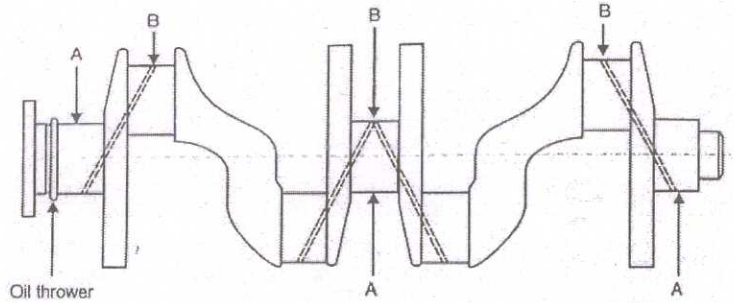
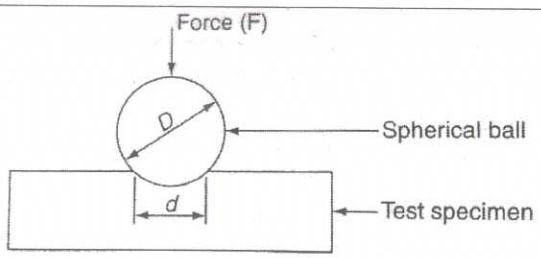
SCHEME OF VALUATION
(Scoring Indicators)

Revision: 2015 Course Code : 2021
Course Title : BASIC MECHANICAL ENGINEERING

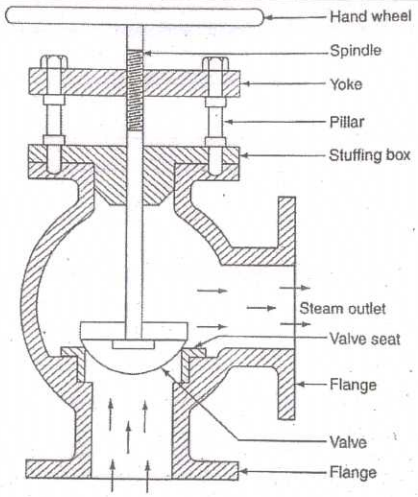
Qst. No.	Scoring Indicator	Split up score	Sub Total	Total
	PART – A			
I.1	Creep is a progressive deformation of a material under a constant static load maintained for a long period of time. It is a slow, temperature-aided, time-dependent deformation.	2	2	
I.2	These are the fittings and devices necessary for the safety of the boiler and complete control of the process of steam generation.	2	2	
I.3	The function of the piston, together with the rings, is to confine the gases in the combustion space and thus transmit the full force of expansion to the connecting rod and crank shaft.	2	2	10
I.4	Shielding the radioactive zones in the reactor from possible radiation hazard is essential to protect the operating men from the harmful effects. Thick layers of lead or concrete are provided all around the reactor for stopping the harmful radiation.	2	2	
I.5	Cooling system provides a proper amount of water circulation all around the engines to keep the temperature at reasonable level. Pumps are used to discharge the water inside and the hot water leaving the jacket is cooled in cooling ponds and is re-circulated again.	2	2	
	PART – B			
II.1	<u>Hardness:</u> It is the ability of a material to offer resistance to penetration or indentation. It is also the ability to resist wear, abrasion, scratch or cutting. The common tests for hardness are the Brinell hardness test, Rockwell hardness test and Vicker's hardness test. <u>Ductility</u>: It is a measure of the amount of deformation a material can withstand before breaking. It is also the ability of a material by which it can be drawn into wires. There are two common measures of ductility. <u>Malleability:</u> It is the ability of a material by which it can be rolled into sheets. A malleable metal is capable of being flattened into thin sheets without cracking following the processes of hammering or rolling. Malleability is the ability of a material to exhibit large deformation subjected to compressive force whereas ductility is the ability of a material to deform upon the application of a tensile force. Aluminium, copper and gold have good malleability.	2 2 2	6	6
II.2	High-speed steel is basically high-carbon steel (0.75 – 1.5% C) containing large amounts of alloying elements. The principal alloying elements used in this steel are tungsten, chromium, molybdenum, vanadium and cobalt. It retains hardness, strength and wear resistance at elevated operating temperatures. There are two basic types of high-speed steels known as T-type and M-type.	2	6	6

	T-type high-speed steel: It contains 12 – 18% tungsten along with chromium, molybdenum and vanadium. The most common variety is called 18-4-1 which contains 0.7% carbon, 18% tungsten, 4% chromium and 1 % vanadium. It is one of the best tool steels. M-type high-speed steel: It is developed to reduce the amount of tungsten and chromium required. It contains 4 – 9% molybdenum as the principal alloying element. A typical variety called 6-6-4-2 contains 6% molybdenum, 6% tungsten, 4% chromium and 2% vanadium. It has excellent toughness and cutting ability.	2 2		
II.3	Wet saturated steam: When the saturated vapour contains particles of liquid evenly distributed over the entire mass of vapour, it is called wet saturated steam. Dry saturated steam: Saturated liquid which contains no liquid particle is called dry saturated steam. Superheated steam: Steam becomes superheated, if at a given pressure, its temperature is higher than that of saturation temperature.	2 2 2	6	6
II.4	<table><tr><th>Fire tube boiler</th><th>Water tube boiler</th></tr><tr><td>1) In Fire-tube boilers hot flue gases pass through tubes and water surrounds them.</td><td>In Water-tube boilers water passes through tubes and hot flue gasses surround them.</td></tr><tr><td>2) These are operated at low pressures up to 20 bar.</td><td>The working pressure is high enough, up to 250 bar in super critical boilers.</td></tr><tr><td>3) The rate of steam generation and quality of steam are very low, therefore, not suitable for power generation.</td><td>The rate of steam generation and quality of steam are better and suitable for power generation.</td></tr><tr><td>4) Load fluctuations cannot be handled.</td><td>Load fluctuations can be easily handled.</td></tr><tr><td>5) It requires more floor area for a given output.</td><td>It requires less floor area for a given output</td></tr><tr><td>6) These are bulky and difficult to transport.</td><td>These are light in weight, hence transportation is not a problem.</td></tr><tr><td>7) Overall efficiency is up to 75%.</td><td>Overall efficiency with an economizer is up to 90%.</td></tr><tr><td>8) Water doesn't circulate in a definite direction.</td><td>Direction of water circulated is well defined.</td></tr></table> *(any six)*	1*6	6	6
II.5	<table><tr><th>Four stroke engine</th><th>Two stroke engine</th></tr><tr><td>1) It has one power stroke for every two revolutions of the crankshaft.</td><td>It has one power stroke for each revolution of the crankshaft.</td></tr><tr><td>2) Heavy flywheel is required and engine runs unbalanced because turning moment on the crankshaft is not even due to one power stroke for every two revolutions of the crankshaft.</td><td>Lighter flywheel is required and engine runs balanced because turning moment is more even due to one power stroke for each revolution of the crankshaft.</td></tr><tr><td>3) Engine is heavy</td><td>Engine is light</td></tr><tr><td>4) Engine design is complicated due to valve mechanism.</td><td>Engine design is simple due to absence of valve mechanism.</td></tr></table>	1*6	6	6

	5) More cost.	Less cost than 4 stroke.			
	6) Less mechanical efficiency due to more friction on many parts.	More mechanical efficiency due to less friction on a few parts.			
	7) More output due to full fresh charge intake and full burnt gases exhaust.	Less output due to mixing of fresh charge with the hot burnt gases.			
	8) Engine runs cooler.	Engine runs hotter.			
	9) Engine is water cooled.	Engine is air cooled.			
	10) Less fuel consumption and complete burning of fuel.	More fuel consumption and fresh charge is mixed with exhaust gases.			
	(any six)				
II.6	Crank and crankshaft The reciprocating motion of the piston is converted into rotary motion by the connecting rod and crank mechanism. All the auxiliary mechanism of the engine having mechanical transmission are geared in one way or the other to the crankshaft and obtain their motive power from it. The shape of the crankshaft, i.e., the mutual arrangement of the cranks depends on the number and arrangement of cylinders and the firing order of the engine. Figure shows a typical crankshaft layout for a four-cylinder engine.  		3 3	6	6
II.7	Disadvantages of nuclear power plant 1. Initial cost of power plant is higher as compared to hydro or steam power plant. 2. Nuclear power plants are not well suited for varying load conditions. 3. Radioactive wastes if not disposed carefully may have bad effect on the health of workers and other population. In a nuclear power plant the major problem faced is the disposal of highly radioactive waste in form of liquid, solid and gas without any injury to the atmosphere. 4. Maintenance cost of the plant is high. 5. It requires trained personnel to handle nuclear power plants.		6	6	6
	PART – C				
III.a	Brinell Hardness Test Brinell hardness test is done by forcing a hard steel or carbide sphere of a specified diameter under a specified load into the test piece and measuring the diameter of the indentation left after the test. The Brinell hardness number is obtained by dividing the applied load by the actual surface area of indentation. The result is a pressure measurement but the units are rarely stated. As per Bureau of Indian Standards (BIS), this test uses a hardened steel ball indenter of 10 mm diameter as shown in figure. For extremely hard metals, a tungsten carbide ball is substituted for the steel ball.		2	8	

	 Procedure as per BIS 1. The indenter is pressed into the sample with a load of 500 kg for soft metals such as copper and brass, 1500 kg for aluminium castings and 3000 kg for materials such as iron and steel. 2. The load is maintained for a specific well time, usually for 10-15 s. 3. After the dwell time, the indenter is removed leaving a round indent in the sample. 4. The size of the indent is determined optically by measuring two diameters of the round indent at right angles using either a low-magnification portable microscope or one that is integrated with the load application device. 5. The Brinell hardness number is a function of the test force divided by the curved surface area of the indent. The indentation is considered to be spherical with a radius equal to that of the ball. $$BHN = \frac{2F}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$ where BHN is the Brinell hardness number; F the applied force (N); D the diameter of the indenter (mm); d the diameter of indentation (mm). A typical Brinell hardness is specified as 275 HBS, where 275 is the Brinell number and the S represents a steel ball. Symbol W is used in place of S if a tungsten carbide ball is used.	2 4		15
III.b	Procedure for Impact testing 1. The swinging pendulum weight is raised to standard height depending upon the type of specimen to be tested. 2. With reference to the vice holding the specimen, the higher the pendulum, the more potential energy it has got. 3. As the pendulum is released, its potential energy is converted into kinetic energy until it strikes the specimen. 4. The Charpy specimen is hit behind the V notch while the Izod specimen placed with the V notch facing the pendulum, will be hit above the V notch. 5. A portion of the energy possessed by the pendulum is used to rupture the specimen and the pendulum rises on the other side of the machine to a height lower than its initial height on the opposite side of the impact testing machine. 6. The energy consumed in breaking the specimen is the weight of the pendulum times the difference in two heights of pendulum on either side of the machine. 7. This energy in metre-kg is the notched impact strength and can be read from the dial of the impact testing machine.	7	7	
IV.a	1. Elasticity: It is the property of a material by which the material regains its original form after removal of the applied load. If it recovers its original shape completely, the body is said to be perfectly elastic.	2		

	2. Elastic Limit: It is also possible for materials to behave elastically but not linear-elastically. A small portion of the elastic region above the proportionality limit, up to which the recoverable strain increases non-linearly with increasing stress, is called the elastic limit. It is the greatest stress the material can withstand without any measurable permanent strain remaining on the complete release of load. 3. Hooke's Law: Hooke's law states that, within the proportional limit, the stress is directly proportional to the strain. $\sigma \alpha \varepsilon$ or $\sigma = E\varepsilon$ or $\frac{\sigma}{\varepsilon} = E = \text{constant}$ Where σ is the stress, ε is the strain and E is the Young's modulus. In other words the ratio of stress to strain is constant. This constant is called Young's modulus or modulus of elasticity. 4. Poisson's ratio: When an axial load is applied on a body of uniform cross-section, it is strained in the axial direction normal to it. The strain in the direction of applied force is called longitudinal strain and that in the direction normal to it is called lateral strain. The ratio of the lateral to the longitudinal strain is constant for a material and is called Poisson's ratio. Its value generally lies between 0.3 and 0.6. Mathematically, it can be expressed as, Poisson's ratio = $\frac{Lateral.strain}{Longitudinal.strain}$	2 2 2	8	15
IV.b	Classification of Plain Carbon Steel 1. Low-Carbon Steel: The carbon content varies between 0.05% and 0.30%. Low-carbon steel has a relatively low tensile strength, but it is soft, ductile and malleable. It is easily machinable and weldable. It is the cheapest of all kinds of steels. Common industrial products such as nuts, bolts, nails, screws, washers, fencing wires, etc. are made of low-carbon steels. 2. Medium-Carbon Steel: The carbon content varies between 0.30% to 0.60%. Medium-carbon steel has lower ductility and higher strength than low-carbon steel and has good wear resistance. It can be heat treated to improve the strength. It is used for large parts, forgings, shafts, gears, axels, connecting rods, crankshafts, railway tracks and wheels and other machine parts which may require good combination of strength and toughness. 3. High-Carbon Steel: The carbon content varies between 0.60% and 1.7%. High-carbon steel is the strongest and hardest of carbon steels with limited ductility. It is used for making cutting tools, knives, chisels, hacksaw blades, axels, springs etc.	2 3 2	7	
V.a	Function: The function of steam stop valve is to regulate the flow of steam from boiler to steam pipe connecting the engine. Location: It is mounted on the highest portion of the steam space of a boiler so that it can supply steam of maximum possible quality.	1 1		



3

8

Construction:

It consists of a valve body having two flanges at right angle. One of the flanges is bolted to the boiler to the highest portion of the steam space while the other is connected to the steam outlet pipe. A valve seat is secured at the chest of the valve body. The valve rests on the valve seat. The valve is connected with the spindle in such a manner that spindle can rotate free in the valve and at the same time it can carry the valve with it when raised or lowered. Spindle has a handle wheel at the top end by which it is rotated. The spindle passes out of a gland and a stuffing box formed in the valve body in order to prevent leakage of steam along the spindle.

3

15

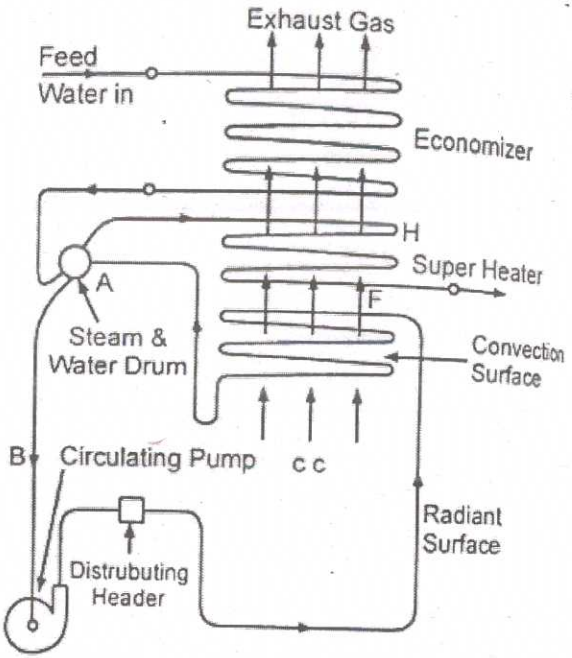
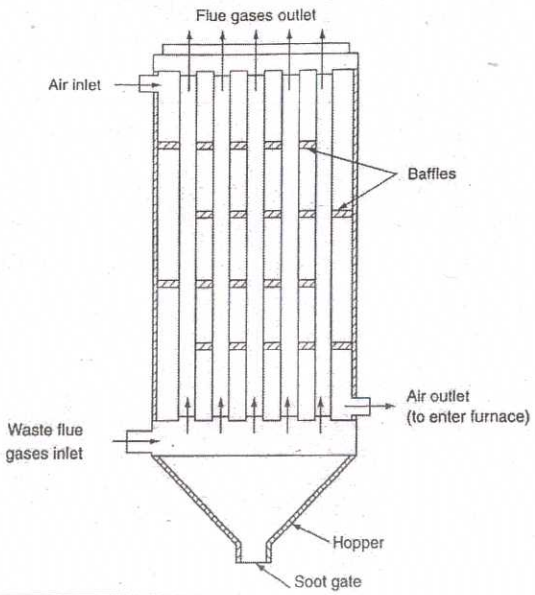
V.b

Classification of Boilers

1. On the basis of the content of the tube as
   - Fire-tube boiler
   - Water-tube boiler
2. On the basis of the position of the furnace as
   - Internally fired boiler
   - Externally fired boiler
3. On the basis of method of the circulation of water as
   - Natural circulation boiler
   - Forced circulation boiler
4. On the basis of the number of tubes as
   - Single tube boiler
   - Multi-tubular boiler
5. On the basis of the position of boiler shell as
   - Vertical boiler *(any seven)*
   - Horizontal boiler
6. Inclined boilerOn the basis of the pressure of steam as
   - Low-pressure boiler
   - High-pressure boiler
7. On the basis of the nature of service as
   - Stationary boiler
   - Portable boiler
   - Mobile boiler
8. On the basis of the number of passes as
   - Once through boiler
   - Recirculation boiler
9. On the basis of the draught used as
   - Natural draught boiler (chimney draught)
   - Forced draught or mechanical draught boiler
   - Steam jet draught boiler

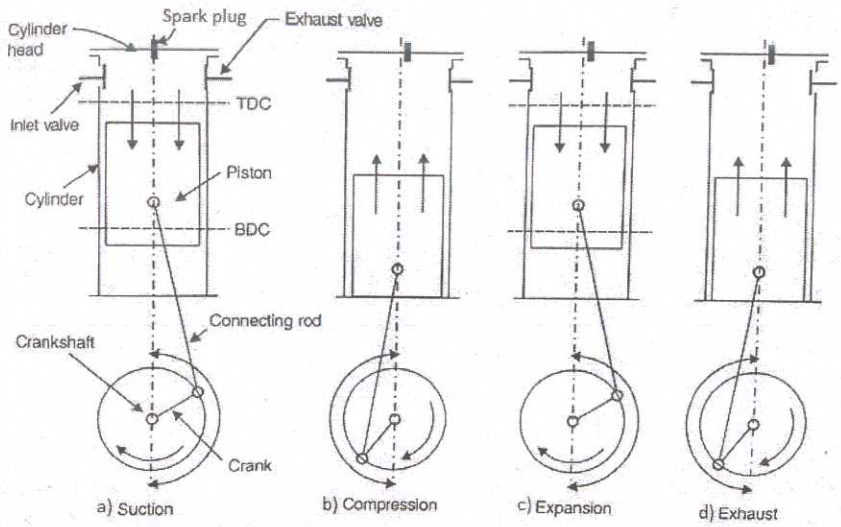
1*7

7

VI.a	La-Mont Boiler  This is a water tube boiler using forced circulation. The flow diagram of tile boiler is shown in figure. The pump for forced circulation is driven by a small steam turbine using steam from boiler. For emergency, an electrically driven auxiliary pump is also fitted. The pump runs at constant speeds Heater irrespective of output and to avoid overheating of the tubes, the amount of water circulated is 5 to 8 times the boiler output. The feed water passes through the economiser to the steam and water drum A from which it is drawn to the circulating pump through the tube B. The pump delivers the feed to the headers at a Header pressure of 0.25 to 0.30 MPa above the drum pressure. The headers distribute the water through nozzles into the generating tubes F, acting in parallel. The water and steam from these tubes pass into the drum A. The steam in the drum is then drawn though the super-heater H. These boilers have been built to generate 300,000 kg of superheated steam per hour at a pressure of 12.8 MPa and temperature of 520 °C.	3 5	8	15
VI.b	Air Preheater:The function of air preheater is to recover some of the heat carried by waste flue gases going to the chimney and transfer to preheat the air entering into the furnace of the boiler for combustion of fuel.  	1 3	7	

	Working: The flue gases are passed through the tubes and the air circulates around them. The air on its travel outside the tubes is forced to deflect by baffles in a zig-zag path for a number of times. This ensures a better heat gain from the flue gases. Soot and other materials carried with the flue gases are collected in the hopper at the bottom and removed periodically through the soot gate.	3		
VII.a	Classification of I.C. Engines Based on number of strokes required for the completion of one cycle 1. 2-Stroke engines. 2. 4-Stroke engines Based on thermodynamic cycle 1. Constant volume combustion (Otto) cycle 2. Constant pressure combustion (Diesel) cycle 3. Mixed or limited pressure (Duel) cycle Ignition system 1. Spark ignition. 2. Compression ignition. Kind of fuel used 1. Light oil engines. 2. Heavy oil engines. 3. Gas engines. 4. By-fuel engines. *(any eight)* Number and arrangement of cylinders 1. In-line engines 2. V-engines 3. Radial engines Fuel supply system 1. Carburettor engines 2. Solid injection or airless injection Cooling system 1. Water cooled engines. 2. Air cooled engines. Lubrication system 1. Splash lubrication system 2. Pressure lubrication system Governing system 1. Quality control 2. Quantity control Valve location 1. Overhead valve engine 2. Side valve engine Speed: 1. High speed engines 2. Low speed engines.	1*8	8	15
VII.b	<table><tr><th>Petrol engine</th><th>Diesel engine</th></tr><tr><td>1) Works on Otto cycle.</td><td>Works on Diesel cycle.</td></tr><tr><td>2) Light weight.</td><td>The cylinder walls have to be made thicker to sustain the high pressure attained due to higher compression ratios. Heavy weight.</td></tr><tr><td>3) Mixture of petrol and air inducted into the cylinder during suction stroke.</td><td>Only air from the atmosphere is sucked into the cylinder.</td></tr></table>	1*7	7	

	4) Carburettor is used for the air-fuel mixture preparation.	Fuel pump and injector is used to inject fuel directly into the combustion space.			
	5) Compression ratio between 5:1 and 8:1.	Compression ratio between 15:1 and 20:1.			
	6) Spark plug is used to ignite the charge after it has been compressed.	Combustion of fuel is due to high temperature of compressed air.			
	7) High speed engines due to light weight.	Comparatively low speeds due to heavy weight.			
	8) Low vibration and noise.	Vibration and noise level is higher because of higher maximum pressure.			
	9) Quantity control engines. The air-fuel mixture being inducted is controlled by the throttle valve in accordance with load on the engine.	Quality control engine. The composition of the mixture is changed admitting more or less fuel with variation in engine load.			
	10) Initial cost is less and running cost is more.	Initial cost is more. Since Diesel is cheaper than petrol, the running cost is less.			
	11) Used in cars, scooters and motor cycles.	Used in heavy duty vehicles like trucks, buses and locomotive engines.			
	(any seven)				
VIII.a	Four Stroke Petrol Engine		3	8	

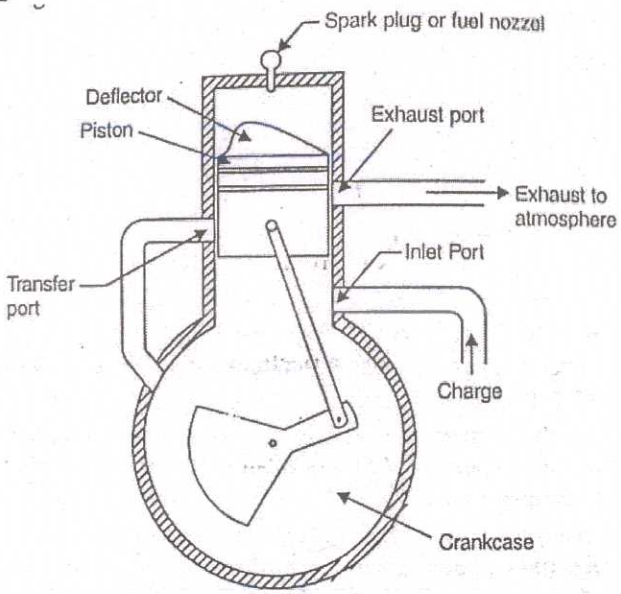


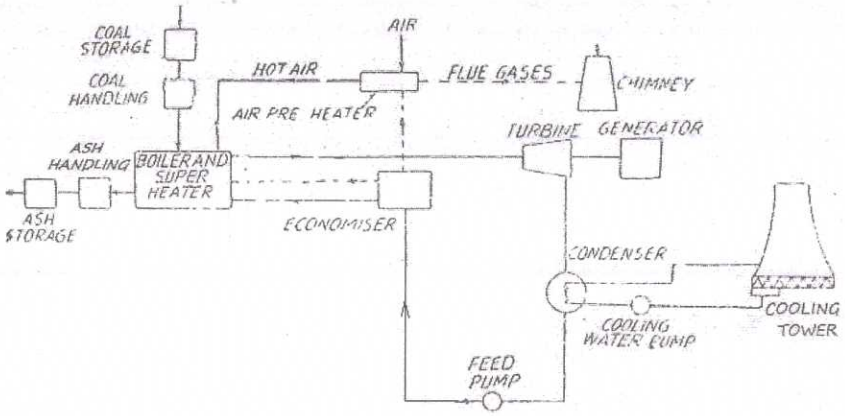
1. Intake or suction stroke (figure a)

Initially the piston is at top dead centre (TDC) position, the inlet valve is open and the outlet valve is closed. The piston moved downwards towards the bottom dead centre (BDC) position and the pressure inside the cylinder is reduced to a value below the atmospheric pressure. The vacuum thus created causes the charge to rush in and fill the space vacated by the piston. The charge consists of a mixture of air and petrol prepared by the carburettor. The suction continues till the piston reaches its BDC position. 5

2. Compression stroke (figure b)

Both the valves (inlet and outlet) are closed and the movement of the piston is from BDC to TDC position. The charge inside the cylinder is compressed to the clearance volume, the volume decreases and there is a continuous rise both in temperature and pressure of the charge.

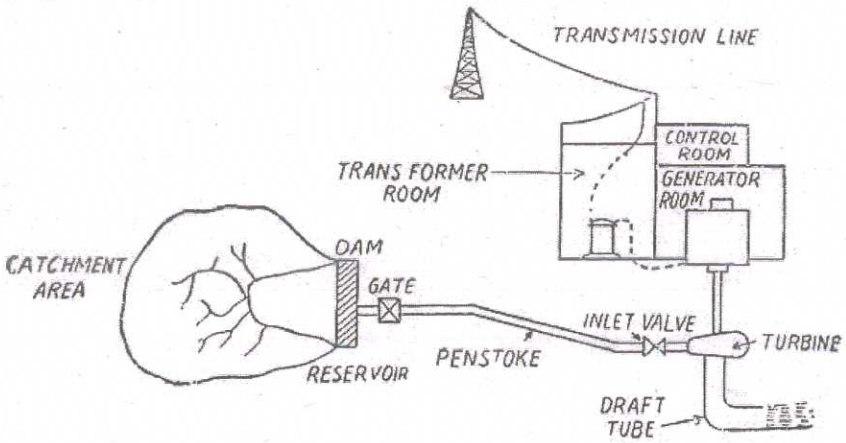
	3. Working, expansion or power stroke (figure c) When the piston reaches TDC position, the charge is ignited by causing an electric spark between the electrodes of a spark plug which is located in the cylinder head. During combustion, the chemical energy of the fuel is released and there is rise both in pressure and temperature of the gases at almost constant volume. With both valves closed, the gases at increased pressure and temperature expand, push the piston down the cylinder and work is done by the system. The reciprocating motion of the piston is subsequently converted into rotary motion of the crankshaft by connecting rod and crank. 4. Exhaust stroke (figure d) The inlet valve remains closed but the exhaust valve opens when the piston reaches BDC position towards the completion of power stroke. The pressure falls slightly above atmospheric pressure at constant volume. The piston moves upwards from BDC to TDC and this upward movement of the piston pushes the spent up gases into the atmosphere through exhaust valve and the exhaust manifold.			15
VIII.b	Construction  Figure shows the arrangement of a typical tree-port engine employing crank case compression. The piston which is closely fitted in the cylinder which is connected to the crankshaft through connecting rod and crank. The top of the piston is usually crown-shaped and that assists in sweeping the spent-up gases towards the exhaust port with the help of fresh charge. The engine employs ports as against valves as provided in a four-stroke system. These ports are cut in the cylinder walls and are three in number: the transfer port, inlet or induction port and the exhaust port. The inlet and exhaust ports are located on one side, and the transfer port is provided on the other side. The cylinder top is provided with an electric spark plug in a petrol engine, or a nozzle for injecting the fuel in a Diesel engine.	4 3	7	
IX.a	Construction - Steam Power Plant A power plant must have following equipments: 1. A furnace to burn the fuel. 2. Steam generator or boiler containing water. Heat generated in the furnace is utilized to convert water in steam. 3. Main power unit such as an engine or turbine to use the heat energy of steam and perform work. 4. Piping system to convey steam and water.			

	 Working Coal received in coal storage yard of power station is transferred to the furnace by coal handling equipment. Heat produced due to burning of coal is utilised in converting water contained in boiler drum into steam at suitable pressure and temperature. The steam generated is passed through the super-heater. Superheated steam then flows through the turbine. After doing work in the turbine the pressure of steam is reduced. Steam leaving the turbine passes through the condenser which maintains the low pressure of steam at the exhaust of turbine. Steam pressure in the condenser depends upon flow rate and temperature of cooling water and on effectiveness of air removal equipment. Water circulating through the condenser may be taken from the various sources such as river, lake or sea. If sufficient quantity of water is not available the hot water coming out of the condenser may be cooled in cooling towers and circulated again through the condenser. Air taken from the atmosphere is first passed through the air pre-heater, where it is heated by flue gases. The hot air then passes through the furnace. The flue gases after passing over boiler and super-heater tubes, flow through the dust collector and then through economiser, air pre-heater and finally they are exhausted to the atmosphere through the chimney.	4 4	8	15
IX.b	Advantages of Diesel power plant *(any seven)* 1. Required very small space. 2. It can also be designed for portable use. 3. It has quick starting facility, the small diesel generator set can be started within few seconds. 4. It can also be stopped as when required stopping small size diesel power station, even easier than it's starting. 5. As these machines can easily be started and stopped as when required, there may not be any standby loss in the system. 6. Cooling is easy and required smaller quantity of water in this type power station. 7. Initial cost is less than other types of power station. 8. Thermal efficiency of diesel is quite higher than that of coal.	1*7	7	

X.a

Essential features of Hydro-electric power plant

1) Reservoir 2) Dam
3) Water way 4) Surge tank
5) Power house and equipment 6) Draft tube
7) Spill way 8) Tail race



3

1. Water reservoir

It is the basic requirement of a hydro-electric power plant. Water reservoir is used to store water which may be utilised to run turbines to produce electric power. Reservoir may be neutral such as lake or artificial. Artificial reservoir can be built by erecting a dam across the river.

2. Dam

A dam is structure or masonry or some other material built at a suitable location across a river. The primary function of the dam is to provide a head of water. Economy and safety are the basic requirement of a dam. Dam should be capable of resisting pressure of water and should be stable under all conditions.

3. Waterway

A waterway is used to carry water from the dam to the power house. It includes canal, penstock (closed pipe) or tunnel. Tunnel is made by cutting the mountains where topography prevents the use of canal or pipeline.

4. Surge tank

Surge tank is a reservoir fitted to the penstock at a point near to the turbine. When the load on the turbine decreases, the gates of the turbine are closed partly by the governor to adjust the rate of flow of water in order to maintain the constant speed of the runner. When the gates are closed, the water is moving to the turbine has to move backward. This backward moving water is stored in the surge tank. Similarly, when the load on the turbine increases, the turbine gates are opened by the governor and increased demand of water is partly met by the water stored in the surge tank. In this way surge tank controls the pressure variations resulting from the rapid changes in water flow in penstock and there by prevents water hammer effects.

5

8

5. Power house and equipment

Power house consists of the main building of hydro-electric power plant where the conversion of energy of water to electrical energy takes place. Some important items of equipment provided in the power house are as follows

1) Turbines 3) Governors
4) Gate valves 5) Flow measurement equipment
6) Transformers 7) Storage batteries
8) Cranes 9) Outgoing connections

	6. Draft tube It is an integral part of reaction turbine. Draft tube connects the runner exit to tail race. The area of the top of the draft tube is same as that of runner to avoid shock and is of circular cross section. The water after doing work on the turbine runner passes through the draft tube to the tail-race. Draft tube is a metallic pipe or concrete tunnel having gradually increasing cross-sectional area towards outlet to ensure that as little energy as possibly is left in water as it discharges into the tail-race. By passing through the draft tube, the outlet velocity of water is reduced considerably and gain in useful pressure head is achieved. 7. Spillway A spillway acts as safety valve for a dam. Spillways and gates help in the passage of flood water without any damage to the dam. They keep the reservoir level below the predetermined maximum level. 8. Tail race Tail-race is a waterway to lead the water discharged from the turbine to the river. The water after doing work on turbine runner passes through the draft tube to tail-race.			15
X.b	Merits 1. It is free from pollution. 2. It is inexhaustible and does not depend on rain. 3. Tidal power plants do not require large area of valuable land because they are located on sea shore. 4. Tidal power has a unique capacity to meet peak power demand effectively when it works in combination with hydropower plant or thermal power plant. Demerits 1. The output varies because of variation in tidal range. 2. The power transmission cost is high because the tidal power plants are located away from load centres. 3. Sedimentation and silteration of basins are the problems associated with tidal power plants. 4. Because of variable tidal range the turbines have to work on a wide range of variable head. 5. Capital cost of the plant is high. *(any seven)*	1*7	7	