traditional Manufacturing	**Smart manufacturing**
Data	Full data collection and its visualization is not possible	Real time data collection and visualization
Process and Operation	Manual Optimization	Automatically Optimized and full traceability
Down time	Unpredictable	Predictable
Maintenance	Preventive/corrective	Preventive/corrective/predictive
Supply chain	Traditional	Smart and 100% transparency
Efficiency	Not fully exploited	Fully exploited
Product development	Time wasting and not flexible	Faster development products even for complex products
Quality	Manual inspection	High quality, less cost and automatic inspection
Flexibility	Not flexible	Totally flexible
Decision making	Poor data	Real time data, smart algorithm to prediction

7 **a)** **Distinguish between fire tube boiler and water tube boiler** **[L2] [CO2] [5M]**

Fire tube Boiler	**Water tube Boiler**
• Hot gases flow inside the tube and the water flow outside the tube	• Water flows inside the tube and the flue gases flows outside the tube
• These boilers are internally fired	• These boilers are externally fired
• As the fire tube is situated inside the boiler, it requires large shell diameter	• It required a smaller shell diameter because it is externally fired
• These boilers are low pressure boilers	• These are high pressure boilers
• Contains large amount of storage	• Contains relatively small amount of storage
• Rate of generation of steam is low	• Rate of generation of steam is high
• Overall efficiency is 75%	• Overall efficiency is 90%
• Operating cost low	• Operating cost is high
• Suitable for small power plants	• Suitable for large power plants

b) **How do you classify the IC Engines?** **[L1] [CO2] [5M]**

Classification of IC Engines:

The IC engines are classified based on the following parameters.

- According to the type of fuel used

  (i)Petrol Engine (ii) Diesel Engine (iii) Gas Engine

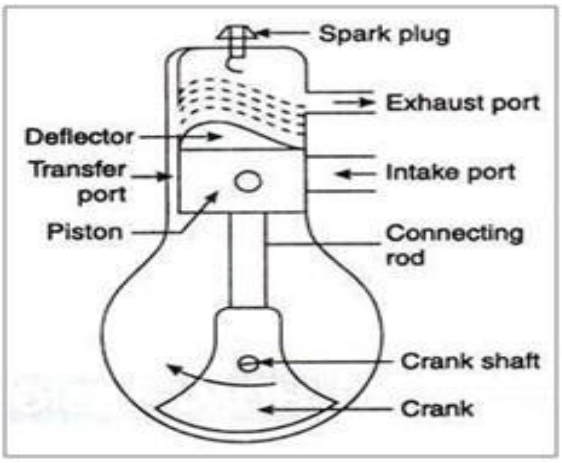
- According to the method of Ignition
  (i)Spark Ignition (SI) Engine (ii) Compression Ignition (CI) Engine
- According to the number of strokes per cycle of operation
  (i)Two stroke Engine (ii) Four stroke Engine
- According to the thermodynamic cycle
  (i)Otto Cycle (ii) Diesel Cycle (iii) Dual Combustion cycle
- According to the number of cylinders used
  (i)Single cylinder engines (ii) Multi cylinder engines
- According to the type of cooling system
  (i)Air cooled engine (ii) Water Cooled engine

8 a) Describe the working of Two stroke Petrol Engine with a neat sketch **[L2] [CO2] [5M]**

In two stroke cycle engines, the whole sequence of events i.e., suction, compression, power and exhaust are completed in two strokes of the piston i.e. one revolution of the crankshaft. There is no valve in this type of engine. Gas movement takes place through holes called ports in the cylinder. The crankcase of the engine is air tight in which the crankshaft rotates.

Upward stroke of the piston (Suction + Compression)

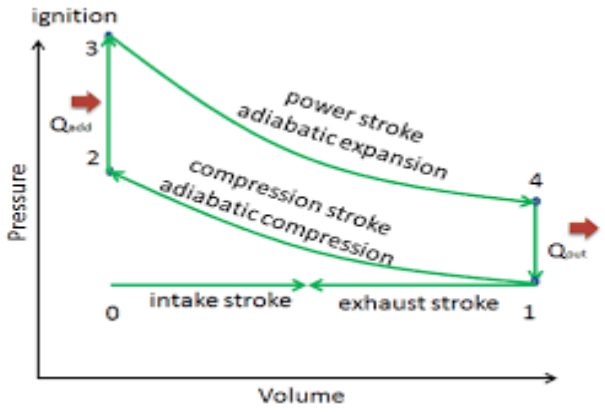
When the piston moves upward it covers two of the ports, the exhaust port and transfer port, which are normally almost opposite to each other. This traps the charge of air- fuel mixture drawn already in to the cylinder. Further upward movement of the piston compresses the charge and also uncovers the suction port. Now fresh mixture is drawn through this port into the crankcase. Just before the end of this stroke, the mixture in the cylinder is ignited by a spark plug. Thus, during this stroke both suction andcompression events are completed.



Downward stroke (Power + Exhaust)

Burning of the fuel rises the temperature and pressure of the gases which forces the piston to move down the cylinder. When the piston moves down, it closes the suction port, trapping the fresh charge drawn into the crankcase during the previous upward stroke. Further downward movement of the piston uncovers first the exhaust port and then the transfer port. Now fresh charge in the crankcase moves in to the cylinder through the transfer port driving out the burnt gases through the exhaust port. Special shaped piston crown deflect the incoming mixture up around the cylinder so that it can help in driving out the exhaust gases. During the downward stroke of the piston power and exhaust events are completed.

b) Draw the P-V diagram of Otto Cycle and explain. **[L4] [CO2] [5M]**



At the start of the cycle, the cylinder contains a mass M of air at the pressure and volume indicated at point 1. The piston is at its lowest position. It moves upward and the gas is compressed isentropically to point 2. At this point, heat is added at constant volume which raises the pressure to point 3. The high pressure charge now expands isentropically, pushing the piston down on its expansion stroke to point 4 where the charge rejects heat at constant volume to the initial state, point 1.

T1—Temperature of the charge at point 1 T2—Temperature of the charge at point 2
V1—Volume of the charge at point 1 ϒV2—Volume of the charge at point 2
ϒ – Compression ration (V2/V1)

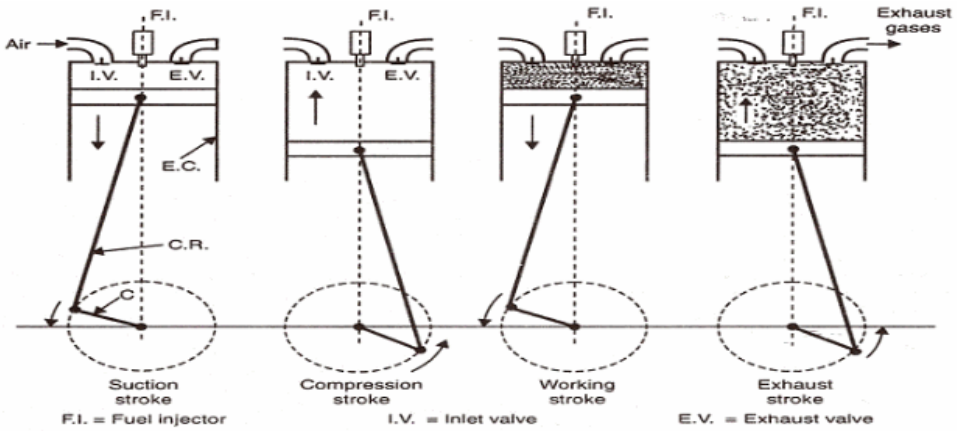
$$\eta_{th} = 1 - \frac{T_1}{T_2}$$
$$= 1 - \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

$$\boxed{\eta_{th} = 1 - \frac{1}{r^{\gamma-1}}}$$

9 a) Illustrate the working of Four stroke diesel engine with a neat sketch **[L2] [CO2] [5M]**

In four stroke cycle engines the four events namely suction, compression, power and exhaust take place inside the engine cylinder. The four events are completed in four strokes of the piston (two revolutions of the crank shaft). This engine has got valves for controlling the inlet of charge and outlet of exhaust gases. The opening and closing of the valve is controlled by cams, fitted on camshaft. The camshaft is driven by crankshaft with the help of suitable gears or chains. The camshaft runs at half the speed of the crankshaft. The events taking place in I.C. engine are as follows:

1. Suction stroke
2. Compression stroke
3. Power stroke
4. Exhaust stroke



Suction stroke

During suction stroke inlet valve opens and the piston moves downward. Only air is drawn inside the cylinder. The exhaust valve remains in closed position during this stroke. The pressure in the engine cylinder is less than atmospheric pressure during this stroke (Fig. 1a)

Compression stroke

During this stroke the piston moves upward. Both valves are in closed position. The air taken in the cylinder is compressed by the upward movement of piston and diesel is injected at the end of the compression stroke and ignition of fuel takes place due to high pressure and temperature of the compressed air.

Power stroke

After ignition of fuel, tremendous amount of heat is generated, causing very high pressure in the cylinder which pushes the piston downward (Fig.1b). The downward movement of the piston at this instant is called power stroke. The connecting rod transmits the power from piston to the crank shaft and crank shaft rotates. Mechanical work can be taped at the rotating crank shaft. Both valves remain closed during power stroke.

Exhaust stroke

During this stroke piston moves upward, Exhaust valve opens and exhaust gases go out through exhaust valves opening. All the burnt gases go out of the engine and the cylinder becomes ready to receive the fresh charge. During this stroke inlet valveremains closed (Fig.1d).

Thus it is found that out of four strokes, there is only one power stroke and three idle strokes in four stroke cycle engine. The power obtained during the power stroke is stored in the flywheel of the engine. The power stroke supplies necessary momentum for useful work.

b) Differentiate between two stroke engine and four stroke engine [L2] [CO2] [5M]

Four stroke engine	**Two stroke engine**
One power stroke for every two revolutions of the crankshaft.	One power stroke for each revolution of the crankshaft.
There are inlet and exhaust valves in the engine.	There are inlet and exhaust ports instead of valves.
Crankcase is not fully closed and air tight.	Crankcase is fully closed and air tight.
Top of the piston compresses the charge.	Both sides of the piston compress the charge.
Size of the flywheel is comparatively larger.	Size of the flywheel is comparatively smaller.
Fuel is fully consumed.	Fuel is not fully consumed.
Weight of engine per HP is high.	Weight of engine per hp is comparatively low.
Thermal efficiency is high.	Thermal efficiency is comparatively low.
Removal or exhaust gases easy.	Removal of exhaust gases comparatively difficult.
Torque produced is even.	Torque produced is less even.
For a given weight, engine would give only half the power of two stroke engine	For same weight, two stroke engine gives twice the power that of four stroke engine.
All types of speed are possible (high and low).	Mostly high speed engines are there.
It can be operated in one direction only.	It can be operated in both direction (Clockwise and counter clockwise).

10 a) Explain the working of simple vapour compression refrigeration system with a neat figure. **[L2] [CO2] [10M]**

It consists of the following essential parts:

Compressor

The low pressure and temperature vapour refrigerant from evaporator is drawn into the compressor through the inlet or suction valve A, where it is compressed to a high pressure and temperature. This high pressure and temperature vapour refrigerant is discharged into the condenser through the delivery or discharge valve B.

Condenser

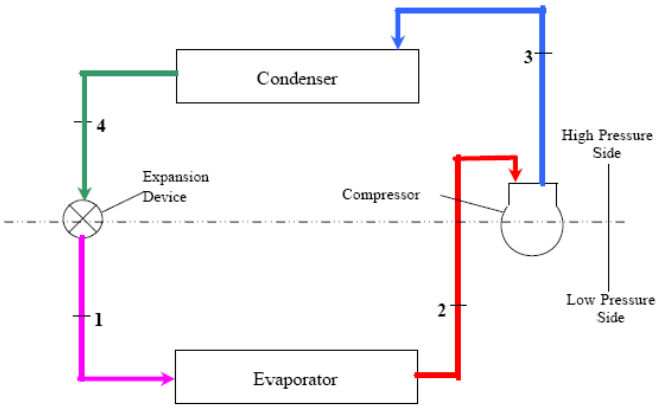
The condenser or cooler consists of coils of pipe in which the high pressure and temperature vapour refrigerant is cooled and condensed. The refrigerant, while passing through the condenser, gives up its latent heat to the surrounding condensing medium which is normally air or water.

Receiver

The condensed liquid refrigerant from the condenser is stored in a vessel known as receiver from where it is supplied to the evaporator through the expansion valve or refrigerant control valve.

Expansion Valve

It is also called throttle valve or refrigerant control valve. The function of the expansion valve is to allow the liquid refrigerant under high pressure and temperature to pass at a controlled rate after reducing its pressure and temperature. Some of the liquid refrigerant evaporates as it passes through the expansion valve, but the greater portion is vaporized in the evaporator at the low pressure and temperature



Evaporator

An evaporator consists of coils of pipe in which the liquid-vapour. Refrigerant at low pressure and temperature is evaporated and changed into vapour refrigerant at low pressure and temperature. In evaporating, the liquid vapour refrigerant absorbs its latent heat of vaporization from the medium (air, water or brine) which is to be cooled.

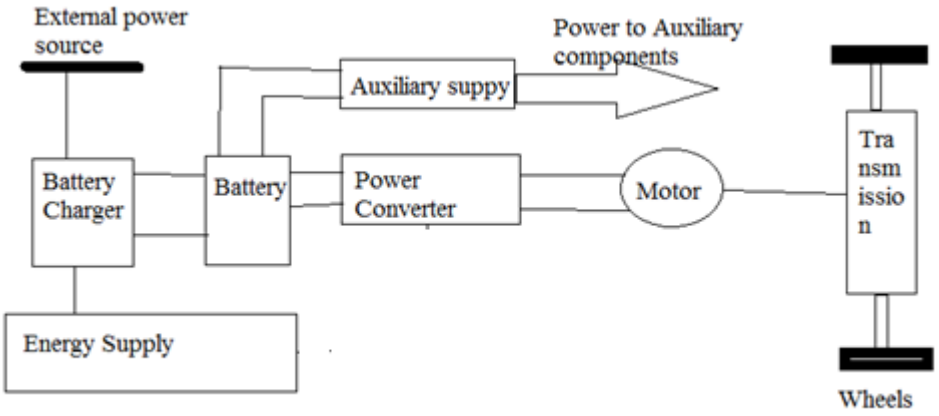
b) Distinguish between SI engines and CI engines **[L2] [CO2] [5M]**

Diesel engine (CI engine)	**petrol engine (SI Engine)**
It has got no carburetor, ignition coil and spark plug.	It has got carburetor, ignition coil & spark plug.

Its compression ratio varies from 14:1 to 22:1	Its compression ratio varies from 5:1 to 8:1.
It uses diesel oil as fuel.	It uses petrol (gasoline) or power kerosene fuel.
Only air is sucked in cylinder in suction stroke.	Mixture of fuel and air is sucked in the cylinder in suction stroke.
It has got 'fuel injection pump' andinjector	It has got no fuel injection pump and injector, instead it has got carburetor and ignition coil.
Fuel is injected in combustion chamberwhere burning of fuel takes places due to heat of compression.	Air fuel mixture is compressed in the combustion chamber when it is ignited by an electric spark.
Thermal efficiency varies from 32 to 38%	Thermal efficiency varies from 25 to 32%
Engine weight per horse-power is high.	Engine weight per horsepower is Comparatively low.
Operating cost is low.	Operating cost is high.
mpression pressure inside the cylinder varies from 35 to 45 kg/cm^2 and temperature is about 500°C.	Compression pressure varies from 6 to 10kg/cm^2 and temperature is above 260°C.

11 a) Describe the functions of various components used in Electric vehicles **[L2] [CO2] [5M]**

The primary components of Electric and Hybrid vehicles are



Electric Motor(s): Electric vehicles are driven by one or more electric motors. These motors convert electrical energy from the battery into mechanical energy to drive the vehicle's wheels.

Battery Pack: The battery pack is the energy storage system of an electric vehicle. It consists of lithium-ion or other advanced battery cells that store electrical energy.

Internal Combustion Engine (ICE): In hybrid vehicles (HEVs), there is an internal combustion engine in addition to the electric motor(s). This engine can run on gasoline or other fuel and is used primarily to generate electricity and recharge the battery.

Generator (In Hybrid Vehicles): HEVs have a generator (or alternator) connected to the ICE. This generator can charge the battery by converting mechanical energy from the ICE into electrical energy.

Power Electronics: Power electronics components, such as inverters and converters, manage the flow of electrical energy between the battery and electric motor(s). They convert DC power from the

battery into AC power for the motors.

Regenerative Braking System: EVs and HEVs use regenerative braking systems to capture energy when slowing down or braking.

Charging Port (EVs): Electric vehicles must be charged from an external power source. They have a charging port on the vehicle's exterior, where users can connect charging cables to recharge the battery.

On board Charger (EVs): Electric vehicles have on board chargers that convert AC power from the grid into DC power suitable for charging the battery. EVs have varying charging capacities, from standard AC to fast DC charging.

b) List out various merits and demerits of Hybrid vehicles. [L1] [CO2] [5M]

Advantages

- Environmentally Friendly
- Energy Efficiency
- Lower Operating Costs
- Quiet Operation
- Instant Torque
- Regenerative Braking
- Reduced Dependency on Fossil Fuels
- Home Charging

Disadvantages

- Limited Range
- Charging Infrastructure
- Charging Time
- Battery Degradation
- Limited Model Selection
- Environmental Impact of Battery Production
- Charging Compatibility
- High initial cost

Course Code: 23CE0101 **R23**

UNIT –III

1 **Answer All the Following Questions**

a. **How do you classify the power plants?** **[L1] [CO3] [2M]**

The power plants are classified based on the type of primary energy resource used. Those are

(i)Steam power plant (ii) Diesel power plant (iii) Hydro power plant (iv) Nuclear power plant

b. **What is the function of Engine cooling system?** **[L1] [CO3] [2M]**

Engine cooling system functions

- Removes excess heat from the engine
- Maintains the engine operating temperature where it works efficiently
- Avoids engine seizing

c. **Define the nuclear fission process with an example.** **[L1] [CO3] [2M]**

Fission may be defined as the **process of splitting an atomic nucleus into fission fragments**.

The fission fragments are generally in the form of smaller atomic nuclei and neutrons.

Large amounts of energy are produced by the fission process.

d. **List out the basic components of Robot.** **[L1] [CO3] [2M]**

The following are the components of Robot

End effector, Robot joints, Manipulator, Kinematics, Wrist, Arm and Body

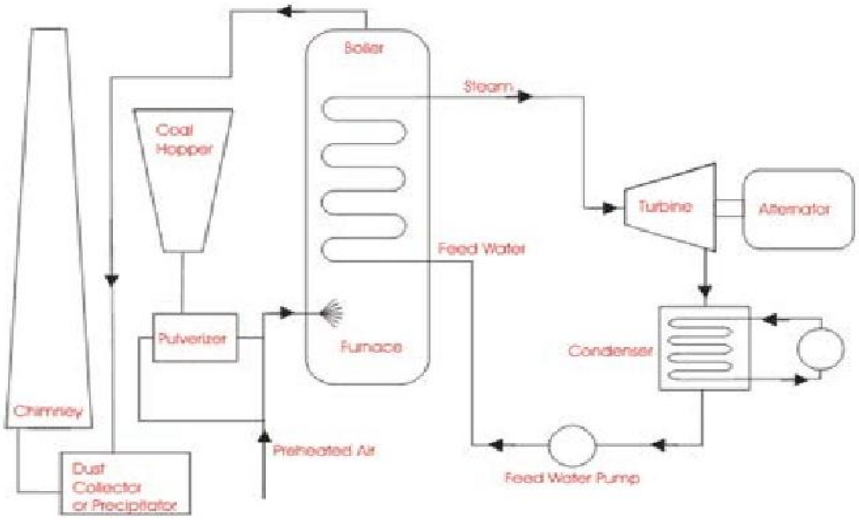
e. **Mention the merits of Gear drive over other drives.** **[L1] [CO3] [2M]**

The following are the merits of gear drive

- Most suitable for power transmission in short distance
- Transmits with high velocity ratio
- No slip during power transmission
- Requires less space
- Most suitable for complicated design

2 **Illustrate the working of steam power plant with a neat sketch.** **[L2] [CO3] [10M]**

A steam power plant consists of a boiler, steam turbine and generator, condenser, feed water, coal hopper, pulveriser and chimney. The steam power plant layout is as shown in the following figure.



Boiler: The boiler is responsible for heating water to generate steam. This is typically achieved by burning fossil fuels (such as coal, oil, or natural gas) or by using nuclear energy. The generated steam is at high pressure and temperature.

Turbine: The high-pressure steam from the boilers is directed into a turbine. The turbine is designed with blades that are turned by the force of the steam's high-speed flow. As the steam flows through the turbine, its high-pressure energy is converted into rotational mechanical energy.

Generator: The turbine is connected to a generator, which consists of coils of wire within a magnetic field. As the turbine spins, it turns the rotor of the generator, creating a moving magnetic field. This movement induces an electric current in the wire coils, ultimately producing electrical energy.

Condenser: After passing through the turbine, the steam is directed to the condenser. Here, the steam is cooled and condensed back into water, releasing its latent heat. This process allows for the efficient reuse of the water in the boiler, reducing water consumption and increasing overall efficiency.

Cooling System: Steam power plants require a cooling system to dissipate excess heat from the condenser. This can involve cooling water from nearby water bodies, cooling towers, or other heat exchange methods.

Coal Hopper: The primary source of steam power plant is coal. This is stored in the hopper and supplied to the furnace through pulveriser.

Pulveriser: The main function of pulveriser is to convert bigger size coals into smaller once, so that the surface area of the coal increases and thereby increasing the combustion of coal in the furnace.

Chimney: The exhaust from the furnace will be sent out through chimney. The height of chimney will be more so that the hot dust particles will not fall on the nearby houses and human beings.

Working Principle:

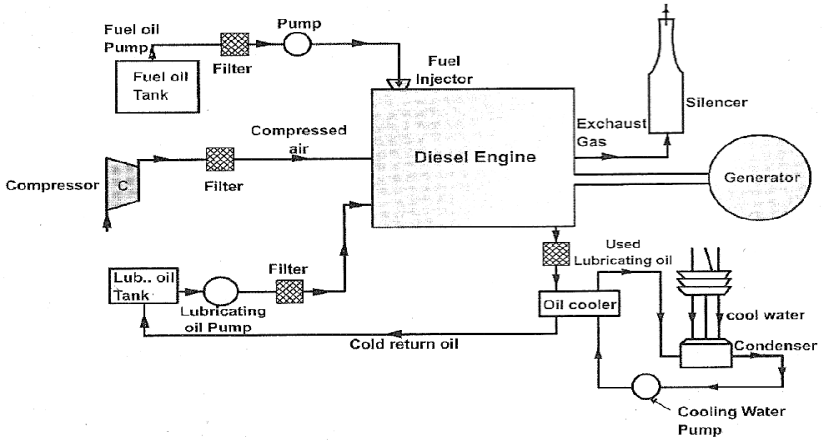
The steam generated in the boiler will be expanded in the turbine, thereby generation of mechanical energy. Further this mechanical energy is converted in to electricity in the generator. The expanded steam will be condensed in the condenser and pumped back to boiler for further use.

3 **Draw the layout of Diesel power plant and explain.** **[L2] [CO3] [10M]**

The major components of the diesel power plant are:

Engine

Engine is the heart of a diesel power plant. Engine is directly connected through a gear box to the generator. Generally two-stroke engines are used for power generation. Now a days, advanced super & turbo charged high speed engines are available for power production.



Air supply system

Air inlet is arranged outside the engine room. Air from the atmosphere is filtered by air filter and conveyed to the inlet manifold of engine. In large plants supercharger/turbocharger is used for increasing the pressure of input air which increases the power output.

Exhaust System

This includes the silencers and connecting ducts. The heat content of the exhaust gas is utilized in a

turbine in a turbocharger to compress the air input to the engine.

Fuel System

Fuel is stored in a tank from where it flows to the fuel pump through a filter. Fuel is injected to the engine as per the load requirement.

Cooling system

This system includes water circulating pumps, cooling towers, water filter etc. Cooling water is circulated through the engine block to keep the temperature of the engine in the safe range.

Lubricating system

Lubrication system includes the air pumps, oil tanks, filters, coolers and pipe lines. Lubricant is given to reduce friction of moving parts and reduce the wear and tear of the engine parts.

Starting System

There are three commonly used starting systems, they are;

- A petrol driven auxiliary engine
- Use of electric motors.
- Battery
- Bendix drive

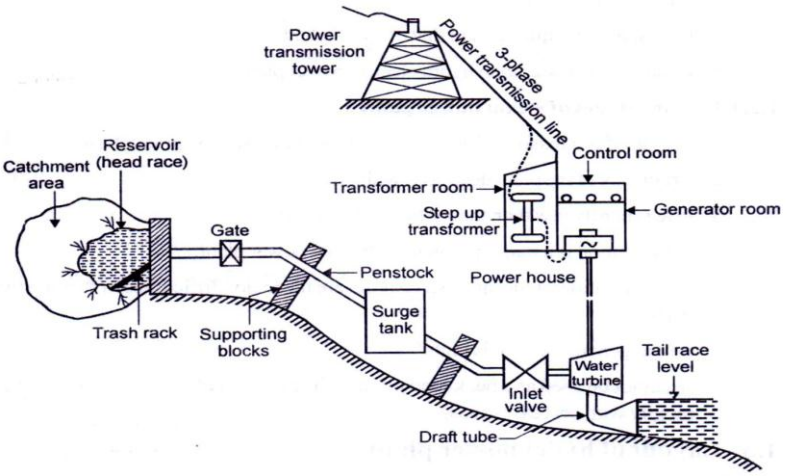
Governing system

The function of a governing system is to maintain the speed of the engine constant irrespective of load on the plant. This is done by varying fuel supply to the engine according to load.

Working Principle: In a diesel power plant, diesel engine is used as the prime mover. The diesel burns inside the engine and the products of this combustion act as the working fluid to produce mechanical energy. The diesel engine drives alternator which converts mechanical energy into electrical energy.

4 **Sketch the general layout of hydroelectric power plant and brief it. [L2] [CO3] [10M]**
Also mention its advantages and disadvantages.

Hydroelectric power plants convert the hydraulic potential energy from water into electrical energy. The salient components of the hydroelectric power plants are



Dam

Dams are structures built over rivers to stop the water flow and form a reservoir. The reservoir stores the water flowing down the river. The height of water in the dam is called *head race*.

Spillway

A spillway as the name suggests could be called as a way for spilling of water from dams. It is used to provide for the release of flood water from a dam.

Penstock and Tunnels

Penstocks are pipes which carry water under pressure from the reservoir to the turbines inside power station.

Surge Tank

Surge tanks will regulate the water flow and pressure inside the penstock.

Power Station

The torque generated by the water in turbine will be transferred to the generator and is converted into electricity.

Working Principle:

In this water flows from the dam to turbine through a pipe known as penstock. This water spins the blades of the turbine, which in turn spins the generator that ultimately produces the electricity.

Advantages

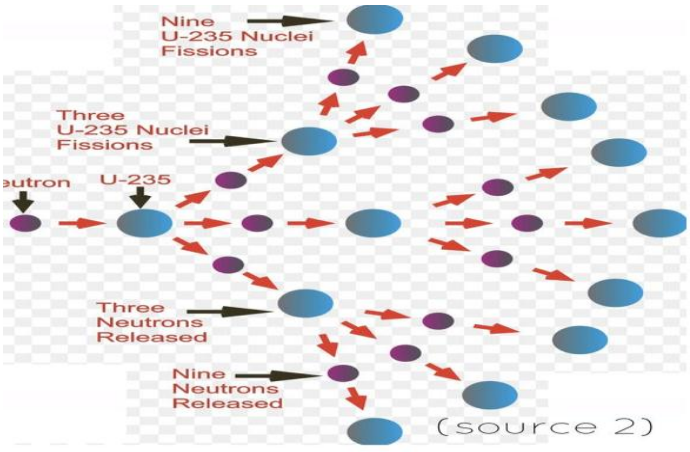
- Water the working fluid is natural and available plenty.
- Life of the plant is very long.
- Running cost and maintenance are very low.
- Highly reliable.
- Running cost is low.
- Maintenance and operation costs are very less.
- No fuel transport problem.
- No ash disposal problem.

Disadvantages

- Initial cost of plant is very high.
- Power generation depends on quantity of water available which depends on rainfall.
- Transmission losses are very high.
- More time is required for erection.

5 a) Describe the nuclear chain reaction process. [L3] [CO3] [5M]

A chain reaction is **a process in which neutrons released in fission produce an additional fission in at least one further nucleus**. This nucleus in turn produces neutrons, and the process repeats. The process may be controlled (nuclear power) or uncontrolled (nuclear weapons).



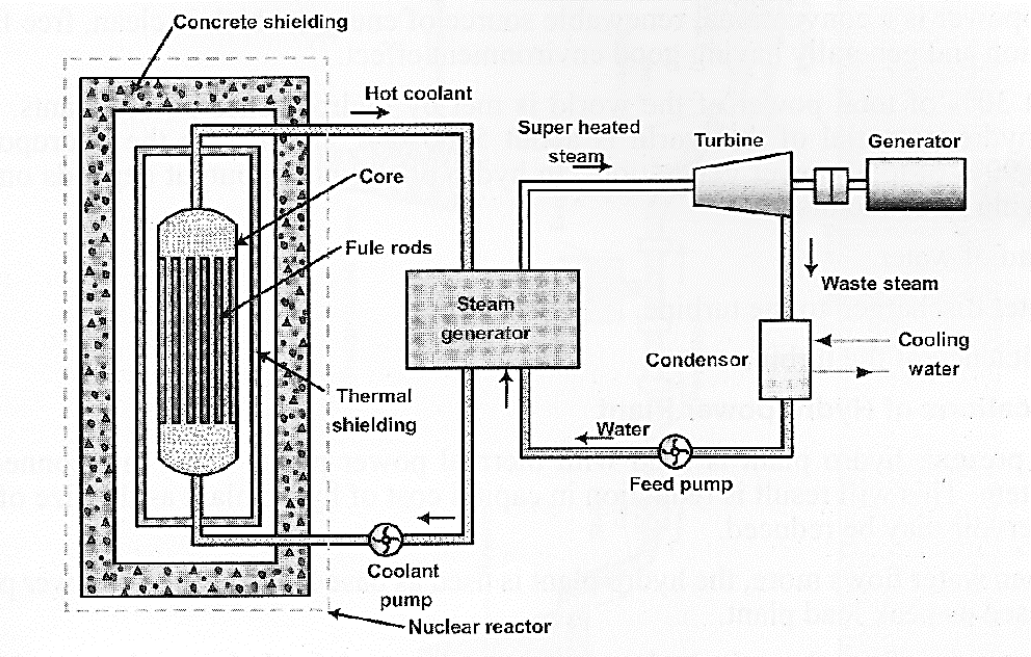
Nuclear fission refers to the splitting of an atomic nucleus into two or lighter nuclei. This process can occur through a nuclear reaction or through radioactive decay. Nuclear fission reactions often release a large amount of energy, which is accompanied by the emission of neutrons and gamma rays.

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n + \text{energy}$$

Ex: Uranium 235 bombarded with neutron split into Barium 141 and Krypton 92 along with 3 neutrons and Energy.

b) **Explain the working principle and layout of Nuclear power plant.** **[L2] [CO3] [5M]**

Nuclear energy originates from the splitting of uranium atoms – a process called fission. This generates heat to produce steam, which is used by a turbine generator to generate electricity. Because nuclear power plants do not burn fuel, they do not produce greenhouse gas emissions.



Heavy elements such as Uranium (U^{235}) or Thorium (Th^{232}) are subjected to nuclear fission reaction in a nuclear reactor. Due to fission, a large amount of heat energy is produced which is transferred to the reactor coolant. The coolant may be water, gas or a liquid metal. The heated coolant is made to flow through a heat exchanger where water is converted into high-temperature steam. The generated steam is then allowed to drive a steam turbine. The steam, after doing its work, is converted back into the water and recycled to the heat exchanger. The steam turbine is coupled to an alternator which generates electricity. The generated electrical voltage is then stepped up using a transformer for the purpose of long distance transmission.

6 **How do you Classify various mechanical power transmission systems? Explain them.** **[L2] [CO3] [10M]**

Mechanical Power transmitting refers to transfer mechanical energy from one component to another machine. Ex: Electric shavers, Water Pumps, Turbines

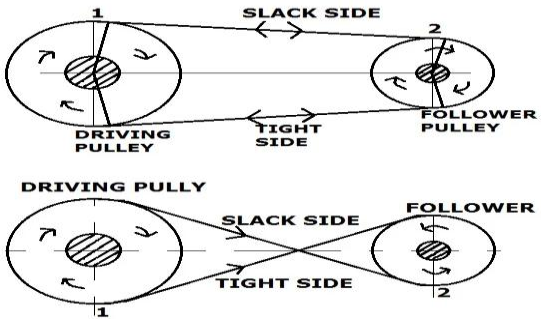
Types of Power Transmission:

(i) Belt drives (ii) Chain drives (iii) Rope drives (iv) Gear drives

BELT DRIVE:

Belts are used to transmit power from one shaft to another shaft by means of pulleys which rotate at same speed or at different speeds. These drives transmit power to either small or long distances.

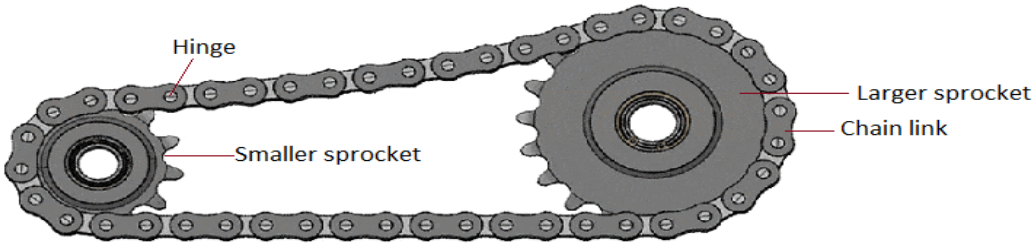
These belt drives are majorly classified into Open belt drive and Cross belt drives.
Open Belt drive: This is used when the shafts should rotate in the same direction, and when the shafts are arranged in parallel. As shown in figure below, A is called Driving pulley and B is called Followers/ Driven pulley.
Cross belt drive: In this, the rotation of pulleys is in opposite direction. this is due to the belt is crossed one. In this, the driver pulls the belt from one side and delivers it to another side.



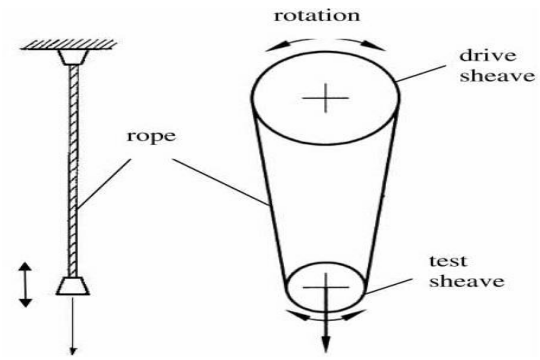
CHAIN DRIVE:

Chain drive is a type of mechanical power transmission system that uses chains to transfer power from one place to another. A conventional chain drive consists of two or more sprockets and the chain itself. The holes in the chain links fit over the sprocket teeth.

The chain drive consists of three elements – driving sprocket/ Larger Sprocket, driven sprocket / Smaller Sprocket, and endless chain wrapped around the sprocket.



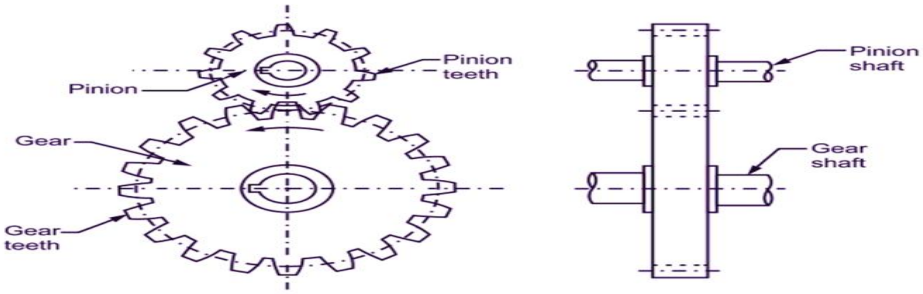
ROPE DRIVE:



When the centre distance between the driver and driven shaft is very large and higher power is required to be transmitted, rope drives are used. Here instead of a belt, wire rope is used. Appropriate size and number of grooves are provided on the pulley rim.

GEAR DRIVE:

Gear drives is used, when centre to centre distance between driver shafts and driven shafts is very small. A gear is a rotating machine part having cut teeth. Toothed wheels can transmit power and motion from one shaft to another shaft by means of successive engagement of teeth**.** Both the gears which are engaged will rotate in opposite direction. Power transmission capacity depends on the friction between surfaces of two discs.



7 a) Differentiate between Belt drives, chain drives and gear drives. [L2] [CO3] [5M]

Particulars	Belt drive	Chain drive	Gear drive
Main element	Pulleys, belt	Sprockets, chain	Gears
Slip	Slip may occurs	No slip	No slip
Suitability	For large centre distance	For moderate centre distance	For short centre distance
Space requires	Large	Moderate	Less
Use	For low velocity ratio	For moderate velocity ratio	For high velocity ratio
Design, manufacturing, complexity	Simplest	Simplest	Complicated
Life	Less	Moderate	Long
Installation cost	Less	Moderate	More
Lubrication	Not required	Required	Requires proper lubrication

b) What is the need of Robots in Industry? [L1] [CO3] [5M]

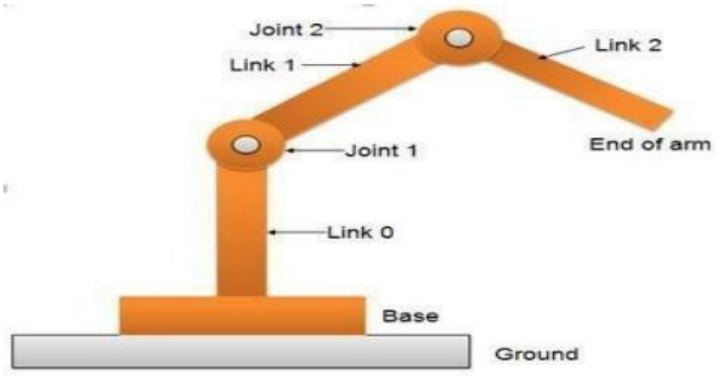
Need of Robots in Industry

- Robots are superior to human in terms of strength, size, speed and accuracy etc.
- Robots are better than human in performing repetitive tasks with better quality and consistency
- Robots don’t have limitations and negative attributes like fatigue, diversion of attention,
- Robots doesn’t expects rest

- Can save work and time
- Can work in adverse conditions also
- Assists in material handling systems
- Can expect faster inspection and testing.

8 a) Describe in detail about Robot Anatomy. [L4] [CO3] [10M]

Robot anatomy deals with the study of different joints and links and other aspects of the manipulator's physical construction. The anatomy of robot is also known as structure of robot. The basic components or sections in anatomy of robots are as follows.
Some of the key facts about robot anatomy.



- **End Effectors:** A hand of a robot is considered as **end** effectors. The grippers and tools are the two significant types of end effectors. The grippers are used to pick and place an object, while the tools are used to carry out operations like spray painting, spot welding, etc. on a work piece.
- **Robot Joints:** The joints in an industrial robot are helpful to perform sliding and rotating movements of a component.
- **Manipulator:** The manipulators in a robot are developed by the integration of links and joints. In the body and arm, it is applied for moving the tools in the work volume. It is also used in the wrist to adjust the tools.
- **Kinematics:** It concerns with the assembling of robot links and joints. It is also used to illustrate the robot motions.

b) Explain various types of joints used in Robots. [L2] [CO3] [5M]

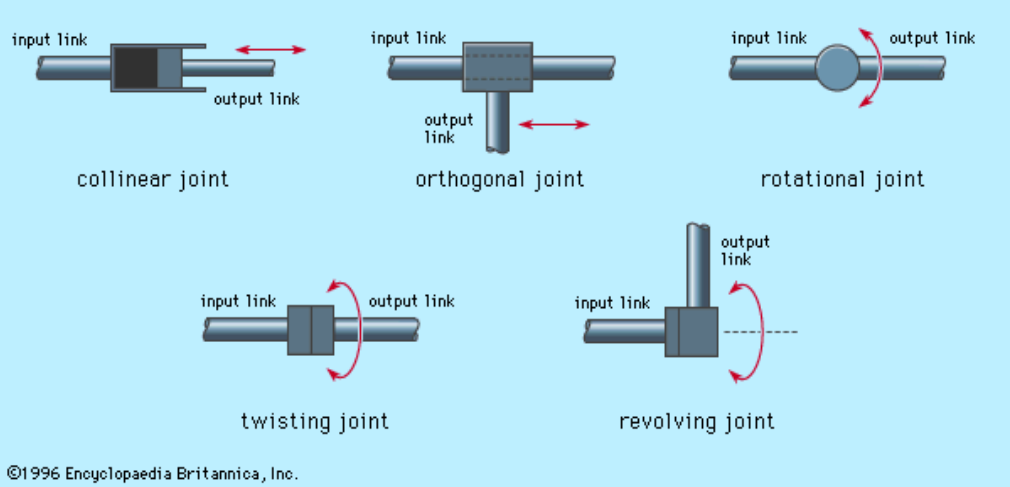
Nearly all industrial robots have mechanical joints that can be classified into following five types as shown in Figure

a) Linear joint (type L joint) The relative movement between the input link and the output link is a translational sliding motion, with the axes of the two links being parallel.

b) Orthogonal joint (type U joint) This is also a translational sliding motion, but the input and output links are perpendicular to each other during the movement.

c) Rotational joint (type R joint) This type provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.

d) Twisting joint (type T joint) This joint also involves rotary motion, but the axis or rotation is parallel to the axes of the two links.



e) Revolving joint (type V-joint, V from the "v" in revolving) in this type, axis of input link is parallel to the axis of rotation of the joint. However the axis of the output link is perpendicular to the axis of rotation.

9 a) Explain in brief about Asimov's laws of Robotics [L1] [CO3] [5M]

The three laws of Robotics or Asimov's laws are set of rules derived by the science friction author Isac Asimov. The Three Laws are:

- A Robot should not injure Human
- A Robot must obey the orders given by human except where such orders would conflict with the First law
- A Robot must protect its own existence as long as such protection doesn't conflict with the first or second law.

b) List out various merits and demerits of Robots in detail. [L1] [CO3] [5M]

Advantages of Robots

Increased efficiency: Industrial robots are able to complete certain tasks faster and better than people, as they are designed to perform these tasks with a higher accuracy level.

Higher quality : Due to their high accuracy levels, robots can also be used to produce higher quality products which adhere to certain standards of quality, whilst also reducing the time needed for quality control.

Improved working environment : Industrial robots are often used for performing tasks which are deemed as dangerous for humans, as well as being able to perform highly laborious and repetitive tasks.

Increased profitability: By increasing the efficiency in the production process, reducing the resource and time needed to complete it, and also achieving higher quality products, industrial robots can achieve higher profitability levels with lower cost per product.

Longer working hours : People distracted after some time and their working pace becomes slow. But a robot will work 24/7, and keeps running at 100%.

Disadvantages:

- Creates economic problems because they replace humans
- Works based on the commands given by humans
- High Initial cost

10 **Classify the robots based on Robot Configurations and explain its working.** **[L1] [CO3] [10M]**

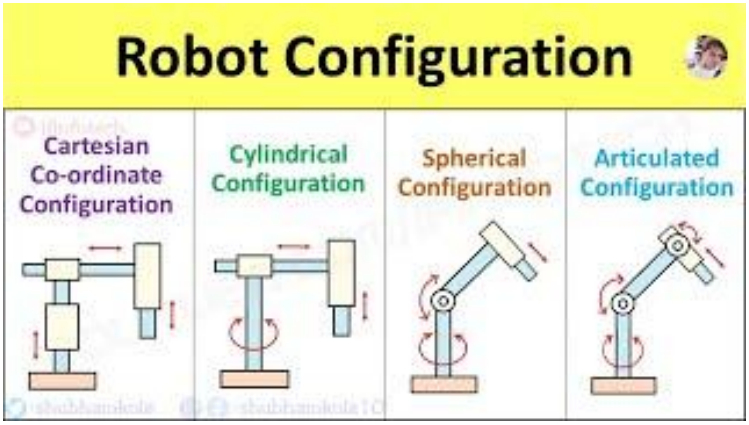
On the basis of physical configuration industrial robots are classified in four different types.
They are :
(i) Cartesian configuration,
(ii) Cylindrical configuration,
(iii) Polar configuration, and
(iv) Jointed-arm configuration.

Cartesian Configuration

Robots having cartesian configurations consist of links connected by linear joints (L). As the configuration has three perpendicular slides, they are also called rectilinear robots. Robot having a similar configuration is known as Gantry Robots. Its structure resembles a gantry-type crane.

Cylindrical Configuration

In the cylindrical configuration, robots have one rotatory (R) joint at the base and linear (L) joints succeed to connect the links. The space in which this robot operates is cylindrical in shape, hence the name cylindrical configuration.



Polar Configuration (Spherical Configuration)

Polar robots have a work space of spherical shape. In general, the arm is linked to the base with a twisting (T) joint and rotatory (R) and or linear (L) joints. The designation of the arm for this arm can be TRL or TRR. Robots with the description of TRL are also called spherical robots. Those having the designation of TRR are called as articulated robots. It resembles a human arm in terms of configuration.

Jointed-Arm Configuration (Articulated configurations)

The combination of cylindrical and articulated configurations is known as jointed-arm configuration. The arm of the robot is connected to the base with a twisting joint. Rotatory joints are used to connect the links in the arm. Generally, the rotation takes place in the vertical plane. Popular robot falling under this category is called SCARA (Selective Compliance Assembly Robot Arm). It is basically used for the assembly purpose.

11 **a)** **Robots are superior to human. Justify** **[L5] [CO3] [5M]**

Yes Robots are superior to humans because of the following reasons

- Works with higher efficiency than human
- Produce components with high quality

- Can works in dangerous environment also
- Works at high laborious and repetitive tasks effectively
- Works for longer hours without fatigue

b) List out various applications of robots in detail [L1] [CO3] [5M]

Applications of Robots

Arc Welding: One of the driving forces for switching to robot welding is improving the safety of workers from arc burn and inhaling hazardous fumes.

Materials Handling : Material handling robots are utilized to move, pack and transferring of parts from one piece of equipment to another This reduces the direct labour costs and hazardous activities performed by human

Machine Tending: Robotic automation for machine tending is the process of loading and unloading raw materials into machinery for processing and overseeing the machine

Painting: Robotic painting is used in automotive production and many other industries as it increases the quality and consistency of the product.

Picking, Packing and Palletizing

Robotic picking and packaging increases speed and accuracy along with lowering production costs.

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