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CMR INSTITUTE OF TECHNOLOGY, BENGALURU.
ACCREDITED WITH A+ GRADE BY NAAC

Internal Assessment Test – II

Sub:	Elements of Mechanical Engineering					Sub Code:	21ME15	Branch:	Chemistry Cycle	
Date:	26/02/2022	Duration:	90 min’s	Max Marks:	50	Sem / Sec:	1^{st} / I - O		OBE	

	Answer any Five Questions. Steam tables to be permitted	MARKS	CO	RBT
1	With a neat sketch explain the construction and working of a wind power plant.	10	CO1	L2
2	With the help of a T – h diagram explain the formation of steam from water at 0°C.	10	CO2	L2
3	With a neat sketch explain the working of a centrifugal pump. Explain the concept of priming and cavitation.	10	CO2	L2
4	With a neat sketch explain the principle and operation of a mixed flow turbine.	10	CO2	L2
5	With a neat sketch briefly explain about the components of a CNC Machine. State few advantages, limitations and applications of a CNC machine.	10	CO1	L2
6	With a neat sketch explain the working of a vapor compression refrigeration system.	10	CO2	L2
7	5 kg of wet steam of dryness 0.8, passes from a boiler to a super heater at a constant pressure of 1 MPa. In the super heater its temperature increases to 350°C. Determine the amount of heat supplied in the super heater. The specific heat of super-heated steam is 2.25 kJ/KgK.	10	CO1	L2

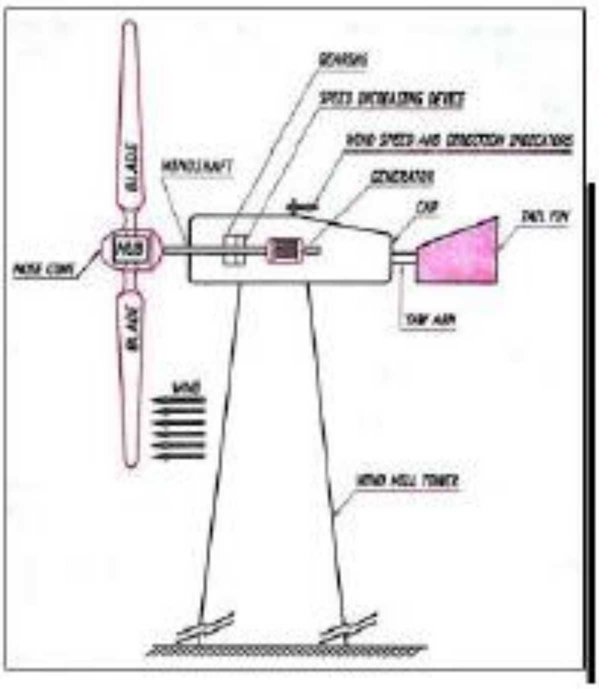
	Answer any 5 question	Split up	Max. MARKS
1.	With a neat sketch explain the construction and working of a wind power plant **Diagram – 4 Mark** **Explanation – 6 Mark**	**4M** **6M**	[10]
2	With the help of a T – h diagram explain the formation of steam from water at 0°C **Diagram – 4 Mark** **Explanation with proper notation – 6 mark**	**4M** **6M**	[10]
3	With a neat sketch explain the working of a centrifugal pump. Explain the concept of priming and cavitation. **Diagram - 4 Mark each** **Explanation - 6 Mark each**	**4M** **6M**	[10]
4	With a neat sketch explain the principle and operation of a mixed flow turbine. **Diagram - 4 Mark each** **Explanation - 6 Mark each**	**10M**	[10]
5	With a neat sketch briefly explain about the components of a CNC Machine. State few advantages, limitations and applications of a CNC machine. **Diagram - 4 Mark** **Explanation - 6 Mark**	**4M** **6M**	[10]
6	With a neat sketch explain the working of a vapor compression refrigeration system **Diagram - 4 Mark** **Explanation - 6 Mark**	**3M** **3M** **4M**	[10]
7	5 kg of wet steam of dryness 0.8, passes from a boiler to a super heater at a constant pressure of 1 MPa. In the super heater its temperature increases to 350°C. Determine the amount of heat supplied in the super heater. The specific heat of super-heated steam is 2.25 kJ/KgK. **Calculating diameter – 2.5 in each case**	**10M**	[10]

1.

Extraction of energy from wind

- The hub is connected to a generator through a gear drive.
- A tower (average 200 m height) helps to minimize turbulence and ground effects.
- The preferred wind speed for maximum power generation is about 40 km/h.
- Nowadays, effort is being made to improve the performance of windmills using aerodynamic and sound engineering principles.
- Winds blow across the blades in turn converting their energy in to mechanical energy due to rotation of blades. The turbine spins the generator and generates electricity.

Wind Mill- Diagram



Steam Formation

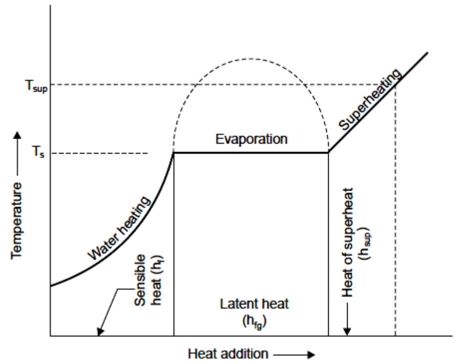
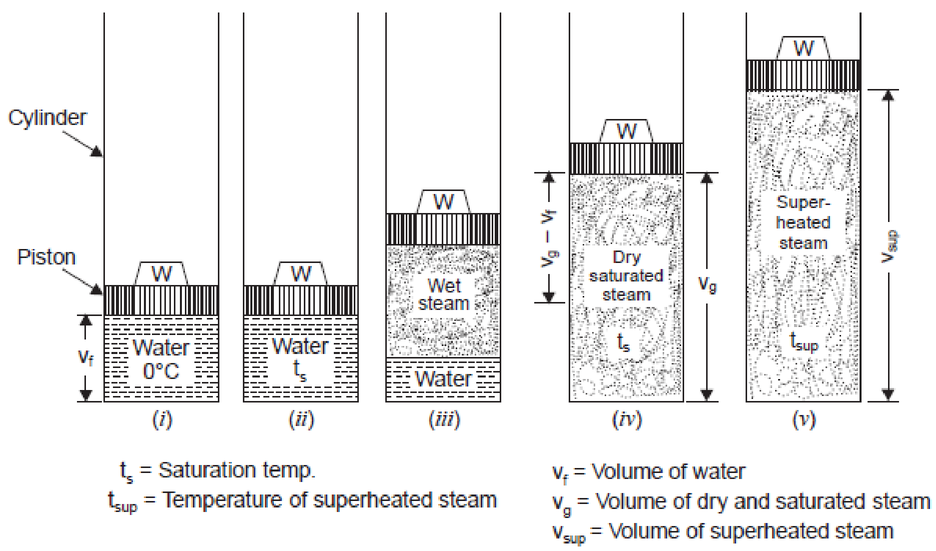


Fig. 3.10. Graphical representation of formation of steam.



Consider a cylinder fitted with a piston which can move freely upwards and downwards in it. Let, for the sake of simplicity, there be 1 kg of water at 0°C with volume *vf* m3 under the piston . Further let the piston is loaded with load *W* to ensure heating at constant pressure. Now if the heat is imparted to water, a rise in temperature will be noticed and this rise will continue till boiling point is reached. The temperature at which water starts boiling depends upon the pressure and as such for *each pressure* (under which water is heated) *there is a different boiling point*. This boiling temperature is known as the temperature of formation of steam or *saturation temperature*.

It may be noted during heating up to boiling point that there will be slight increase in volume of water due to which piston moves up and hence work is obtained as shown. This work, however, is so *small* that is can be *neglected*.

Now, if supply of heat to water is continued it will be noticed that rise of temperature after the boiling point is reached *nil* but piston starts moving upwards which indicates that there is increase is volume which is only possible if steam formation occurs. The heat being supplied does not show any rise of temperature but changes water into vapour state (steam) and is known as *latent heat* or *hidden heat*. So long as the steam is in contact with water, it is called *wet steam* and if heating of steam is further progressed such that all the water particles associated with steam are evaporated, the steam so obtained is called *dry and saturated steam*.

Again, if supply of heat to the dry and saturated steam is continued at constant pressure there will be increase in temperature and volume of steam. The steam so obtained is called *superheated steam* and it *behaves like a perfect gas*. This phase of steam formation is illustrated in Fig

Centrifugal Pump:

→ Centrifugal Pump is a power absorbing turbomachine used to raise liquids from a lower level to a higher level by creating the pressure required, using centrifugal action.

→ It converts mechanical energy into hydraulic energy (in form of pressure energy).

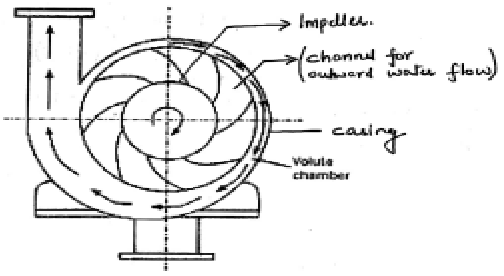


Fig : Centrifugal Pump

→ Construction
Main parts : (i) Impeller (ii) Casing (iii) Suction pipe (iv) Delivery pipe

→ Impeller is a rotating component of the pump.

→ Impeller consists of specially designed channel (passage for water flow), starting from centre toward the outer periphery in radial direction.

→ Casing is that part of the pump which receives the fluid being pumped by the impeller.

→ Casing is in spiral shape, with increasing cross-sectional area towards its outlet (To maintain velocity constant)

→ The inlet of the pump is connected to the sump, and outlet is connected to the delivery tank.

→ The pipe connecting sump & inlet of impeller is suction pipe

→ The pipe connecting outlet of pump & delivery tank is called as delivery pipe

Working :-

→ The motor drives the impeller, via a shaft.

→ As the impeller rotates, the water enters at the inlet of the impeller due to suction.

→ As the impeller rotates, the water entering the inlet of impeller is continously thrown out due to the centrifugal force.

→ The water passes through the specially designed channels in the impeller, towards the outer periphery of the impeller.

→ The casing space is filled by water continously, and is discharged to the delivery tank continously.

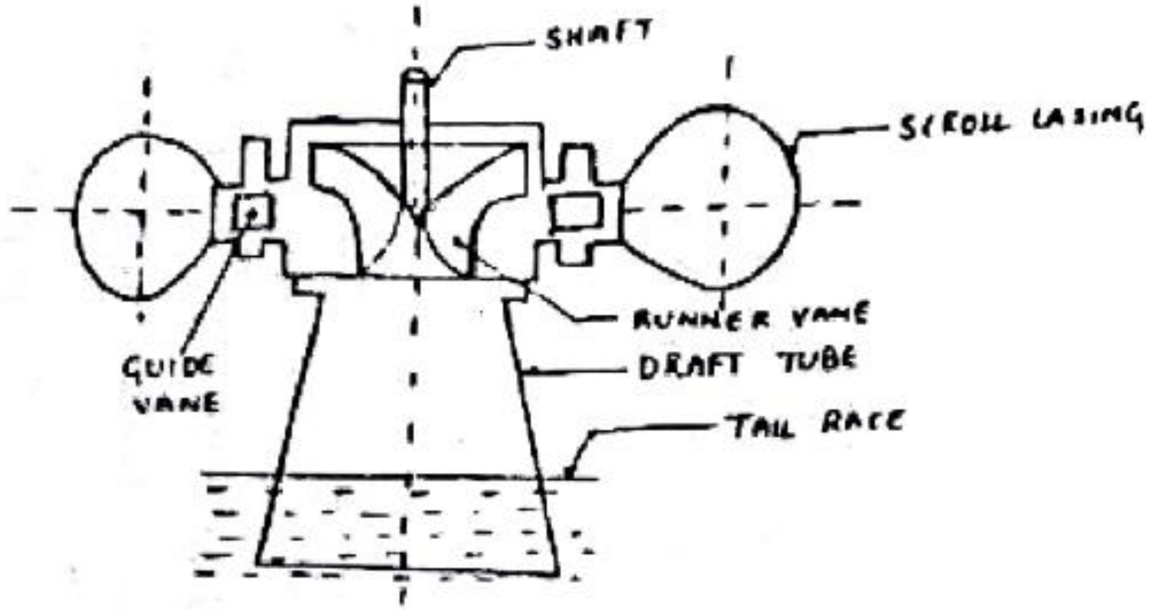
→ The pressure head (m of water) developed by centrifugal action is entirely by the velocity imparted to the liquid by the rotating impeller.

→ Hence, speed of the shaft is enough to produce necessary centrifugal force for discharging.

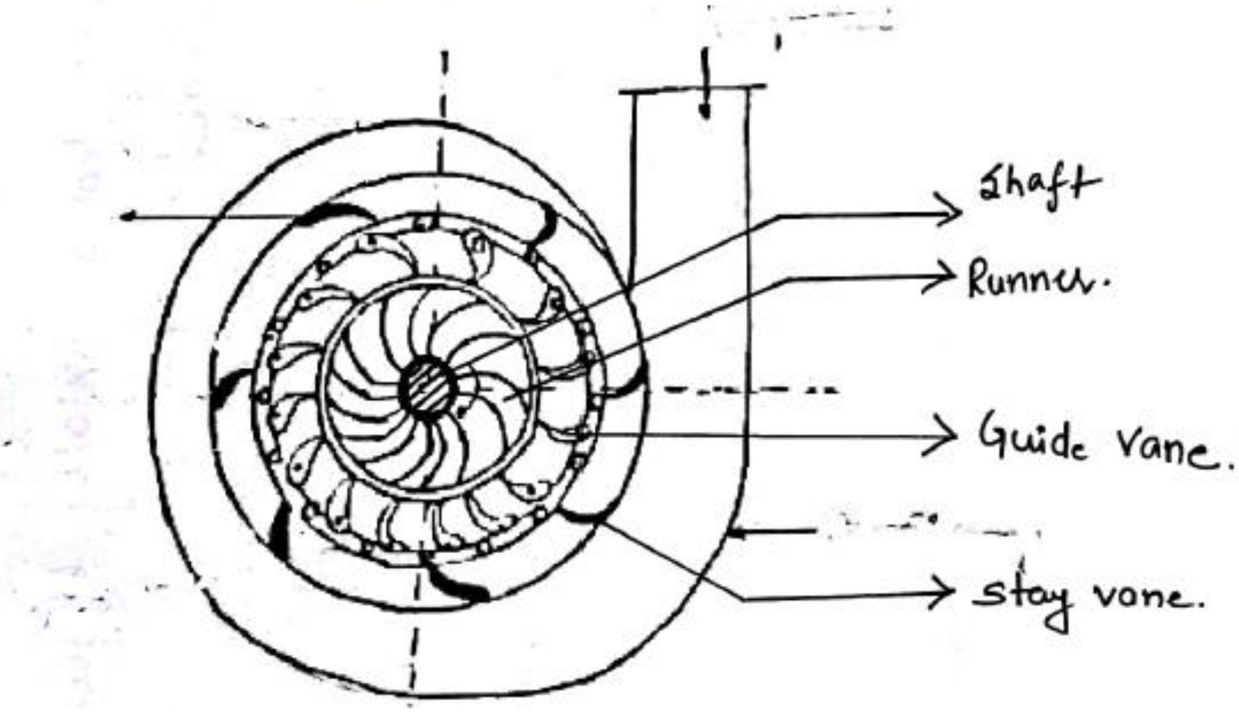
Francis Turbine (Impulse- Reaction Turbine)

- Francis turbine is a water turbine used for medium head and medium flow rate application.
- Runner, the rotating part of turbine contains set of blades over which the water glides during the flow.
- Runner is connected to the generator via a shaft for electricity production.
- In runner water enters radially and leaves axially, hence also called as a mixed flow turbine.
- The cross-section of blade in the runner has a thin Air-foil shape and a bucket shape towards the outlet
- So, when water flows over it, there is a low pressure region on one side and a high pressure region on other side of blade, giving rise to a lift force. (due to air foil shape)
- The bucket shape introduces an impulse force on runner
- Hence Pressure Energy (converts to lift force) and kinetic Energy (used up for impulse force) from the fluid and is used up to do the work on turbine
- Hence both kinetic Energy (K.E) and Pressure Energy (P.E) drops down.
- Francis turbine is not a pure reaction turbine, as some portion of force comes from impulse action also.

FRONT VIEW OF FRANCIS TURBINE



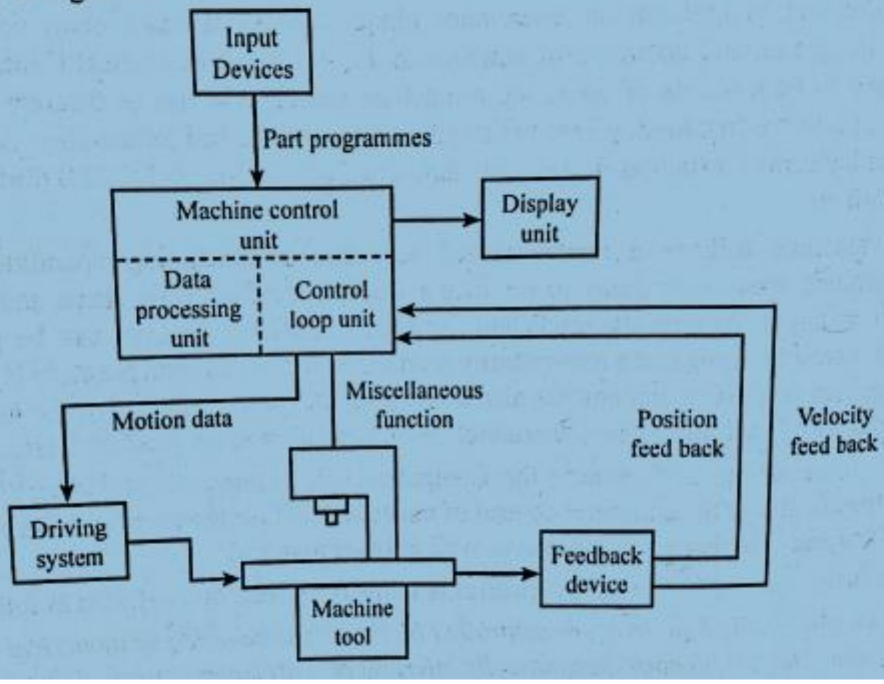
TOP VIEW OF FRANCIS TURBINE



5.

The machine control unit (MCU) is a microcomputer that stores the program and executes the commands into actions by the machine tool. The MCU consists of two main units: the data processing unit (DPU) and the control loops unit (CLU). The DPU software includes control system software, calculation algorithms, translation software that converts the part program into a usable format for the MCU, interpolation algorithm to achieve smooth motion of the cutter, editing of part program (in case of errors and changes).

The DPU processes the data from the part program and provides it to the CLU which operates the drives attached to the machine leadscrews and receives feedback signals on the actual position and velocity of each one of the axes. A driver (dc motor) and a feedback device are attached to the leadscrew. The CLU consists of the circuits for position and velocity control loops, deceleration and backlash take up, function controls such as spindle on/of. Refer Fig. 5.18.



6.

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

STEP 1: COMPRESSION

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

STEP 2: CONDENSATION

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

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

STEP 3: THROTTLING AND EXPANSION

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

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

STEP 4: EVAPORATION

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

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

7.. P = 10 Bar, x = 0.8, m = 5kg

From Steam Tables corresponding to 10 bar,

Tsat = 179.88

h_f = 762.52 KJ/Kg

h_{fg} = 2014.6 KJ/Kg

Enthalpy of steam with dryness 0.8, h = hf + x hfg = 2374.2 KJ/Kg

Enthalpy of super heated steam , h sup = hf + hfg + Cp (Tsup-Tsat) = 3159.89 KJ/Kg

Amount of heat Supplied = h sup – h = 785.69 KJ/Kg

Total amount of heat supplied In super heater = mass * heat supplied per kg

= 5 x 785.69

= 3948.45 KJ