

ELEMENTS OF MECHANICAL ENGINEERING

[21EME25]

ASSIGNMENT - I

1. Fundamental difference b/w subtractive and additive manufacturing? How 3D printing is the emerging trend in mechanical engineering?

Additive manufacturing

1. Involves adding layers of materials to create an object
2. Uses computers and specialist 3D printing equipment to create products
3. Best suited for smaller temp or parts especially in plastic
4. End result is a rough surface that needs to be finished by sanding or blowing.
5. Parts that require a lot of detail can be built in layers
6. Cheap and slow process

Subtractive manufacturing

1. Involves removal of material from an object
2. Uses computers & robotics to assist standard machining process ie drilling or milling
3. Best suited for manufacturing voluminous items and parts in metal
4. End result can be machined smooth stepped etc
5. Not ideal for parts that require certain intricacies and details
6. Fast and expensive process

3D printing is a fast -emerging technology. Nowadays 3D printing is widely used in mass customization, production of any types of open source designs in the field of agriculture in healthcare, automotive industry, plastic 3d printing aerospace industry, locomotive industry etc. Using 3D printing one can print an object layer by layer deposition of material directly from a computer aided design (CAD) model. It enables us to produce complex shapes using less material than traditional manufacturing methods.

2. Compare between renewable and non renewable energy source.

Renewable energy sources

1. Renewable resources cannot be depleted over time
2. Renewable resources include sunlight, water, wind and also geothermal sources such as hot springs & fumaroles
3. These are sustainable resources
4. Their rate of renewal is greater than the rate of getting exhausted.

Non-renewable energy sources

1. Non-renewable resources deplete over time
2. Non renewable energy resources include fossil fuels such as coal and petroleum
3. These are exhaustible resources
4. Their rate of renewal is slower than the rate of getting exhausted

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| 5. They are environment friendly as the amount of carbon emissions is low. | 9. They are not environment friendly, as the amount of carbon emission is high. |
| 6. The total cost of these resources is low. | 6. The total cost of these resources is comparatively high. |
| 7. Requires large land area for the installation of power plant. | 7. Requires less land area for the installation of the power plant. |
3. As a mechanical engineer discuss the emerging trends and technologies in aerospace sector and its contribution to GDP.

Aerospace structures differ from other structures due to their high demand for performance and light weight. 3D printing has been proven to be an excellent manufacturing solution for producing components and parts that utilize significantly less material than other comparable, traditionally manufactured parts. Here complex geometric shapes can be built that have great strength despite the reduced density in the material used. Reducing weight is paramount to the aerospace technology industry due to increasing performance in areas of speed, capacity, fuel consumption, emissions and more.

The main emerging trends in aerospace sector:-

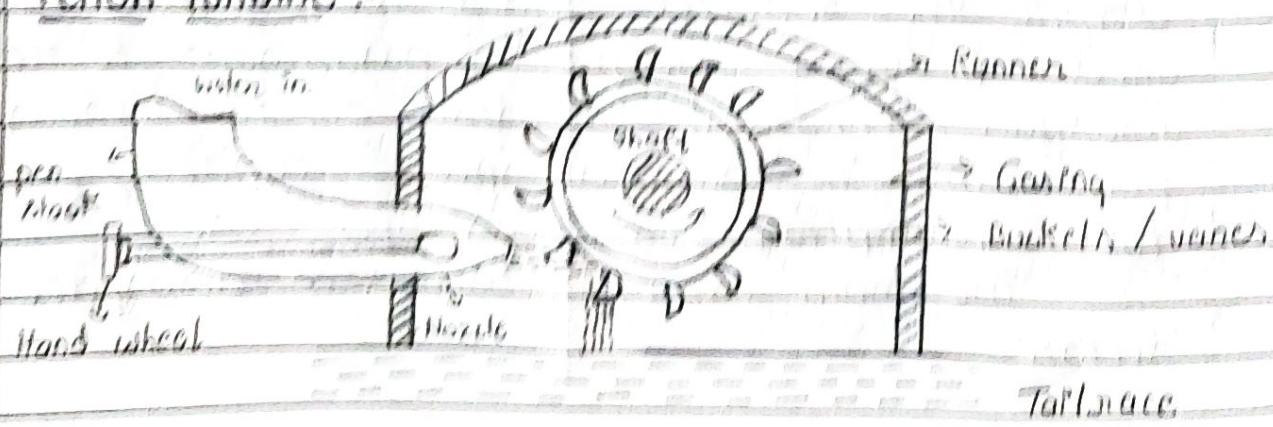
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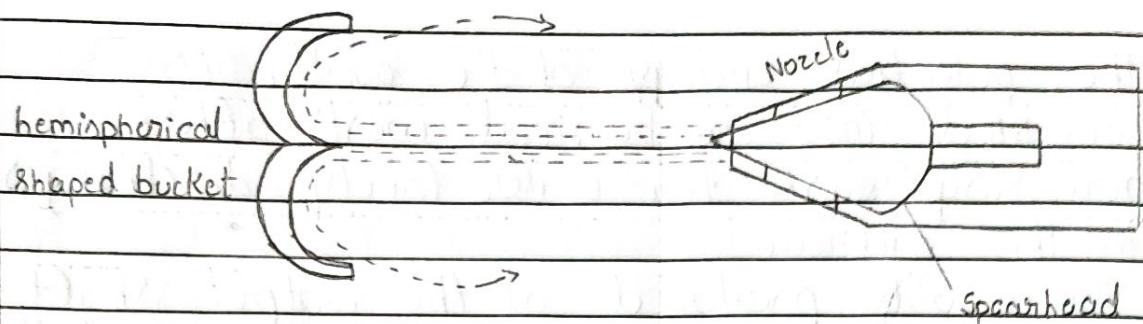
- Zero fuel aircraft
- Structural health monitoring (SHM)
- Advanced materials
- Smart automation and block chain
- Additive manufacturing (3D printing)
- Supersonic flights
- Utilizing Internet of things (IoT) to anticipate maintenance issues
- Artificial intelligence (AI)
- Autonomous flight systems.

A study has said aerospace sector is currently contributing Rs 33000 crores to an 0.5% of Indian GDP and supporting 1.7 million jobs in the country besides creating much needed critical metals. Air transport is a driver of global trade and e-commerce, allowing globalization of production. By facilitating tourism aerospace sector helps to generate economic growth and alleviate poverty.

4 With the neat sketch explain the working principle of 'Pelton' turbine.

⇒ Pelton turbine:





Flow of water on bucket

PRINCIPLE :-

Pelton wheel is a tangential flow impulse turbine used for high heads and a small quantity of water flow. The turbine converts the pressure energy of water into kinetic energy entirely in the distributor.

WORKING:-

- In operation water from the reservoir (dam) having potential energy flows through the pen stock and enters the nozzle.
- The water from a high head source is applied to the nozzle provided with a spreadhead, which controls the quantity of water flowing out of the nozzle.
- As water flows through the nozzle the potential energy of water is completely converted into kinetic energy.
- The high velocity jet of water comes from the nozzle impinges on the curved blades; it is fixed around the runner wheel.
- The impulse force due to a high velocity jet of water sets the runner wheel into rotary motion. Hence the shaft coupled to the runner wheel also rotates thereby doing useful work.

- The potential energy of the water is converted into mechanical work after performing work the water freely discharges to the tailrace.
- The work produced at the output shaft is used to drive a generator to produce electricity.

5. Explain the three processes of utilization of solar energy

⇒ 1) Solar thermal energy harvesting:

Direct solar energy is directly converted into thermal energy (heat energy) by using a collector. This process is called a Helio-thermal process. The surface on which the solar rays fall is called a collector. The collector may be either flat plate collector or focusing collector.

2) Solar Pond technology:-

A salinity gradient solar pond is an integral collection and storage device of solar energy. By virtue of having built in thermal energy storage, it can be used irrespective of time and season. In an ordinary pond or lake, when the sun's rays heat up the water, the heated water being lighter, rises to the surface, and loses its heat to the atmosphere. This

technology inhibits the phenomena by dissolving salt into the bottom layer of thin ponds making it too heavy to rise to the surface even when hot. The useful thermal energy is hence withdrawn from the solar pond in the form of hot brine.

3) Photovoltaic cell:-

Solar energy can be directly converted to electrical energy by means of photovoltaic cell / effect. The photovoltaic effect is defined as the generation of an electromotive force (EMF) as a result of the absorption of ionizing radiation. Devices which convert sunlight to electricity are known as photovoltaic cells.

6. Explain the working of Tidal power plant.

⇒ Tide or wave is periodic rise and fall of water level of the sea. The ocean tides rise and fall and water can be stored during the rise period and it can be discharged during fall. A dam is constructed separating the tidal basin from the sea and a difference in water level is obtained b/w the basin and sea. During high tide period, water flows from the sea into the tidal basin through the water turbine. The height of tide is above that of tidal basin. Hence the turbine unit operates and generates

power, as it is directly coupled to a generator. During low tide period, water flows from tidal basin to sea, as the water level in the basin is more than that of the tide in the sea. During this period also the flowing water rotates the turbine and generates power. The generation of power stops only when the sea level and the tidal basin level are equal. For the generation of power economically using this source of energy requires some minimum tide height and suitable site.

7. Define the following:-
 1] Internal energy
 2] enthalpy 3] entropy 4] Formation
 of steam 5] Latent heat.

⇒ 1] Internal energy :- (U)

It is the energy possessed by a body or a system due to its molecular arrangement and motion of the molecules. It is the sum of PE and KE of the particles that form the system.

2] Enthalpy (H)

Enthalpy refers to the total heat content of a system. It is defined as the sum of internal energy (U) and the product of pressure and volume of the system

$$H = U + PV$$

3. Entropy (S) :-

Entropy is the measure of a system's thermal energy per unit temperature that is unavailable for doing useful work.

4. Steam :-

Steam is a mixture of water and air (or) it can also be defined as vapour of water.

5. Latent heat :-

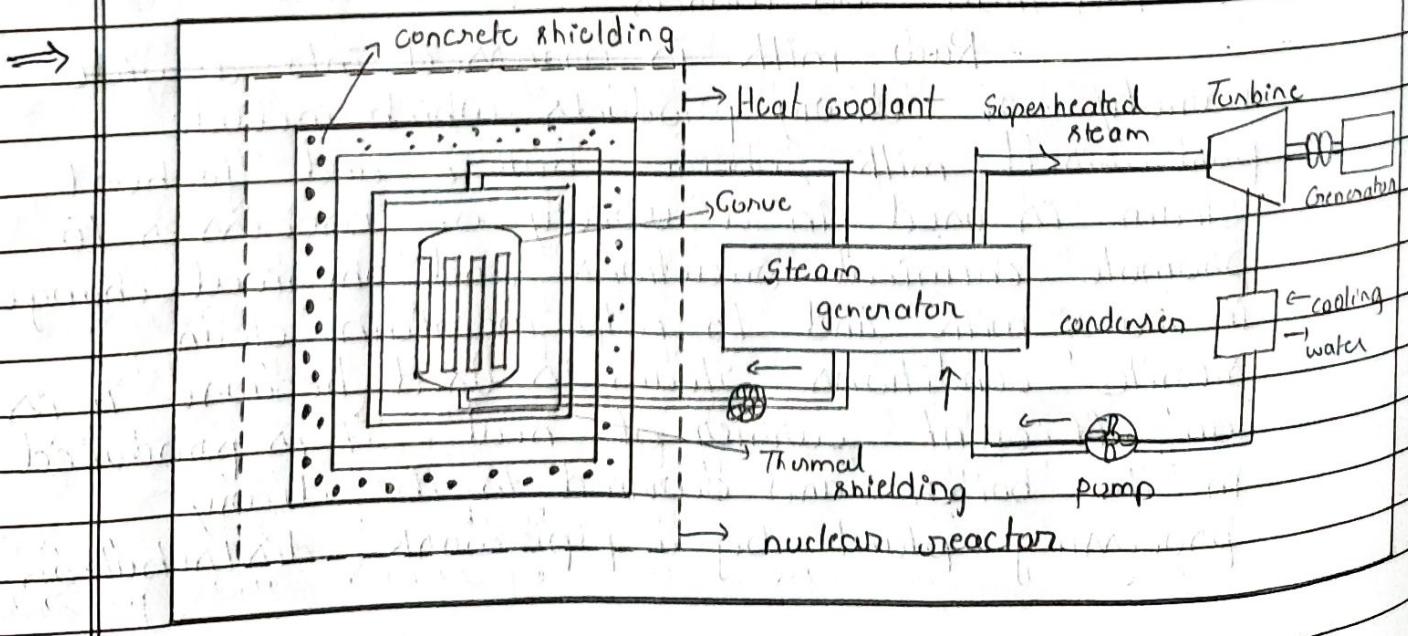
Latent heat is energy released or absorbed by a body or a thermodynamic system during a constant temperature process usually a first order phase transition.

8. Discuss the application of steam in milk industry in less than 500 words

Raw milk is processed into a wide variety of dairy products which include pasteurised milk, cheese, butter and yoghurt. Steam is used in a variety of processes to promote chemical reactions and physical changes in raw milk and to help maintain clean sterile conditions. Steam is used because it is an efficient carrier of heat. It is produced in the boiler and carried to the dairy processing plant by a pipework distribution.

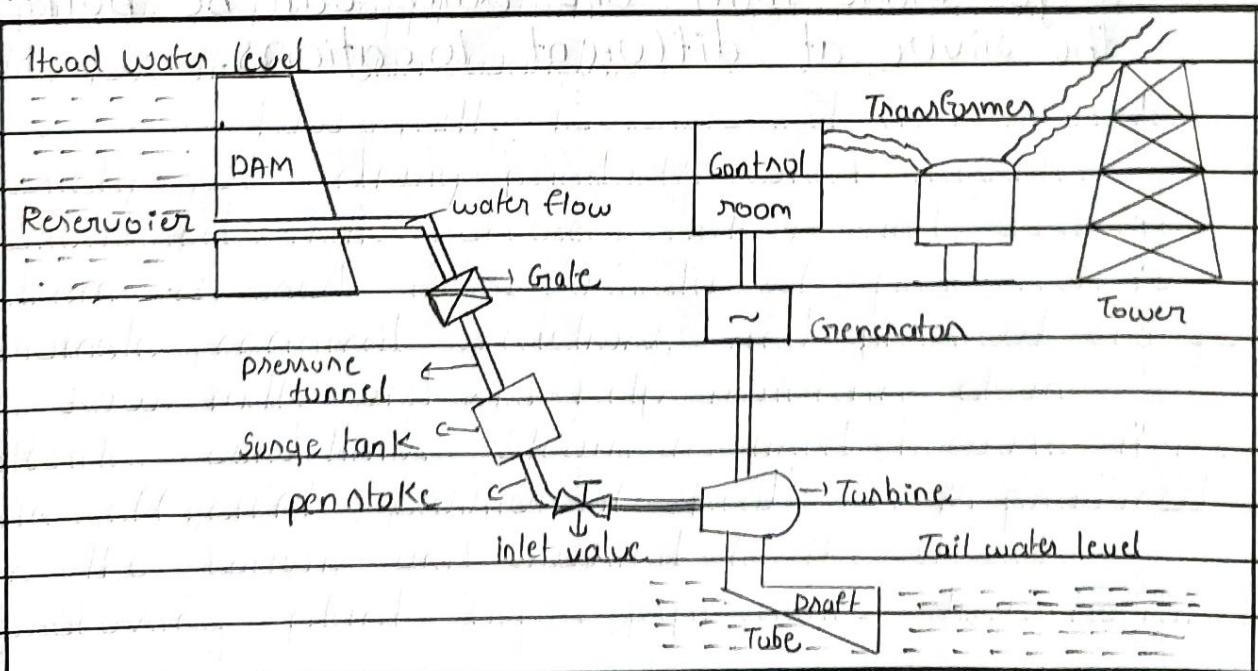
system. At each processing plant by a pipework distribution system. At each process steam transfers its heat and condenser back to condensate. The temperature of many processes can be accurately controlled by controlling the pressure of the steam. Any entrained moisture and incondensable gases in the steam can lower its heat content and impair the heat transfer rate. Steam leaving the boiler house should contain as little moisture and incondensable gases as possible. This ensures that the maximum amount of heat is available and minimizes the risk of pipeline and equipment damage from water channel.

- a. with neat sketch explain the principle of nuclear power plants.



A generating station in which nuclear energy is converted into electrical energy is known as a nuclear power station. Nuclear energy is the energy that holds the nucleus of an atom. The energy released during nuclear fission or fusion especially when used to generate electricity. The most common nuclear fuels are ^{235}U . Nuclear fission reactions take place in nuclear reactors which are controlled chain reactions to generate electricity. Uncontrolled chain reactions take place during the explosion of an atomic bomb. The main components of this power plant are a nuclear reactor, control rods, steam generators, condenser and cooling tower.

10. With a neat sketch, explain the principle of hydro-electric power plants.



The water flowing in the river possesses two types of energy

1. The Kinetic energy due to the flow of water and
2. Potential energy due to the height of water

In hydroelectric power plant potential energy of water is utilised to generate electricity

The formula for total power that can be

generated from water is hydro-electric power plants due to its height. The potential energy of water stored at height is converted to mechanical energy in a water turbine. The mechanical energy produced by the water turbine is converted into electrical energy

After doing useful work water is discharged from the turbine to the river through the water to the tailrace through a draft tube.

In certain cases where the river is very large more than one dam can be built across the river at different locations.