CMR INSTITUTE OF TECHNOLOGY

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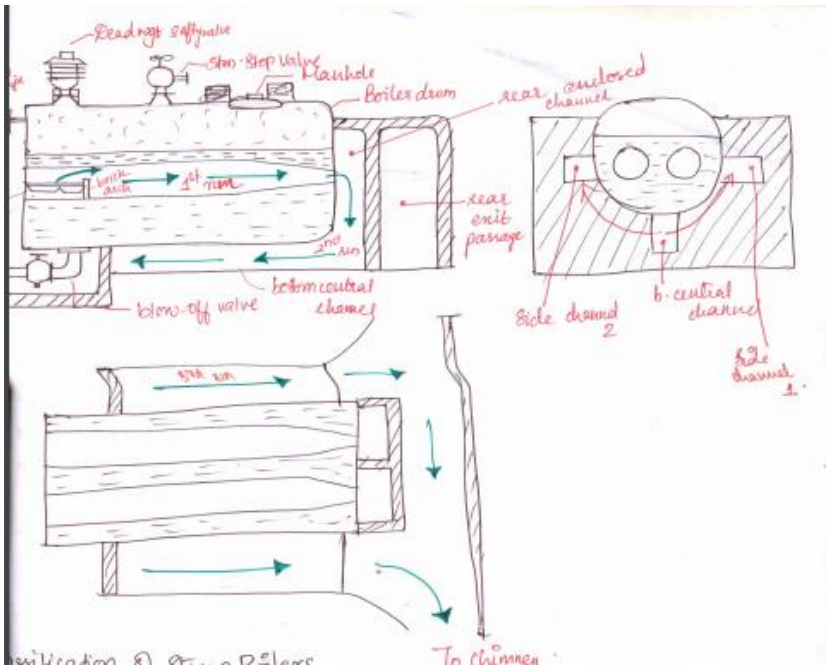
Internal Assesment Test - II

Sub:	**Elements of Mechanical Engineering**							Code:	**15EME14**
Date:	04 /11 / 2016	Duration:	90 mins	Max Marks:	50	Sem:	I	Branch:	**ALL**

Answer Any **FIVE** Questions completely

		Marks	OBE CO	OBE RBT
1.	Briefly explain the construction and working of a Lancashire boiler with a neat sketch. Show the path of the flue gas.	[**10**]	CO1	L1



Construction

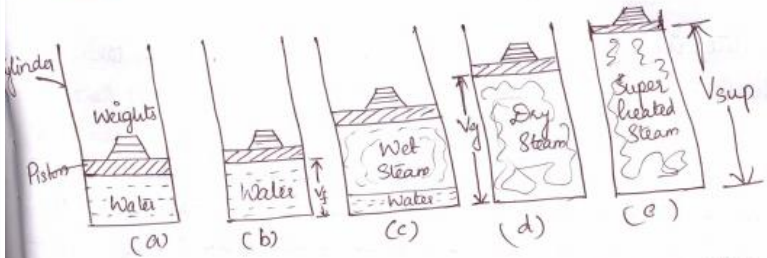
Consists of a horizontal cylindrical shell placed on a brick work setting. 2 large flue tubes of diameter about 0.4 times of that of the boiler shell are fitted inside the shell & runs throughout its length. In each of these flue tubes furnace grates are provided inside at their front end. The space underneath the grate is the ash pit. The brick work setting is designed so as to provide an enclosed chamber for each of the flue tubes at the rear end of the boiler shell, which are connected to the bottom central channel which in turn is connected to the side channels 1 & 2 at their front end. The 2 side channels are connected at their rear end to a common rear passage which is connected to the chimney.

Working

- When fuel is charged on the furnace grates through the furnace door sufficient amount of air also enters the area of the grate
- The hot gases produced by burning of the fuel initially in tubes first run pass along the length of the flue tubes through flue tubes, through them from the front end to the rear end of the boiler. The heat transfer takes place from the hot gases to the water, through the walls of flue tubes.
- The hot gases emerge from both the flue tubes into the respective rear enclosed chambers provided at the rear end of the boiler shell. On their second run from the rear enclosed chambers they pass downwards & unite in the bottom central channel & travel from the rear end to the front end of the boiler. During this path, the heat transfer takes place from the hot gases to water, through bottom portion of the boiler shell exposed to the bottom central channel.
- After passing along the bottom central channel, the hot gases divide at the front end of the boiler shell and enter into the side channels 1 & 2 and in their 3rd run pass through them to the rear end of the boiler. The hot gases emerging at the rear end of these side channels, re-unite in the rear passage & make their exit to the chimney through the rear passage. During the path of the hot gases in the side channels 1 & 2, the heat transfer takes place from them to water through the portion of the boiler shell exposed to the side channels. Steam accumulated in the steam space is taken out through the steam stop valve.
- The boiler is mounted with essential mountings & accessories like steam stop valve, safety valve, blow off valve, pressure gauge, water gauge etc. as shown at their appropriate places. The superheater which consists of a set of U-tubes is placed at the rear end of the shell. The flue gases before they are passed into the bottom central channel heats up the steam in the superheater tubes & convert into superheated steam

2	Draw a neat sketch of temperature – enthalpy diagram and indicate the following on it: Latent heat of evaporation, degree of super heat, sensible heat and saturation temperature. Explain the steam formation process from water at 0ºC.	**[10]**	CO2	L1

▷ Formation of Steam at Const. Pressure



Consider 1 kg of water at 0°C contained in the piston-cylinder arrangement (a). The piston & weights maintain a constant P in the cylinder. If we heat the water contained in the cylinder, it will be converted to steam, as follows.

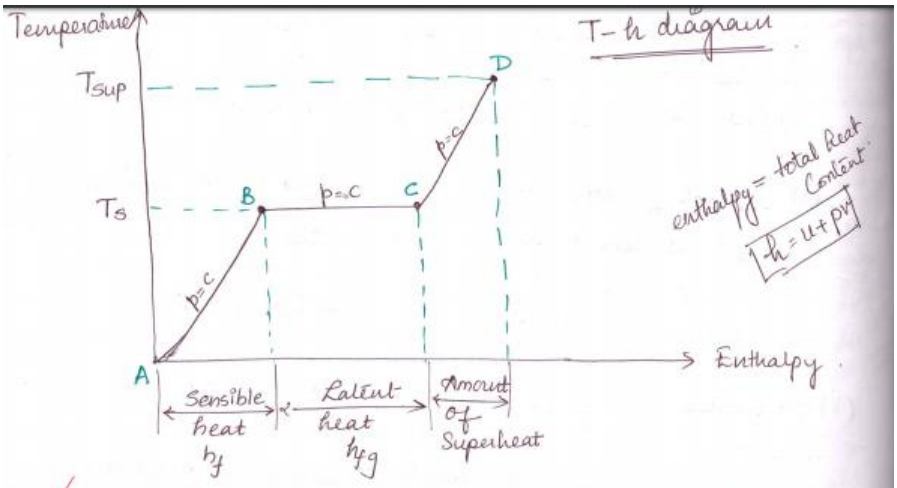
(i) The vol. of water will increase slightly with the increase in T (b). It will cause the piston to move slightly upwards & hence work is obtained. This increase in work or volume is generally, neglected for all types of calculations

(ii) On further heating, the T reaches the BP. The BP of water, at normal atmospheric P of 1.013 bar is 100°C, but it increases with increase in P. When the BP is reached, the T remains constant & water evaporates, thus pushing the piston up against the const. P. Consequently the specific vol. of steam ↑ (c). At this stage, the steam will have some particles of water in suspension, & is termed as 'wet steam'. This process will continue till the whole water is converted into wet steam.

(iii) On further heating, the water particles in suspension will be converted into steam. The entire steam, in such a state, is termed as 'dry or saturated steam' (d). Practically, dry steam behaves like a perfect gas.

(iv) On further heating, the T of steam starts rising. The steam, in such a state, is termed as superheated steam (e)

In practice, in the steam generators (boilers), water will be taken at atmospheric P & T, and converted into steam by application of heat. As the steam is continuously generated, its P gradually increases & is supplied from the boilers to the engines or turbines at constant P. To know the values of various properties of steam at a particular P, the above experiment is conducted by heating water from 0°C at a given const. P.



Saturation Temperature : T at which water begins to boil at the stated P ; indicated by B.
(Ts)

Sensible heat (h_f) or enthalpy of the liqd : The amount of heat required to raise the T of 1 kg of H_2O from 0°C to the sat. temp (T_s°C) at a given constant P

Latent heat of evaporation or Enthalpy of evaporation (h_{fg}) : The amount of heat required to evaporate 1 kg of water at sat. temp T_s, to 1 kg of dry steam at the same saturation T at given const. P.

Superheated Temp : Temp. of steam above the saturation temperature at a given Pressure. During this process of heating, dry steam will be heated from its dry state & the process is known as superheating.

Amount of Superheat or Enthalpy of Superheat : The amount of heat required to increase the T of dry steam from its saturation T to any desired higher T, at the given const. P.

Degree of Superheat : difference between the superheated T & the saturation T.

Wet Steam : When the steam contains moisture or particles of water in suspension. It means that the evaporation of water is not complete & the whole of latent heat has not been absorbed.

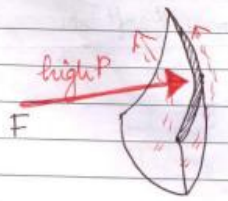
Dry Saturated Steam : When the wet steam is further heated, & it does not contain any suspended particles of water. The dry-sat steam has absorbed its full latent heat & behaves practically, in the same way as a perfect gas.

Superheated Steam : When dry steam is further heated at a const. Pressure, thus raising its T; Since the P is constant, therefore the volume of sup-heated steam increases. The vol. of 1kg of sup-htd steam is considerably greater than the vol. of 1kg of dry steam at the same P.

3.	Draw a neat sketch of a Francis turbine indicating the parts and its function. Explain its working.	**[10]**	CO2	L1

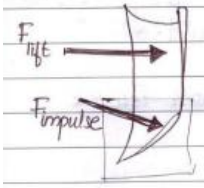
The runner is fitted with a collection of complex blades. The direction of water inflow is radial and that of outflow is axial. During the course of flow, water glides over the blades & does not change the direction drastically as in case of impulse turbines.

The blades are shaped specially. They have a thin aerofoil cross-section and their number may varies between 16–24.



The aerofoil cross-section results in high & low pressure regions on either side of the blade, thereby generating a lifting force, as shown.

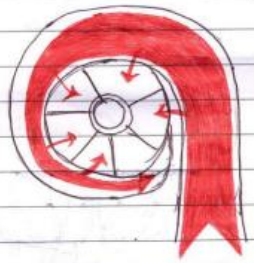
Towards the lower portion, the blade is curved in a bucket shape, so that the water hits and produces an impulse force before leaving the blade.



Both impulse & lift forces causes the turbine to rotate. So, Francis turbine is not a pure reaction turbine. As flows over the blades, both its Pressure & KE comes down.

As the flow enters radially & leaves axially, they fall under the category of mixed flow turbines.

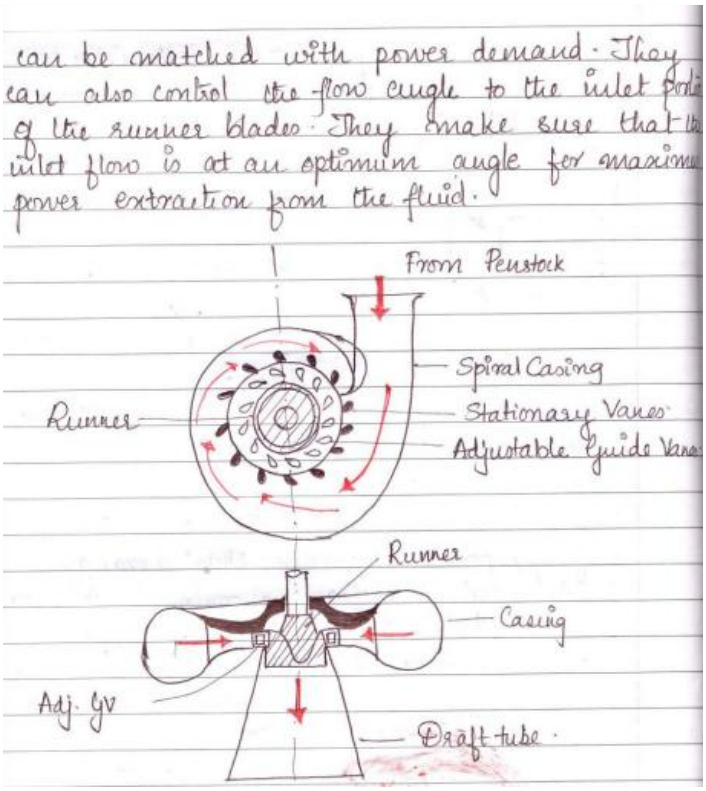
The runner is connected to a generator through a shaft, for power generation. This arrangement is fit inside a spiral casing. The casing is designed with decreasing cross-sectional area along the flow direction so as to reduce the flow-rate of water along its length.



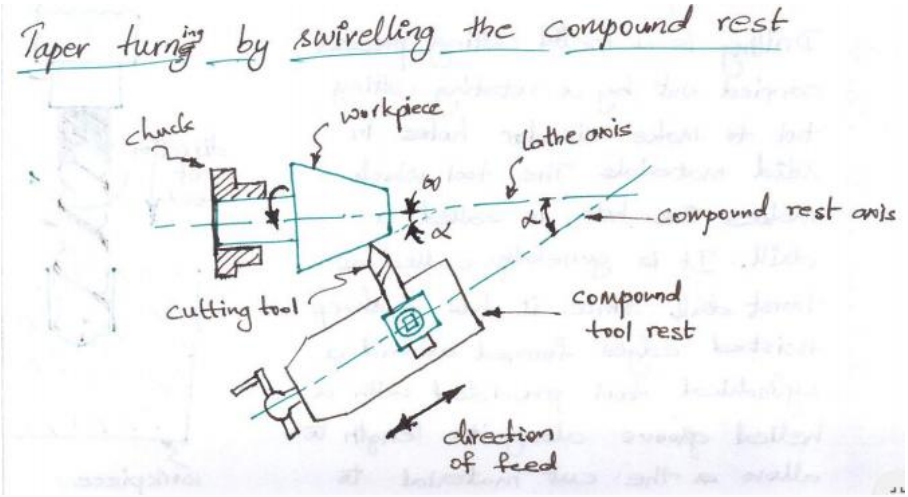
This decreasing area ensures that the flow enters the runner at almost uniform velocity.

Stay vanes & guide vanes are fitted at the runner entrance. Their basic purpose is to convert one part of the pressure energy into KE. The flow which comes in, meets the stay vanes (which are fixed), which steers the flow into the runner section, thereby reducing the swirl of the inlet flow.

The guide vane mechanism is used to control water flow rate so that power production



4 (a)	Explain the process of taper turning by swiveling of the compound rest with a neat sketch.	**[06]**	CO3	L1



Taper turning is an operation on a lathe to produce conical surface on the workpieces. To achieve this the compound rest is swiveled by an angle α w.r.t. the lathe axis. The angle α is determined by formula

$$\alpha = \tan^{-1}\left[\frac{D-d}{2L}\right]$$

where
D → Larger diameter of the taper
d → smaller diameter of the taper
L → length of the taper

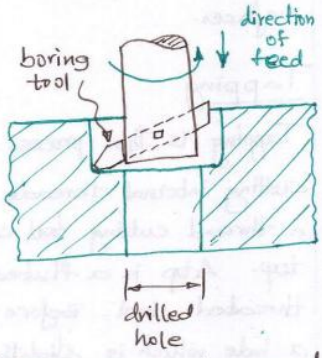
The compound tool rest is swiveled to the required taper angle and then locked in the angular position. The carriage is also locked at that position. Only the compound tool rest is moved linearly at an angle so that the cutting tool produces the tapered surface on the workpiece. This method is limited to short tapered lengths due to the limited movement of the compound tool rest.

(b) Differentiate between: (i) Boring and reaming; (ii) Counter sinking and counter boring. **[04]**

CO3 L2

Boring

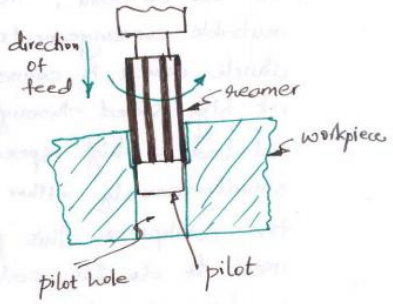
Boring is done on a drilling machine to increase the size of an already drilled hole. When a suitable size drill is not available, initially a hole is drilled to the nearest size & then using a single point cutting tool, the size of the hole is increased.



Initially drilled hole is known as pilot hole as it guides the bore tool. By giving a linear movement to the boring tool while it is continuously rotating inside the pilot hole, the size of the hole is increased to its entire depth of the hole.

Reaming

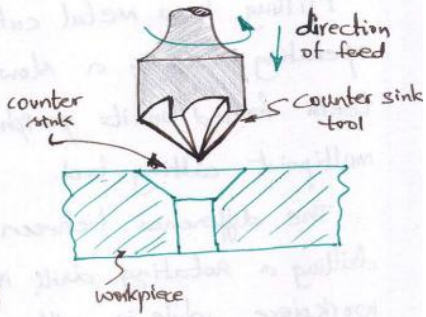
Reaming is the process of smoothing the surface of the drilled holes with a reamer. A reamer is similar to the twist drill, but has straight flutes. After drilling the hole to a slightly smaller size, the reamer is mounted in place of twist drill and with the speed reduced to half of that of the drilling, reaming is done in the same way as drilling. It removes only a small amount of material & produces a smooth finish on the drilled surfaces.



Countersinking

It is an operation of making the end of a hole into a conical shape. It is done by using a countersinking tool. It is also done for deburring the holes.

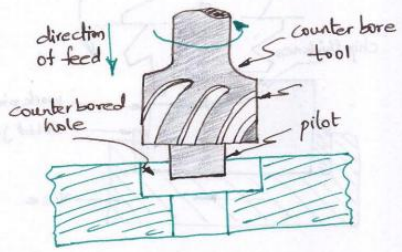
The cutting speeds for countersinking must be one-half of that used for similar size drill. The countersunk holes are used when the countersunk screws are to be screwed into the holes so that their top faces have to be in flush with the top surface of the workpiece.



Counter boring

counter boring is to increase the size of a hole at one end only through a small depth. It forms a larger sized recess or a shoulder to the existing hole. The cutting tool will have a small cylindrical projection known as pilot to guide the tool while counterboring. The speeds for counterboring must be two-thirds of the drilling speed the corresponding size of the drilled hole.

Generally counterboring is done on the holes to accommodate the socket head screws, or grooved nuts, or round head bolts.



5 (a)	Explain the principle of arc welding with a neat sketch. State the functions of flux.	**[07]**	CO5	L1

Electric Arc Welding :-

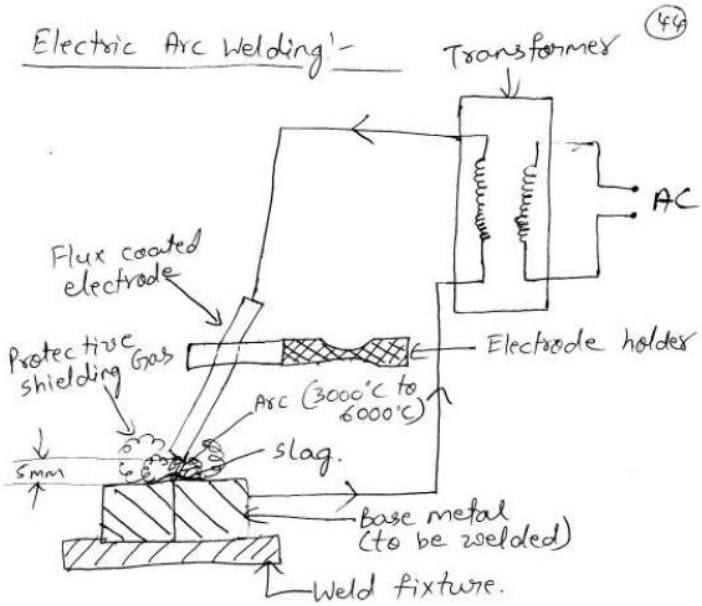


Fig 4.1 :- Electric Arc Welding

Construction :-

The schematic representation of an electric arc welding setup is shown in the figure above. It has a transformer whose negative terminal is connected to the electrode where as the positive terminal is connected to the workpiece or the weld fixture. The electrode is held in place by an electrode holder its held by hand and the

electrode is coated with flux. The base metal or work piece which has to be joined is firmly held in the weld fixture. The approximate distance between the electrode tip and the workpiece to maintain an arc is around 5mm.

Working:-

The transformer which is connected to an AC supply increases the voltage and this electricity is passed through the electrode. But there is a gap between electrode and the workpiece. In order for the circuit to be complete the electricity has to jump from the electrode to the workpiece. This is how the arc is produced. This arc is around 3000°C to 6000°C (depending on the current). At these temperatures, the work pieces melts at the joint and the electrode also melts. The electrode is made of the

arc, the molten metal of the two work pieces flow and combine together and the electrode metal that also melts fills in the gaps. The flux produces shielding gas, usually CO_2, which protects the weld pool (molten metal of the wor

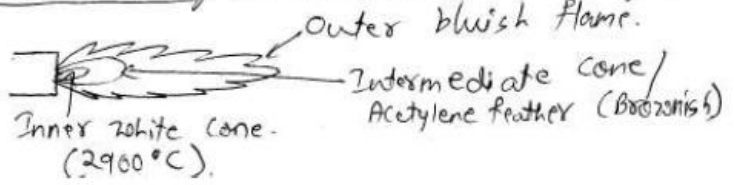
piece) from oxygen and nitrogen in the atmosphere and prevents the formation of metal oxides & nitrides. Now the electrode is slowly moved across the joint and hence as the arc moves away from the weld pool, the molten metal solidifies creating a fusion of the two work pieces. This process continues throughout the joint as the electrode is slowly moved across it.

(b) List the different types of oxy-acetylene flames and state its application.

[03] | CO5 | L1

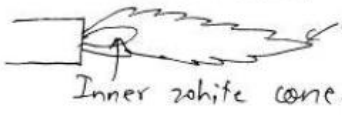
Different types of Oxy-acetylene flame:-

(i) Carburising Flame or Reducing Flame:-



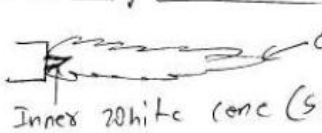
In this flame there is excess amount of acetylene is present in the gas ration i.e., Oxygen : Acetylene ratio is 0.95 to 1, Hence the combustion of acetylene is incomplete as inadequate amount of oxygen is available for combustion. The temperature developed is 2900°C (at the white inner cone) Used for high carbon alloys like high carbon steel, cast iron and also for aluminium alloys.

(ii) Neutral flame:-



For complete combustion to occur there should be right proportions of oxygen-acetylene mixture. i.e, 1:1, here maximum temperature of 3100°C is reached. This is the flame which is used regularly for oxy-acetylene welding. It is used for steels & non-ferrous metals.

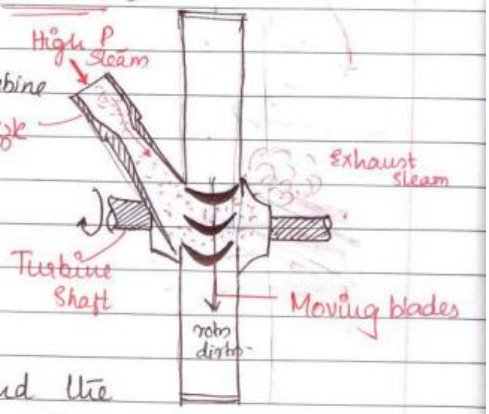
(iii) Oxidising flame:-



In this flame oxygen is in excess supply than required. Hence over combustion occurs and so the maximum temperature reached is 3400°C. Here the welded metals get oxidised because of the presence of excess oxygen. Therefore this flame is used only for materials which do not oxidise easily in presence of excess oxygen like zinc & copper alloys. (50)

6 (a) Draw a neat sketch of a simple impulse steam turbine indicating the parts. Explain its working. **[06]** CO2 L2

▷ DE LAVAL TURBINE (IMPULSE)



- Single Stage impulse turbine
- Main components :—
  i) Nozzle
  ii) Rotor
  iii) Casing

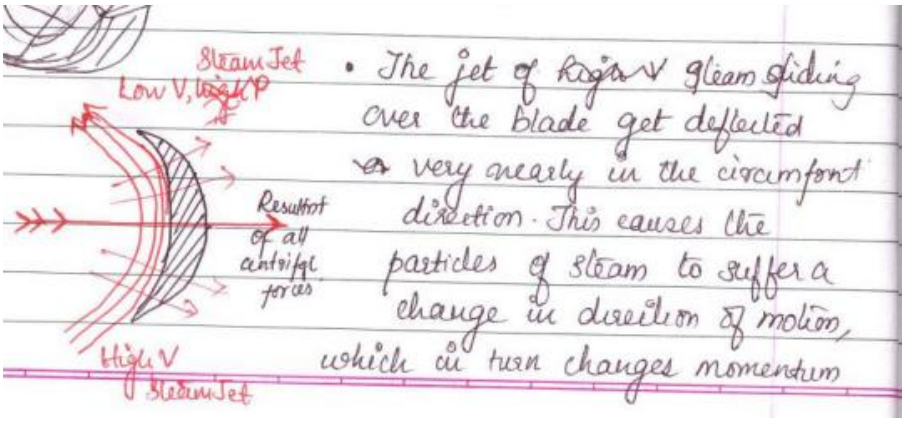
Nozzles are located around the inner periphery of the casing at about 20° to the wheel tangent. They produce high velocity steam jet which strikes the blades at a number of points

Rotor is a circular disc mounted on a horizontal shaft. A number of blades are fixed on its periphery. The blades are symmetrically curved.

Casing houses the rotor in an airtight metallic chamber.

Working:—

- Steam is expanded from its high initial P to lower P in a nozzle.
- The high velocity jet coming out of the nozzle is made to glide over a curved vane called 'blade'.



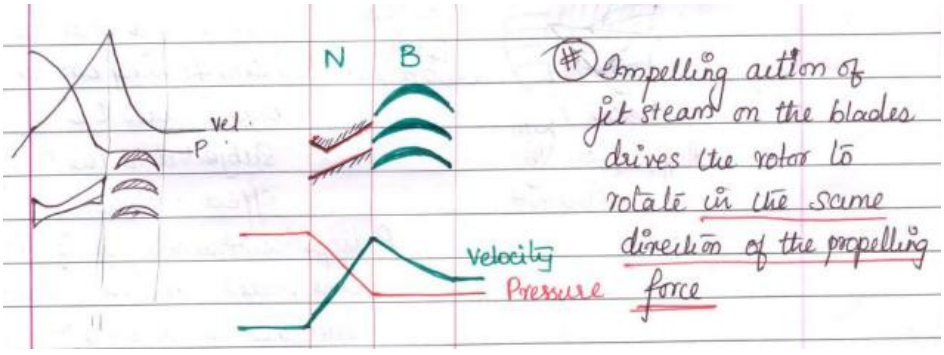
• The jet of high V steam gliding over the blade get deflected very nearly in the circumfntl direction. This causes the particles of steam to suffer a change in direction of motion, which in turn changes momentum and therefore generates a force, centrifugal in nature.

Steam particles exert centrifugal P all along the curved blade surface. The resultant of these, acting on the entire curved blade surface, causes the blade to move.

(Blades absorb the KE from steam & V↓)

When a no. of such blades are fitted on the circumference of a revolving wheel (rotor), they will be moved by the action of steam & in turn sets the rotor in continuous action.

In impulse turbines, all the expansion or P drop happens in the nozzle. The P of steam supplied to the blades ~~is~~ is low and remains so as it glides over & leaves. However, velocity of steam continuously reduces as it glides over the blades, owing to the conversion of KE into mechanical energy of rotation.



(#) Impelling action of jet steam on the blades drives the rotor to rotate in the same direction of the propelling force

(b) Differentiate between Pelton and Francis turbines. **[04]** CO5 L2

	Impulse Turbines	Reaction Turbines
①	Steam expands completely from a high P to a low P in the nozzle before entering the moving blades	① High P steam continuously expands successively in both fixed & moving blades.
②	The symmetrical profile of the moving blades provides a uniform section for the flow of the steam between them causing no expansion of the steam.	② The assymmetrical profile of both the moving & fixed blades provide a varying section for the flow, between them which causes expansion of the steam.
③	P of steam at both the ends of the moving blades & as well as while passing thro over them remains constant.	P of steam at both ends of the fixed & moving blades as well as while passing over them are different.
④	Because of the large drop in P in the nozzle, the steam speed ~~and~~ as well as rotor speeds are high.	Due to smaller P drop over both fixed & moving blades, both the steam speed & the rotor speed are relatively low.
⑤	Due to larger P drop in the nozzle & less no. of stages, size of the impulse turbine for the same power output is comparitively small.	Due to smaller P drops in every stage & more no. of stages, the size of the reaction turbine for the same power output is large.
⑥	Occupies less space / unit power.	Occupies more space for unit power.
⑦	Suitable for small power generation prime movers.	Suitable for medium & high power gentn prime movers.
⑧	Due to high rotor speeds compounding is required to reduce the speed.	The speeds are relatively less & hence no compounding is required.

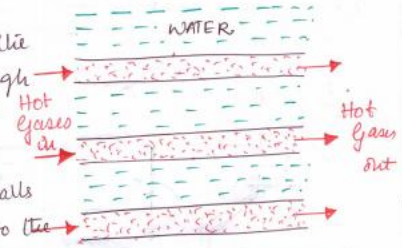
7(a)	Differentiate between fire tube and water tube boilers.	**[04]**	CO1	L2

Classification of Boiler

Based on the principle of working or the contents in the tube as, (i) Fire tube boilers & (ii) Water tube boilers.

Fire tube boilers

Hot flue gases produced by the combustion of fuels are led through a tube or nest of tubes around which the water circulates. Heat is conducted through the walls of the tubes from the hot gases to the surrounding water.

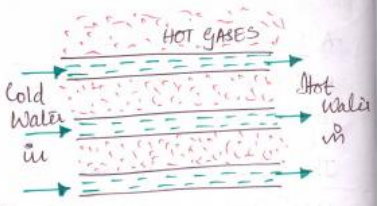


— Suitable for steady working & upto 20 bar.

eg: Simple Vertical boiler, Lancashire boiler, Locomotive boiler etc.

2. Water tube boilers

- water circulates inside the tubes while the hot gases produced by the combustion of the fuels pass around them externally.
- more suitable than previous, for steam generation at very high P and also when steam is to be raised quickly starting with cold water & fires out.
- eg: Babcock & Wilcox boiler, Stirling boiler & Benson boiler.



(b) Differentiate between welding, soldering and brazing. **[06]** CO5 L2

Welding:-

Definition:-

Welding is a process of joining similar metals by application of heat with or without application of pressure and with or without the use of filler material.

Brazing:- (Silver soldering)

Definition:-

It is a process of fusion of two similar or dissimilar metals by molten filler alloy called spelter. melting at or below the melting point (M.P) of metals to be joined but above 450°C.

Soldering:-

Definition:-

Soldering is a method of uniting two or more pieces of metal by means of a fusible alloy called solder applied in the molten state. The M.P of solder is below 450°C.

Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1:	Discuss the various energy sources and their applications based on their advantages and disadvantages. Familiarize with different types of boilers along with their construction and working.	1	-	-	-	-	-	-	-	-	-	-	-
CO2:	Explain the energy conversion mechanism involved in different prime movers like IC engines & turbines.	2	-	-	-	-	-	-	-	-	-	-	-
CO3:	Differentiate between the metal removal process using lathe, drilling & milling machines.	2	-	-	-	1	-	-	-	-	-	-	-
CO4:	Identify different types of industrial robots and discuss about different levels of automation.	-	-	-	-	-	-	-	-	-	-	-	-
CO5:	Discuss the application and usage of various engineering materials along with some common joining processes.	2	-	-	-	1	-	-	-	-	-	-	-
CO6:	Differentiate between different refrigeration systems and explain air-conditioning systems.	-	-	-	-	-	-	-	-	-	-	-	-

Cognitive level	KEYWORDS
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PO1 - *Engineering knowledge*; PO2 - *Problem analysis*; PO3 - *Design/development of solutions*; PO4 - *Conduct investigations of complex problems*; PO5 - *Modern tool usage*; PO6 - *The Engineer and society*; PO7- *Environment and sustainability*; PO8 – *Ethics*; PO9 - *Individual and team work*; PO10 - *Communication*; PO11 - *Project management and finance*; PO12 - *Life-long learning*