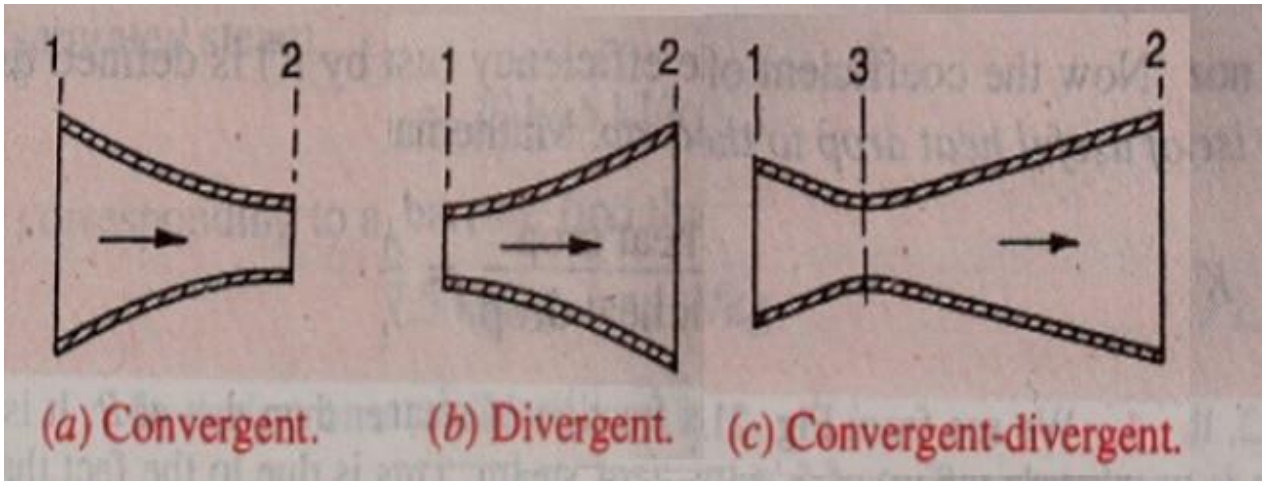
QUESTION BANK FOR ORAL EXAMINATION:

1. What is Nozzle and what are different types of Nozzle?

Nozzles are Conical shaped piece of tube, where potential energy of steam is converted into kinetic energy,



1. Convergent Nozzle
2. Divergent Nozzle
3. Convergent-Divergent Nozzle

Convergent Nozzle:

A typical convergent nozzle is shown in fig. in a convergent nozzle, the cross-sectional area decreases continuously from its entrance to exit. It is used in a case where the backpressure is equal to or greater than the critical pressure ratio.

Divergent Nozzle:

The cross-sectional area of the divergent nozzle increases continuously from its entrance to exit. It is used in a case, where the back pressure is less than the critical pressure ratio.

Convergent-Divergent Nozzle:

In this case, the cross-sectional area first decreases from its entrance to the throat and then increases from throat to exit.it is widely used in many types of steam turbines

2. Define the terms & explain a) Impact of jets b) Jet Propulsion

3. What is the difference between the force exerted by jet on a single curved plate movingcurved plates?

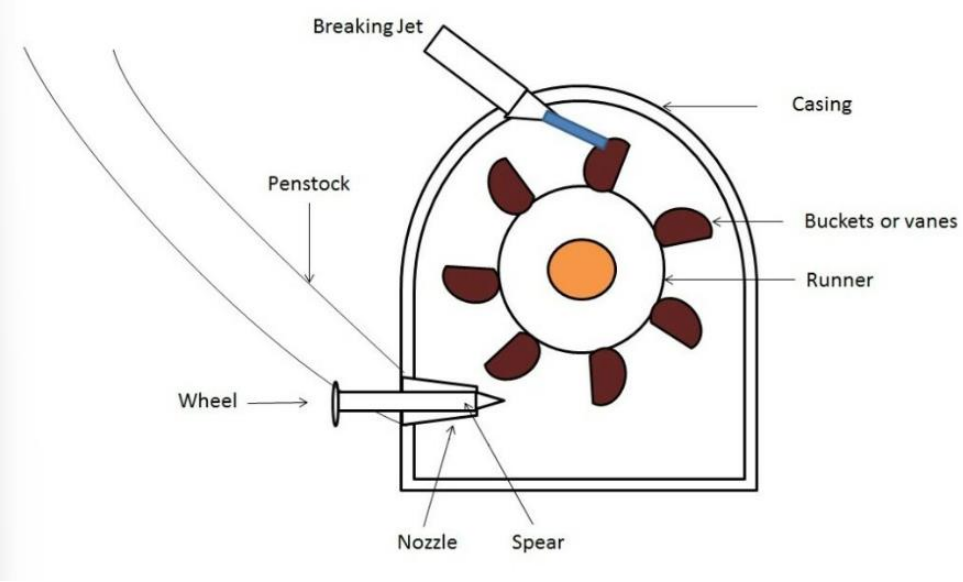
4. Differentiate between the force exerted by a jet of water on fixed vertical plate and movingvertical plate.

5. What do you understand by hydrodynamic machines? Discuss impulse momentum equationas applied to these machines?

6. What is Pelton Wheel turbine?

The Pelton wheel turbine is one kind of an impulse turbine utilized for high heads of water (greater than 300 meters) and was invented by an American Engineer, Lester Allan Pelton.
Parts of a Pelton Wheel Turbine:

- Nozzle
- Runner and buckets
- Casing and
- Breaking jet



Working Principle

Water flows from the nozzle with high kinetic energy along the runner's path. When the water jet comes in touch with the bucket, it exerts a push on the bucket, which is called the impulse force.

The nozzle applied at the end of the penstock is provided with a spear or needle, which is fixed at the end of a rod to control the water quantity hitting the runner.

During this process, the momentum of the water is conveyed to the turbine. The impulse force generated due to this momentum of water makes the turbine rotate.

The double semi ellipsoidal buckets split the water jet into two equal amounts, which helps in balancing the wheel(runner). This guarantees a smooth transfer of the water jet to the turbine wheel.

For maximum efficiency and power, the turbine is designed in a way that the velocity of the water jet is twice that of the bucket.

7. What is difference between Impulse and Reaction water turbine?

Basis of Difference	Impulse Turbine	Reaction Turbine
Definition	The type of turbine in which only kinetic energy of water (impulse force) is used to rotate the turbine is known as impulse turbine.	The type of water turbine in which both kinetic energy as well as pressure energy of water is used turn the turbine is called the reaction turbine.
Water flow	In an impulse turbine, the water flows through a nozzle and strikes to the blades of the turbine.	In reaction turbine, the water is guided by the guide blades (fixed blades) to flow over the turbine.
Force on blades	In impulse turbine, an impulsive force rotates the turbine.	In reaction turbine, a reaction force on the blades is rotation the turbine.
Pressure of water while flowing over moving blades	In impulse turbine, the pressure of water remains unchanged and is equal to atmospheric pressure when it flows over the moving blades.	In the reaction turbine, the pressure of water continuously decreases when it flows over the blades.
Decrease in pressure of water	In impulse turbine, the pressure of water is reduced in the nozzle before entering the turbine.	In reaction turbine, the pressure of water is decreasing while flowing over the blades.
Change in pressure of water	In impulse turbine, all the pressure of water is converted into kinetic energy before striking the turbine blades.	In reaction turbine, there is no change in the pressure of water before striking the turbine blades.

Water head	The impulse turbines are most suitable for large water heads.	The reaction turbines are suitable for relatively low water heads.
Water flow rate	The impulse turbines are suitable for comparatively low water flow rates.	Reaction turbines are suitable in cases where water flow rates are higher.
Necessity of turbine casing	In impulse turbine, there is no necessity of turbine casing as it has no hydraulic function. It is just provided to prevent splashing of water.	In reaction turbine, the turbine casing is required because the pressure at inlet is very high as compared to pressure at outlet. Therefore, the casing seals it from the atmospheric pressure.
Blades profile	The blades of an impulse turbine are of symmetrical profile.	The blades of a reaction turbine are asymmetrical, having aerofoil profile.
Water discharge	In impulse turbine, the water discharges directly from the turbine wheel to tail race.	In a reaction turbine, the water discharges into a draft tube first and then into the tail race.
Turbine size	For the same power output, the size of impulse turbine is smaller.	The reaction turbine have relatively large size for the same power output.
Examples	Popular examples of impulse turbine are: Pelton wheel turbine, Turgo turbine and cross-flow turbine.	Popular examples of reaction turbines are: Francis turbine and Kaplan turbine.

8. What are basis on which Hydraulic Turbines are classified.

I) On the basis of type of energy at inlet – a. Impulse turbine

b. Reaction turbine

ii) On the basis of direction of flow through runner – a. Tangential flow turbine

b. Radial flow turbine

c. Axial flow turbine

d. Mixed flow turbine

iii) On the basis of head at the inlet of turbine – a. High head turbine

b.Medium head turbine

c. Low head turbine

iv) On the basis of specific speed of turbine – a. Low specific speed turbine

b. Medium specific speed turbine

c. High specific speed turbine

9. Define the terms Hydraulic Machines, Turbines and Pumps.

Hydraulic machine are those machines which convert hydraulic energy (energy possessed by water) into mechanical energy (which is further converted into electrical energy) or mechanical energy into hydraulic energy**.**

The hydraulic machines, which convert the hydraulic energy into mechanical energy, are called turbine while the hydraulic machines which convert the mechanical energy into hydraulic energy are called pumps.

10. Define the hydraulic efficiency of a turbine

Hydraulic Efficiency: It is defined as the ratio of power given by the water to runner of a turbine (runner is a rotating part of a turbine and on the runner vanes are fixed) to the power supplied by the water at the inlet of the turbine.

$$\eta_h = \frac{\text{Power delivered to runner}}{\text{Power supplied at inlet}} = \frac{RP}{WP}$$

11. Define the Mechanical efficiency of a turbine.

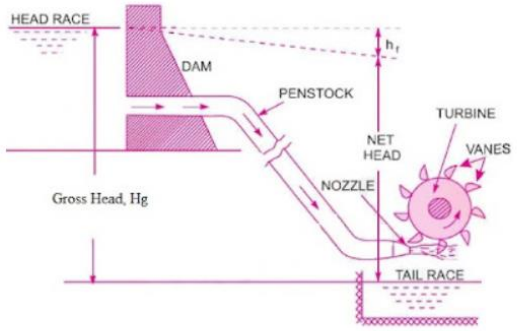
It is the ratio of the power delivered by water to the runner of a turbine and the power transmitted to the shaft of turbine. Due to mechanical losses, the power available at the shaft of the turbine is less than the power delivered.

12. Define the Overall efficiency of a turbine.

It is defined as the ratio of power given by water to the runner of turbine to the power supplied by the water at the inlet of turbine.

13. Define the terms of Gross Head.

Gross head is basically defined as the difference between the head race level and tail race level when water is not flowing. Gross head will be indicated by H_g as displayed here in following figure.



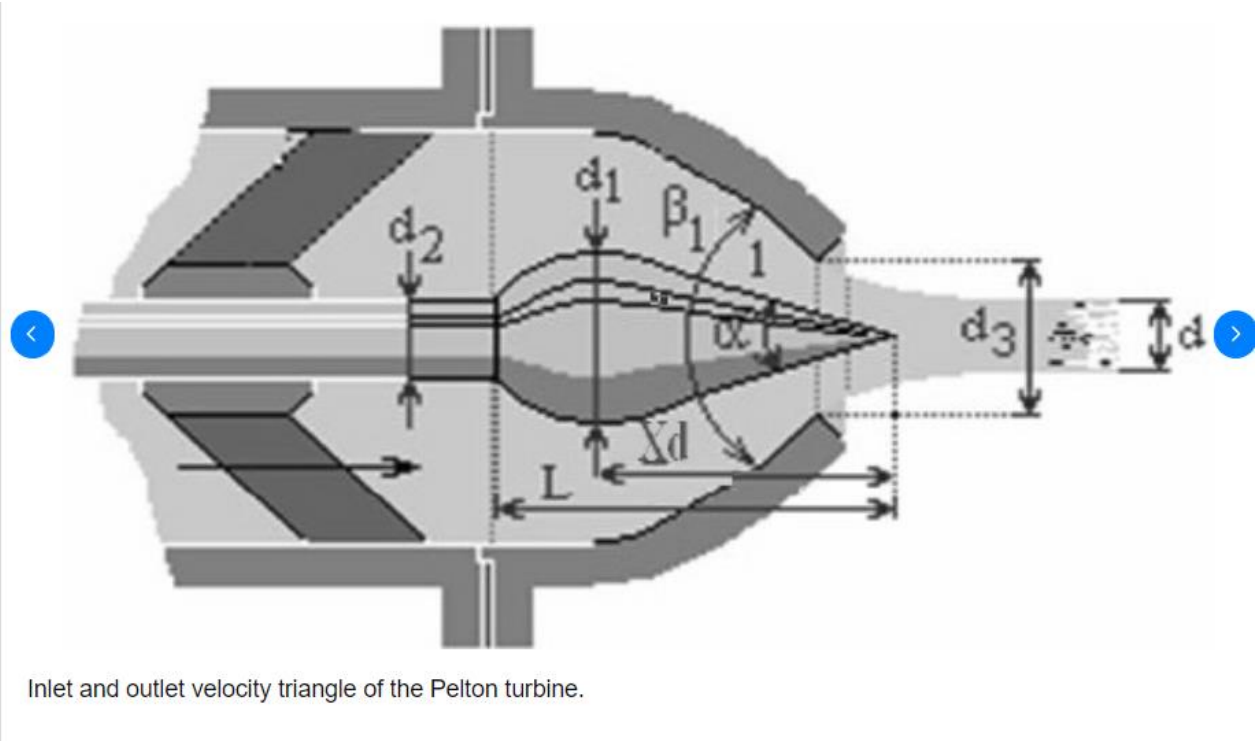
14. Define the terms of Net Head.

Net head is basically defined as the head available at the inlet of the turbine. Net head is also simply called as effective head. When water will flow from head race to the turbine, there will be some losses of head due to friction between water and penstock. There will also be other losses of head such as loss of head due to bend, fitting, at entrance of penstock etc. We must note it here that these losses will be very less and could be neglected when we compare with head loss due to friction.

Net head available at the inlet of turbine could be written as mentioned here.

Net head, H = Gross head (H_g) – head loss due to friction (h_f)

15. Draw inlet or outlet velocity triangles for a Pelton turbine and indicate their direction ofvarious velocities.



Inlet and outlet velocity triangle of the Pelton turbine.

16. What factors decide the type of turbine to be used in a hydroelectric project?

17. Write the names of parts of various systems and which are required for Governing ofPelton Turbine.

Oil pressure governor is used for governing of Pelton turbine. Oil pressure governor, as displayed here in following figure, will have following components.

1. Oil sump
2. Oil pump
3. Servomotor or relay cylinder
4. Control valve or distribution valve or relay valve
5. Centrifugal governor or pendulum
6. Piping arrangements
7. Spear rod or needle

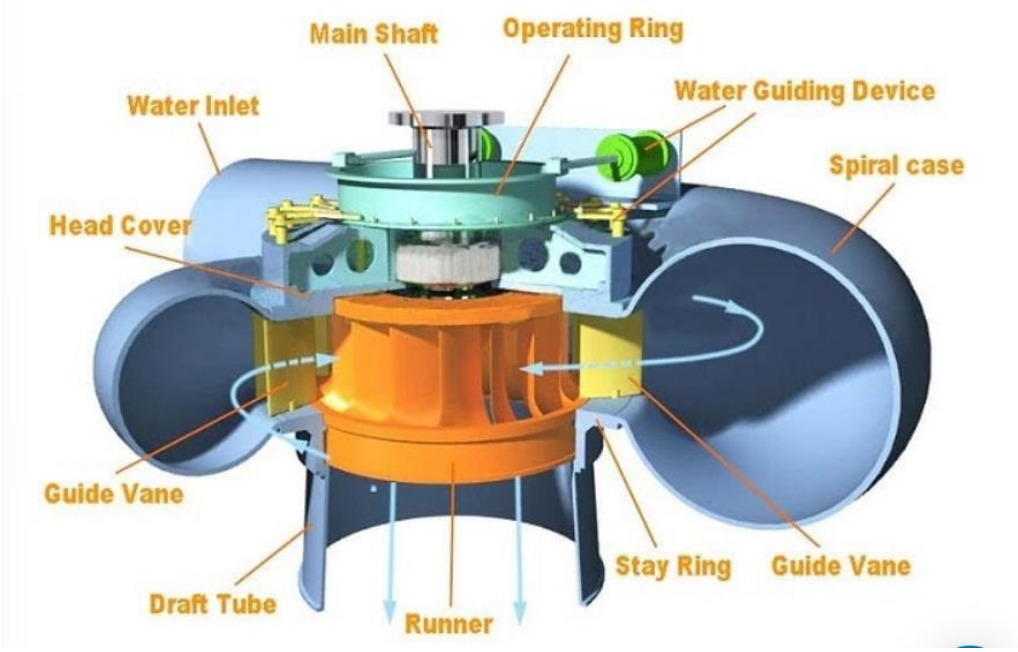
18. What do you mean by run-away sped of a Pelton wheel?

It is the maximum unsafe speed of the runner due to sudden decrease in load on turbine

19. What are different components for Francis Turbine?

Major Components of Francis Turbines

- Spiral Casing
- Stay Vanes
- Guide Vanes
- Runner Blades
- Draft Tube



- Spiral Casing

The spiral casing is the inlet medium of water to the turbine. The water flowing from the reservoir or dam is made to pass through this pipe with high pressure. The blades of the turbines are circularly placed, which means the water striking the turbine's blades should flow in the circular axis for efficient striking. So the spiral casing is used, but due to the circular movement of the water, it loses its pressure.

- Stay Vanes

Stay and guide vanes guide the water to the runner blades. Stay vanes remain stationary at their position and reduces the swirling of water due to radial flow, as it enters the runner blades, thus, making the turbine more efficient.

- Guide Vanes

Guide vanes are not stationary, they change their angle as per the requirement to control the angle of striking of water to turbine blades to increase the efficiency. They also regulate the flow rate of water into the runner blades thus controlling the power output of a turbine according to the load on the turbine.

- Runner Blades

Runner blades are the heart of any Francis turbine. These are the centers where the fluid strikes and the tangential force of the impact causes the shaft of the turbine to rotate, producing torque. Close attention to the design of blade angles at inlet and outlet is necessary, as these are major parameters affecting power production.

- Draft Tube

The pressure at the exit of the runner of the reaction turbine is generally less than atmospheric pressure. The water at the exit, cannot be directly discharged to the tailrace. A tube or pipe of the gradually increasing area is used for discharging water from the exit of the turbine to the tailrace.

This tube of the increasing area is called Draft Tube. One end of the tube is connected to the outlet of the runner. However, the other end is submerged below the level of water in the tail-race.

20. What is difference between Kaplan Turbine and Axial Flow Turbine?

21. What is the difference between Radial and Axial flow turbine.

Axial flow turbine- liquid flows parallel to the rotational axis of the shaft of the turbine. An example includes Kaplan Turbine

Radial flow turbine -liquid flows perpendicular to the rotational axis of the shaft of the turbine. An example includes Francis turbine

22. What do you mean by inward flow and outward flow in a turbine?

23. Why Draft Tube is used in a reaction turbine.

The draft tube is a conduit which connects the runner exit to the tail race where the water is being finally discharged from the turbine. The primary function of the draft tube is to reduce the velocity of the discharged water to minimize the loss of kinetic energy at the outlet. This permits the turbine to be set above the tail water without any appreciable drop of available head.

24. What are cavitations and how can it be avoided in reaction turbine?

Captivation is the formation of vapor bubbles within a liquid at low-pressure regions that occur in locations in which the liquid has been increased to excessive velocities.

In reaction turbine by following methods we can avoid captivation:

a. We can use a turbine runner of stainless steel.

b. Runner blades should be polished.

c. By appropriate speed of the runner.

25. Mention difference between Kaplan Turbine and Propeller Turbine.

26. Write main parts and their functions of a Kaplan Turbine.

a. Scroll Casing

It is a spiral type of casing that has decreasing cross section area. The water from the penstocks enters the scroll casing and then moves to the guide vanes where the water turns through 90° and flows axially through the runner. It protects the runner, runner blades guide vanes and other internal parts of the turbine from an external damage.

b. Guide Vane Mechanism

It is the only controlling part of the whole turbine, which opens and closes depending upon the demand of power requirement. In case of more power output requirements, it opens wider to allow more water to hit the blades of the rotor and when low power output requires it closes itself to cease the flow of water. If guide vanes is absent than the turbine can not work efficiently and its efficiency decreases.

c.. Draft Tube

The pressure at the exit of the runner of Reaction Turbine is generally less than atmospheric pressure. The water at exit cannot be directly discharged to the tail race. A tube or pipe of gradually increasing area is used for discharging water from the exit of turbine to the tail race. This tube of increasing area is called Draft Tube. One end of the tube is connected to the outlet of runner while the other end is sub-merged below the level of water in the tail-race.

d. Runner Blades

The heart of the component in kaplan turbine are its runner blades, as it the rotating part which helps in production of electricity.Its shaft is connected to the shaft of the generator. The runner of the this turbine has a large boss on which its blades are attached and the the blades of the runner is adjustable to an optimum angle of attack for maximum power output. The blades of the Kaplan turbine has twist along its length.

Q27)hat is the efficiency of a draft tube in hydraulic turbine?

A.27) There is one inlet and two exits for the draft tube. The main aim of this type of draft tube is to reduce the swirling motion of water. The efficiency of this type of tube design is almost 88%

Q.28) What are the important parameters which are varied during a test on a turbine

A.28) Gas turbine power and fuel flow, and gas compressor efficiency generally are the primary parameters, while compressor flow range and surge margins are examples of other common performance parameters.

Q.29) Explain the Thoma's Cavitation factor.

A.29) Thoma's Cavitation Factor: It is an equation which is used to measure the cavitation in a hydraulic pump installation. It is denoted by the symbol 'σ'.

Thoma's cavitation parameter (σ): It is the ratio of Net Positive Suction Head (NPSH) to the total head.

Q.30) Explain the governing mechanisms of Kaplan Turbine.

A.30) A Kaplan turbine has adjustments in both guide vanes and runner vanes. Generally, double regulators are provided in a Kaplan turbine. The governor regulates the guide blade opening as well as the runner vane angles simultaneously. The adjustment of guide vanes is similar to that of a Francis turbine.

Q.31) Explain the performance characteristics curve of Francis Turbine

A 31) Performance characteristics are of three types:

A] Constant head characteristics: In order to obtain these curves the tests are performed on the turbine by maintaining a constant head and a constant gate opening and the speed is raised by changing the load on the turbine.

B]Constant speed or Main characteristics: In order to obtain these curves the tests are performed on the turbine by operating them at constant speed and varied discharge.

C] Constant efficiency or Iso-efficiency or Maschel curves: These curves show the efficiency of the turbine for all conditions of running and hence these are also known as universal characteristic curves.

Q.33) What is centrifugal pump?

A.33) Centrifugal pump is a hydraulic machine which converts mechanical energy into hydraulic energy by the use of centrifugal force acting on the fluid.

Q.35) Write names and functions of various types of casings which are commonly used in a Centrifugal Pump

A.35) Based on the type of casing,

A] Volute or constant velocity pump: It has a volute or collecting passage round the impeller of gradually increasing area from cut water to delivery pipe

B] Vortex or variable velocity pump: This pump has a relatively larger overall diameter compared to a volute pump in order to provide an annular space between the impeller and volute passage.

C] Diffuser or turbine pump: It is similar to vortex pump but a diffuser ring with guide vanes is fixed in annular space which isbused to guide the liquid leaving the impeller.

Q.36) What do you mean by static suction lift as applied to a centrifugal pump?

A.36) Suction lift exists when the source of supply is below the centerline of the pump. Therefore, the static suction lift is the vertical distance in feet from the centerline of the pump to the free level of the liquid to be pumped.

Q.37) What are the important characteristics curves for Centrifugal Pumps?

A.37) The characteristic curves of centrifugal pumps plot the course of the following parameters against flow rate (Q): head (H) (see H/Q curve), power input (P), pump efficiency (η) and NPSHr, i.e. the NPSH required by the pump.

Q.38) What are the functions of multistage pumps?

A.38) The applications for multi stage pumps are many and varied and can be used for delivering water to high rise buildings, reverse osmosis (RO), boiler feed water, spraying, high pressure cleaning, water works, heating, condensate, fuel delivery, oil and gas production, power generation & mining and other high pressure and temperature applications.

Q.39) What do you mean by impeller in series and impellers in parallel?

A.39) When the impeller is connected in series with the same shaft of a centrifugal pump, it produces a high head, and to discharge in large quantity of liquid, impeller should be connected in parallel with the same shaft of the pump.

Q.40) What is Priming and why is it necessary?

A.40) Priming is the process of removing air from the pump and suction line to permit atmospheric pressure and flooding pressure to cause liquid to flow into the pump. Without priming, pumps will cease to function and break down.

Q.42) What are the effects of cavitations and what are the precautions against cavitation?
A.42) a] Effects of cavitation:
1] The metallic surfaces are damaged and cavities are formed.
2] Due to sudden collapse of vapor bubble, considerable noise and vibrations are produced.
3] The efficiency of turbines decreases due to cavitation.
B] Precaution against cavitation:
1] The pressure of the flowing liquid in any part of the hydraulic system should not be allowed to fall below its vapor pressure.
If the flowing liquid is water, then the absolute pressure head should not be below 2.5 m of water.
2] The special materials or coatings such as aluminium-bronze and stainless steel, which are cavitation resistant materials, should be used.

Q.43) Explain the terms 'NPSH available' and 'NPSH required'.
A.43) a] NPSH Available (NPSHA): The absolute pressure at the suction port of the pump.
B] NPSH Required (NPSHR): The minimum pressure required at the suction port of the pump to keep the pump from cavitating.

Q.44) Differentiate between Compressor, Blower and Fan
A.44) According to ASME, a fan is a device with a pressure ratio of up to 1.11. A blower has a pressure ratio between 1.11 And 1.2. On the other hand, the pressure ratio in a compressor is more than 1.2.

Q.45) What is Deep Well Turbine Pump?
A.45) Deep-well turbine pumps are used to pump groundwater. They consist of a housing or bowl, impellers, and a shaft, all of which are installed in the well. Impeller types include closed and semi-open impellers.

Q.46) What is Air Lift Pump?
A.46) The airlift pump – also called mammoth pump – exploits the increase of the oxygen intake in water under pressure. At the same time, rising air is used to lift – and therefore circulate – water. This makes the mammoth pump suitable for aerating and circulating large volumes of water.

Q.47) What is Steam Nozzle or Diffuser?
A.47) A nozzle increases the velocity of a fluid, while a diffuser decreases the velocity of a fluid. Nozzles can be used by jets and rockets to provide extra thrust. Contrastly, many jet engines use diffusers to slow air coming into the engine for a more uniform flow.

Q.48) Define a pump
A.48) A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy.

Q.49) What is impact of jet means?
A 49) Impact of Jet means the force exerted by the jet on a plate which may be stationary or moving. The plate may be flat or curved. This force is obtained from Newton's 2^{nd} law of motion or Impulse – Momentum principle.

Q.50) What is tangential flow turbine?
A.50) When the flow is tangential to the wheel circle, it is a tangential flow turbine. A Pelton

turbine is a Tangential flow turbine.

Q.51) What is radial flow turbine?
A.51) Radial means that the fluid is flowing in radial direction that is either from inward to outward or from outward to inward.

Q.52) What are the devices used for pressure measurement?
A.52) Instruments used to measure and display pressure mechanically are called pressure gauges, vacuum gauges or compound gauges (vacuum & pressure). The widely used Bourdon gauge is a mechanical device, which both measures and indicates and is probably the best known type of gauge.