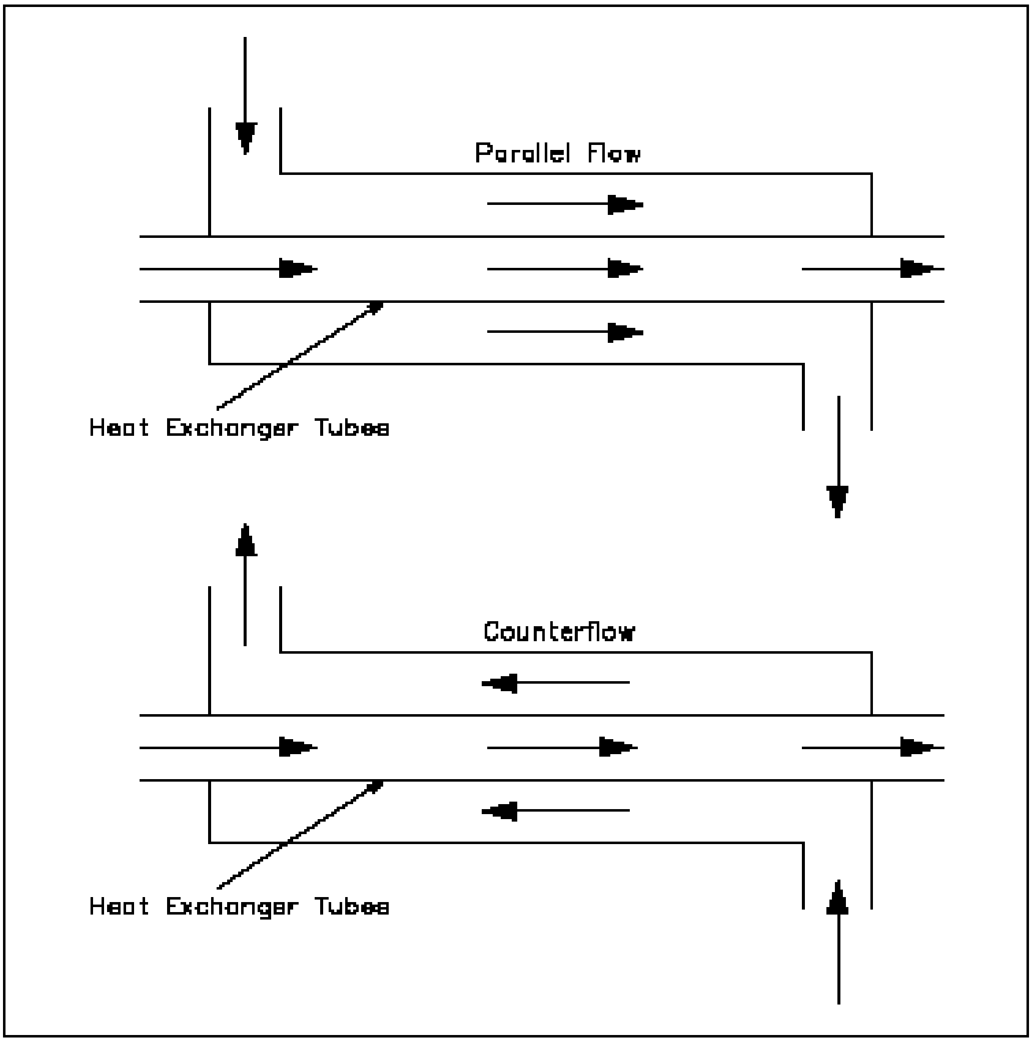
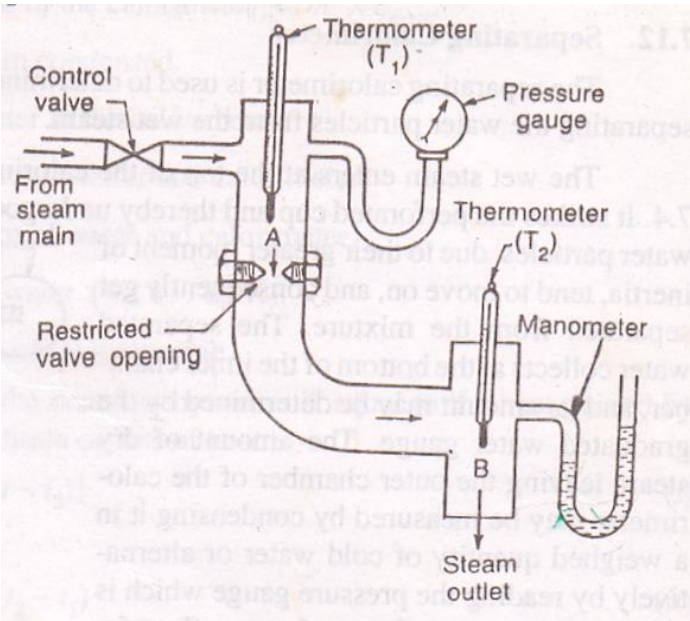
SUMMER-16 EXAMINATIONS

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. NO.	MODEL ANSWER	marks	total
1	**ATTEMPT ANY FIVE**		**20M**
ANS 1)	The sources of energy are classified into 2 main types. 1. Renewable energy source: the energy sources which are continuously produced by the nature. Or the source that can be renewed 2. Non-renewable energy source: These energy sources are limited and their production rate is very slow.ie. these sources cannot be renewed or require rather long time	**2M EACH**	**4M**
ANS 2)	System: Thermodynamic system is defined as definite area or space where some thermodynamic process is taking place. Thermodynamic system may be classified into following three types 1. Closed system: This is a system of fixed mass and entity whose boundaries are determined by the space occupied by it. It does not permit any mass transfer across its boundary, but permits transfer of energy. 2. Open system: This system permits both mass and energy transfer across the boundaries 3. Isolated system: It is a system with fixed mass and no heat or energy cross its boundary	**4M**	**4M**
ANS 3)	Both heat and work have some similarities in the way they behave that you will have to consider. First both, heat and work, are directional quantities. This means that both of them have a certain magnitude and direction in relation to whether the energy is entering or leaving the system. Second, both heat and work are only recognized when energy crosses the systems boundaries. Third, building upon the second statement, systems only contain energy not work or heat. Fourth, both heat and work are associated with a process as the system follows a path from one state towards another state	**4M**	**4M**
ANS 4)	1. Wet steam: When steam contains moisture or particles of water it is called to be wet steam 2. Dry steam: When wet steam is further heated and it does not contain any particles of water it is known as dry steam 3. Dryness fraction: it is the ratio of mass of actual dry steam to the mass of same quality of wet steam 4. Superheated steam: when dry steam is further heated at constant pressure thus raising its temperature it is said to be superheated steam.	**1M EACH**	**4M**
ANS 5)	1. Dalton's law of partial pressure: The pressure of the mixture of air and steam is equal to the sum of the pressures which each constituent would exert if it occupied the same space by itself $p_c = p_s + p_a$ $where,$ p_a= partial pressure of air p_s= partial pressure of steam 2. Function of Condenser: a steam condenser is closed vessel into which steam is exhausted and condensed after doing work in an engine cylinder or turbine. They have following two functions. i. To maintain low pressure to obtain maximum energy and high efficiency ii. To supply pure feed water.	**2M EACH**	**4M**

ANS 6)	Scavenging: the process of removing burnt gases from the combustion chamber of the engine cylinder is known as scavenging. Following are the methods of scavenging: 1. Cross flow scavenging: in this the transfer port and exhaust port are situated on opposite sides of engine cylinder 2. Back-flow or loop scavenging: in this method the inlet and outlet ports are situated on same side of engine cylinder 3. Uniflow scavenging: in this method, the fresh charge while entering from one side of the engine cylinder pushes out the gases through exit valves	**1M DEF. 1M TYPE**	**4M**
ANS 7)	 **Figure 9 Fluid Flow Direction** In parallel flow exchanger, both fluids in heat exchanger flow in same direction.	**2M DIAG. 2M EXPL.**	**4M**

Q.2.	ATTEMPT ANY TWO		16M
ANS A)	 Fig. 7.5. Throttling calorimeter. A throttling calorimeter used to determine the dryness fraction of steam. It consists of a sepreator into which steam is admitted through a control valve from steam main. The pressure and temprature are measured by pressure gauge and thermometer provided. It may be noted that temprature recorded by the thermometer is same as the saturation temprature.corresponding to the pressure of steam in calorimeter. This steam is then throttled through a narrow aperture of restricted valve openings, its total heat remaining constant. The steam is in superheated state after throttling at a lower pressure than previous. The temprature and pressure of steam leaving the caloriemeter B is noted by another thermometer and manomenter.	4M DIAG. 4M EXPL.	8M

ANS B)	Equivalence of Kelvin-planck and Clausis statement.	4M EACH	8M

1.53. Equivalence of Kelvin-Planck and Clausius Statements

Though Kelvin-Planck and Clausius statements of the second law of thermodynamics appea to be different, from each other, but these two statements are virtually equivalent in all respects. The equivalence of the Kelvin-Planck and Clausius statements can be proved if it can be shown that the violation of Kelvin-Planck statement implies the violation of Clausius statement and vice versa. This is discussed as follows :

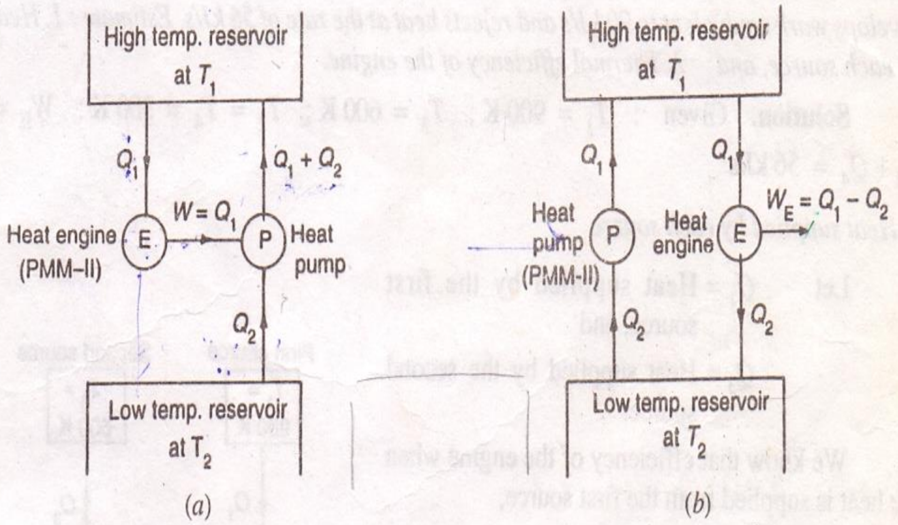
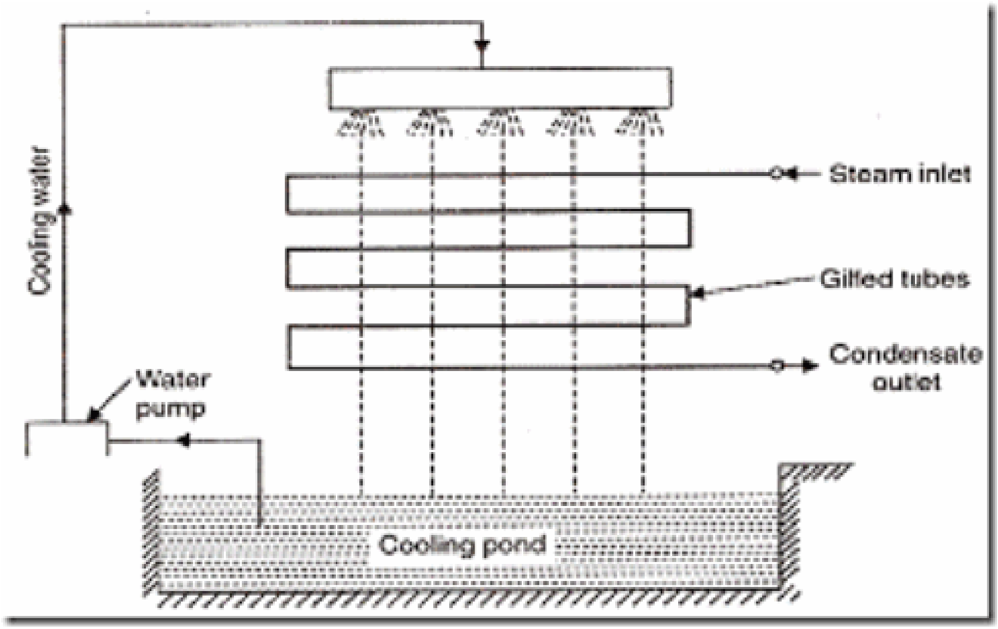


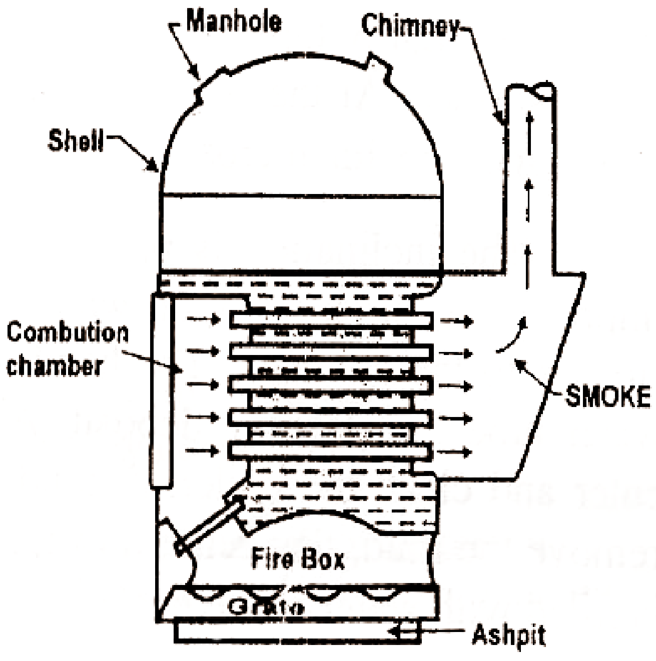
Fig. 1.13. Equivalence of Kelvin-Planck and Clausius statements.

1. Consider a system as shown in Fig. 1.13 (*a*). In this system, a heat engine having 100 percent thermal efficiency (*i.e.* PMM-II) is violating the Kelvin-Planck statement as it converts the heat energy (Q_1) from a single high temperature reservoir at T_1, into an equivalent amount of work (*i.e.* $W = Q_1$). This work output of the heat engine can be used to drive a heat pump (or refrigerator) which receives an amount of heat Q_2 from a low temperature reservoir at T_2 and rejects an amount of heat ($Q_1 + Q_2$) to a high temperature reservoir at T_1. If the combination of a heat engine and a heat pump (or refrigerator) is considered as a single system, as shown in Fig. 1.13 (*a*), then the result is a device that operates in a cycle and has no effect on the surroundings other than the transfer of heat Q_2 from a low temperature reservoir to a high temperature reservoir, thus violating the Clausius statement. Hence, a violation of Kelvin-Planck statement leads to a violation of Clausius statement.

2. Consider a system as shown in Fig. 1.13 (*b*). In this system, a heat pump or refrigerator (*i.e.* PMM-II) is violating the Clausius statement as it transfers heat from a low temperature reservoir at T_2 to a high temperature reservoir at T_1 without any expenditure of work. Now let a heat engine, operating between the same heat reservoirs, receives an amount of heat Q_1 (as discharged by the heat pump) from the high temperature reservoir at T_1, does work ($W_E = Q_1 - Q_2$) and rejects an amount of heat Q_2 to the low temperature reservoir at T_2. If the combination of the heat pump (or refrigerator) and the heat engine is considered as a single system, as shown in Fig. 1.13 (*b*), then the result is a device that operates in a cycle whose sole effect is to remove heat at the rate of ($Q_1 - Q_2$) and convert it completely into an equivalent amount of work, thus violating the Kelvin-Planck statement. Hence, a violation of Clausius statement leads to a violation of Kelvin-Planck statement.

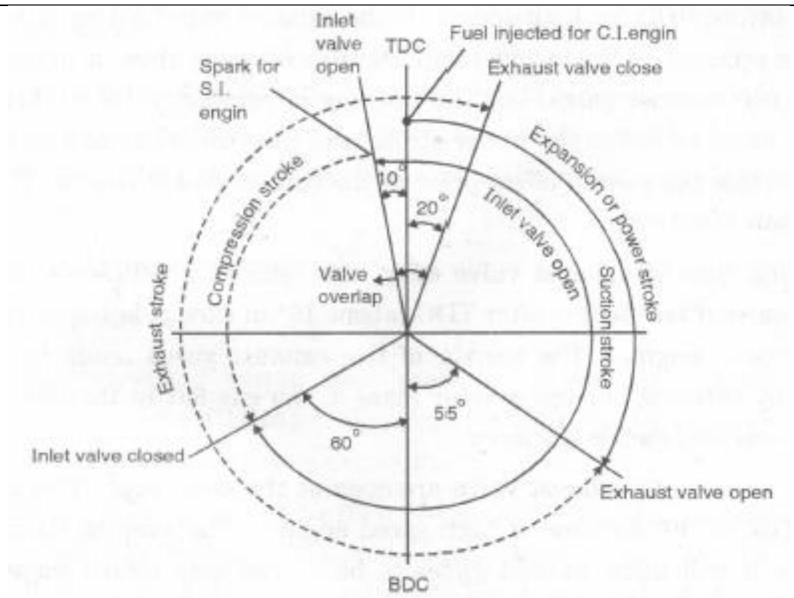
ANS C)	Evaporative type Surface condenser  The steam to be condensed enters at the top of a series of pipes outside of which a film of cold water is falling. At the same time, a current of air circulates over the water film causing rapid evaporation of some of the cooling water. As a result of this steam ciculating inside the pipe is condensed. The reamining cooling water is collected at an increased temperature and is reused. Its original temperature is restored by addition of requisite quantity of cold water. The evaporative condensers are provided when the circulating water is to be used again and again. These condensors consists of sheets of gilled piping, which is bent backwards and forwards placed in a vertical plane as shown in the figure.	**4M DIAG. 4M EXPL.**	**8M**

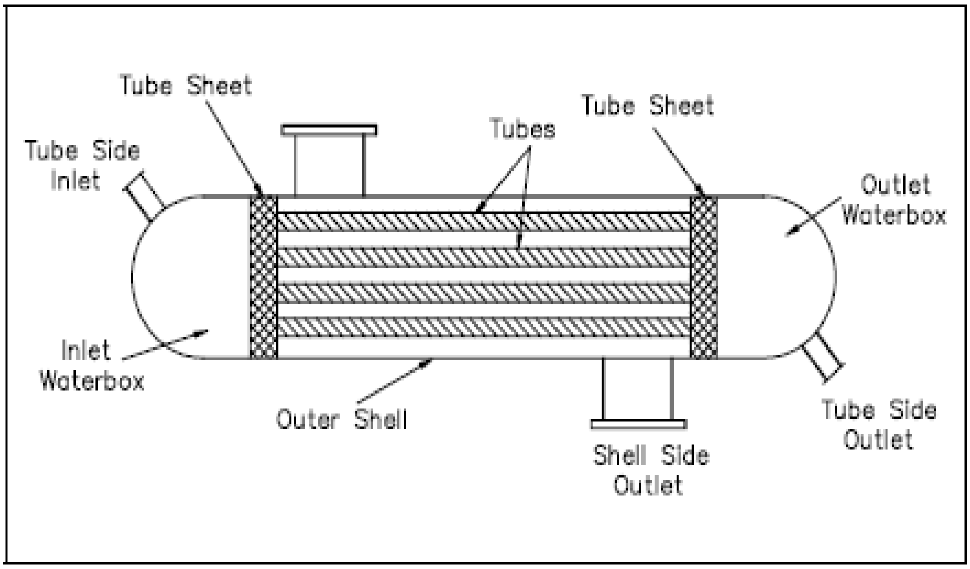
<table>
<tr><td>Q.3.</td><td>Attempt any four</td><td></td><td>16M</td></tr>
<tr><td>ANS A)</td><td>Difference between point function and path function:
<table>
<tr><td>Path Function</td><td>Point Function</td></tr>
<tr><td>Their magnitudes depend on the path followed during a process as well as the end states.</td><td>They depend on the state only, and not on how a system reaches that state.</td></tr>
<tr><td>Work (W), heat (Q), Pressure, volume, enthalpy, internal energy are path functions.</td><td>All properties are point functions.</td></tr>
<tr><td>When the two properties locate a point on graph (coordinates axes) then those properties are known as point function</td><td>Those properties, which cannot be located on graph by a point but are given by area or show on the graph.</td></tr>
</table></td><td>2M EACH</td><td>4M</td></tr>
<tr><td>ANS B)</td><td>Cochran boiler:



Cochran Boiler (Elevation)</td><td>4M</td><td>4M</td></tr>
<tr><td>ANS C)</td><td>Nozzle: a Steam nozzle is a passage of varying cross-section, which converts heat energy of steam into kinetic energy. The main use of steam nozzle in steam turbine is to produce a jet of steam with high velocity. The smallest section of nozzle is known as throat.
Types of steam nozzle:
1. Convergent: when cross-section of a nozzle decreases continuously from entrance to exit is called convergent nozzle.
2. Divergent: when the cross-section of a nozzle increases continuously from entrance to exit is called divergent nozzle.
3. Convergent-divergent: when the cross-section of a nozzle first decreases from its entrance and then increases from its throat to exit is called convergent-divergent nozzle</td><td>1M

3M (1M EACH)</td><td>4M</td></tr>
</table>

ANS D)	 (i) Inlet valve timing: • It bears on the actual quantity of air sucked during suction. i.e. it affects on volumetric efficiency from Fig. 1.9. The suction valve open 10° before the arrival of piston to TDC on the exhaust stroke. This insure that the valve will be fully open and fresh charge starting to flow into the cylinder as soon as possible after TDC. • When the piston moves BDC and start to move, compression stroke, the inertia of the entering fresh charge tend to cause it to continue to move into the cylinder. To take advantage the intake valve closes after BDC. So that max. (air + fuel) charge is taken in. This is called ram effect. • If the intake valve is to remain open for a long time beyond BDC and the intake valve closed at 60° after BDC. At low speed engine inertia is low, the charge speed is low, so the air inertia is low so the intake valve closed early after BDC. (10° after BDC). • There is a limit to the high speed for advantage of ram effect. At very high speeds the effect of fluid friction may be more than 'offset the ramming effect and the charge for cylinder fall off. (ii) Exhaust valve timing: • The exhaust valve is s.et to open before BDC (about 25° before BDC, in low speed '. and 55° before BDC fo.r high speed) ..If the exhaust valve did not start open until BDC, the pressure in the cylinder considerably increase above atmosphere required to expel the exhaust gases, but the opening of exhaust valve earlier reduces the pressure near the end of the power stroke and thus causes some loss of useful work on this stroke, the overall effect prior to the time of piston reaches BDC results in overall gain in output. • The closing time of exhaust valve effect the volumetric efficiency. By closing the exhaust valve a few degree after TDC (about 15° in case of low speed or 20° in case of high speed engine). The inertia of the exhaust gases tends to scavenge the cylinder by carrying out the greater mass of the gas left in the clearance volume. This increase volumetric efficiency. • Both the intake and exhaust valve are open at the same time. This is called valve overlap (15° or 30° for slow or high speed engine). This overlap should not exceed otherwise it will allow burned gases to be sucked into intake manifold or fresh charge to escape through the exhaust valve.	**2M DIAG. 2M EXPL.**	**4M**

ANS E)	Lubricant additives: Lubricant additives are chemical compounds that improve the lubricant performance. Advantages of lubricants: • Enhance existing base oil properties with antioxidants, corrosion inhibitors, anti-foam agents and demulsifying agents. • Suppress undesirable base oil properties with pour-point depressants and viscosity index (VI) improvers. • Impart new properties to base oils with extreme pressure (EP) additives, detergents, metal deactivators and tackiness agents.	**2M DEF. 2M ADVA.**	**4M**
ANS F)	 Figure 8 Typical Tube and Shell Heat Exchanger	**4M**	**4M**

<table>
<tr><td>Q.4.</td><td>Attempt any four</td><td></td><td>16M</td></tr>
<tr><td>ANS A)</td><td>Renewable and non-renewable energy sources:
<table>
<tr><td>Renewable energy</td><td>Non-renewable energy</td></tr>
<tr><td>the energy sources which are continuously produced by the nature.</td><td>These energy sources are limited and their production rate is very slow.</td></tr>
<tr><td>The sunlight, wind power, water, plants and biomass are some of the examples for renewable energy sources.</td><td>Examples of non-renewable energy sources are coal, oil, peat and nuclear power.</td></tr>
<tr><td>The nature of these energy sources is, they are continuously replenished by the nature, when people consume them. These sources do not directly provide energy, but these energy sources can transform into usable energy form.</td><td>It is very convenient to use non-renewable energy sources (fuel, natural gas, coal, etc) to fulfill our energy requirements, but we have a limited supply on the earth.</td></tr>
<tr><td>These technologies are often called “clean” or “green” because they produce a little amount of environment pollutants compared to that of non-renewable energy sources.</td><td>These sources are more polluting than renewable sources.</td></tr>
<tr><td>The price of renewable energy source is less or free. But the cost of harnessing this energy is greater. Due to the high initial cost few countries are using these sources.</td><td>The prices of non-renewable energy sources are relatively high and it always increases since the demand is very high compared to the supply. Not all countries have these energy sources and those who have these energy sources have the power to control the world market price.</td></tr>
</table></td><td>1M EACH</td><td>4M</td></tr>
<tr><td>ANS B)</td><td>Solution. Given : $p = 8$ bar ; $x = 0.8$
Enthalpy of 1 kg of steam
From steam tables, corresponding to a pressure of 8 bar, we find that
$h_f = 720.9$ kJ/kg and $h_{fg} = 2046.5$ kJ/kg
We know that enthalpy of 1 kg of wet steam,
$h = h_f + x\,h_{fg} = 720.9 + 0.8 \times 2046.5 = 2358.1$ kJ Ans.
Heat required to raise 2 kg of this steam from water at 20° C
We have calculated above the enthalpy or total heat required to raise 1 kg of steam from wat at 0° C. Since the water, in this case, is already at 20° C, therefore
Heat already in water $= 4.2 \times 20 = 84$ kJ
∴ Heat required per kg of steam
$= 2358.1 - 84 = 2274.1$ kJ
and heat required for 2 kg of steam
$= 2 \times 2274.1 = 4548.2$ kJ Ans.</td><td>1M

2M

1M</td><td>4M</td></tr>
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<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>ANS C)</td><td>Sources of air leakages in condenser:
The following are the main sources of air into the condenser:
1. The dissolved air in the feed waterenters into the boiler
2. The air leaks into the condenser through various joints due to high vacuum pressure
3. Dissolved water with injection water
Effects of air leakage:
1. It reduces the vacuum pressure in the condenser
2. Since the air is a poor heat conductor it reduces the rate of heat transmission
3. It requires a larger air pump.</td><td>2M sources 2M effects</td><td>4M</td></tr>
<tr><td>ANS D)</td><td>Turbocharging: In turbocharged engines, the combustion air is already pre-compressed before being supplied to the engine. The engine aspirates the same volume of air, but due to the higher pressure, more air mass is supplied into the combustion chamber. Consequently, more fuel can be burnt, so that the engine's power output increases related to the same speed and swept volume. is a turbine-driven forced induction device that increases an internal combustion engine's efficiency and power output by forcing extra air into the combustion chamber.This improvement over a naturally aspirated engine's power output is because the turbine can force more air - and proportionately more fuel - into the combustion chamber than atmospheric pressure alone.

Supercharging: it is the process of increasing the mass, or in other words of the air-fuel mixture induced into the engine cylinder. This is usually done with the help of compressor or blower known as supercharger. The main objective of supercharging is to reduce mass of engine per brake power and to increase the power output of an engine when greater power is required</td><td>2M EACH</td><td>4M</td></tr>
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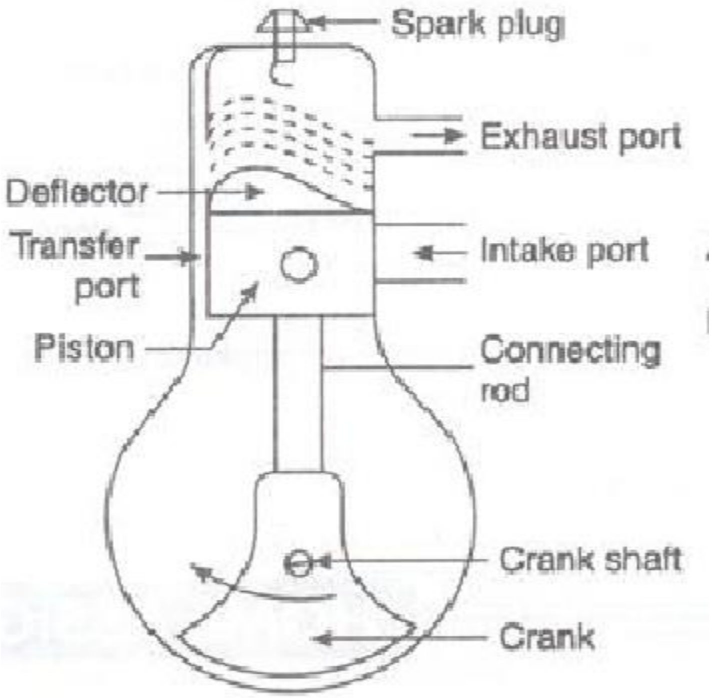
<tr>
<td>ANS E)</td>
<td>2S petrol engine:
Construction:

Working: In 2S petrol engine the working cycle is completed in two strokes of piston or one revolution of the crankshaft. This is achieved by carrying out the suction and compression processes in one stroke, expansion and exhaust processes in second stroke. It has no valves but consists of inlet or induction port (IP), exhaust port (EP), and a third port called the transfer port (TP). The ignition starts due the spark given by the spark plug and the piston is pushed down performing the working strokes and in doing so the air fuel mixture already drawn from the inlet port in the previous stroke is compressed Immediately afterwards as the exhaust port is uncovered by the further downward movement of the piston, the transfer port which is only very slightly lower than exhaust port is also uncovered and a charge of compressed fuel air mixture enters the cylinder and further pushes out the burnt gases out of the exhaust port. The top of the piston is made of a particular shape that facilitates the deflection of fresh charge upwards and thus avoids its escape along with the exhaust gases. This process is known as scavenging. After reaching the bottom dead center when the piston moves up, it first closes the inlet port, then transfer port and then exhaust port. The charge of fuel which previously entered the cylinder is now compressed. Simultaneously there is a fall of pressure in the crank case, creating a partial vacuum. When the piston is nearing the upward movement, the inlet port opens and a fresh charge of air fuel mixture from the carburetor enters the crank case. After the ignition of the charge, the piston moves down for the power stroke and the cycle is repeated as before</td>
<td>2M cons.
2M working</td>
<td>4M</td>
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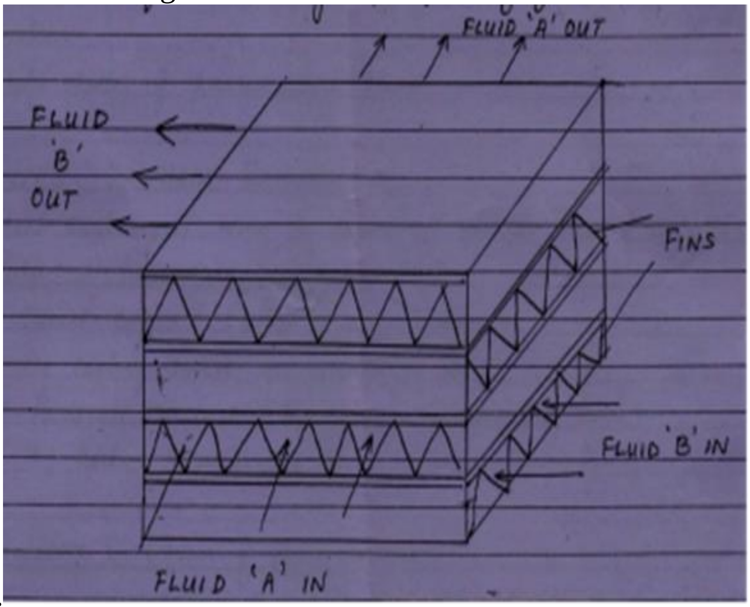
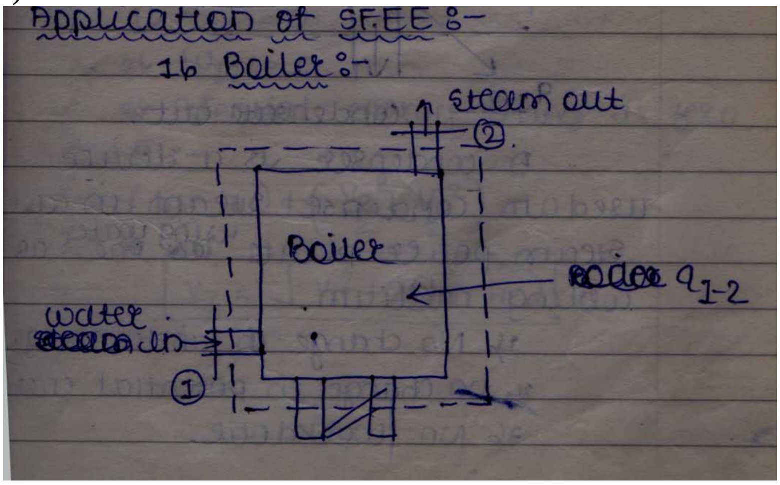
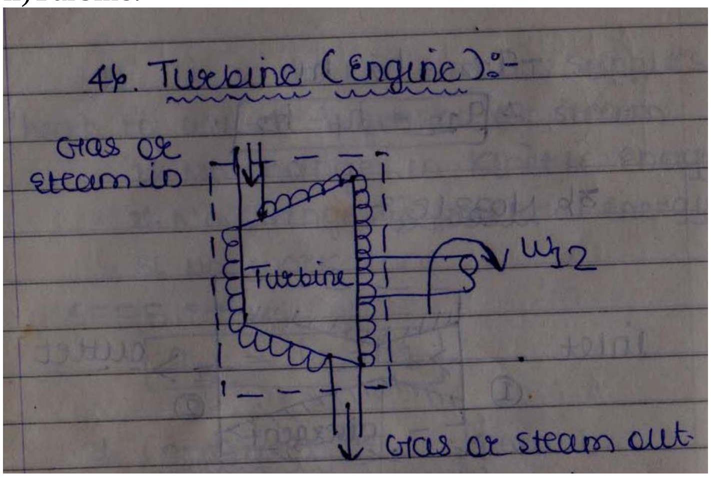
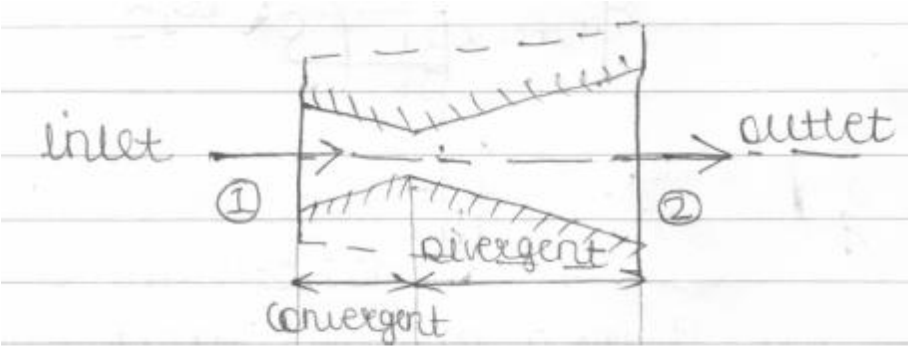
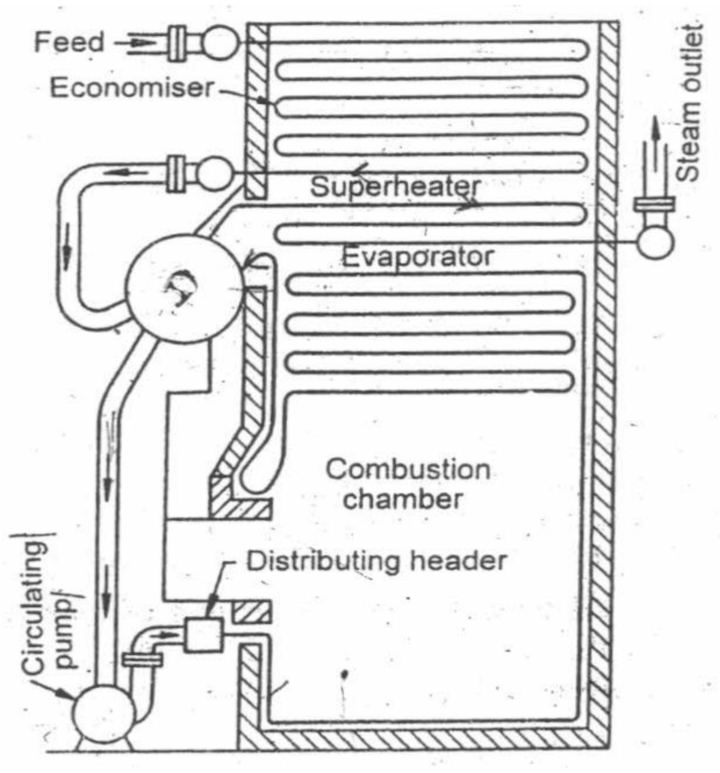
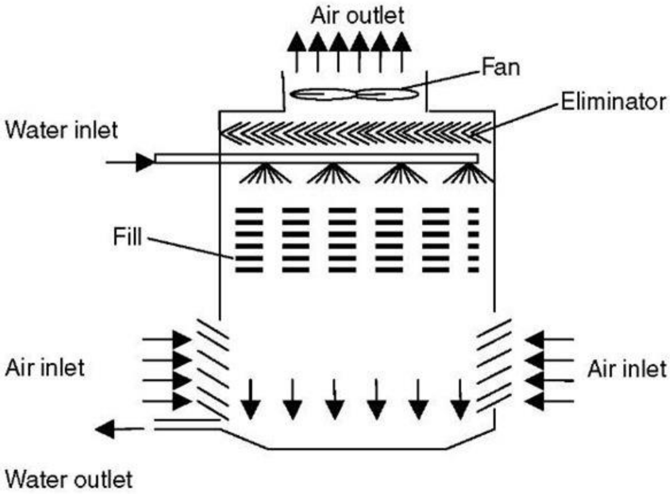
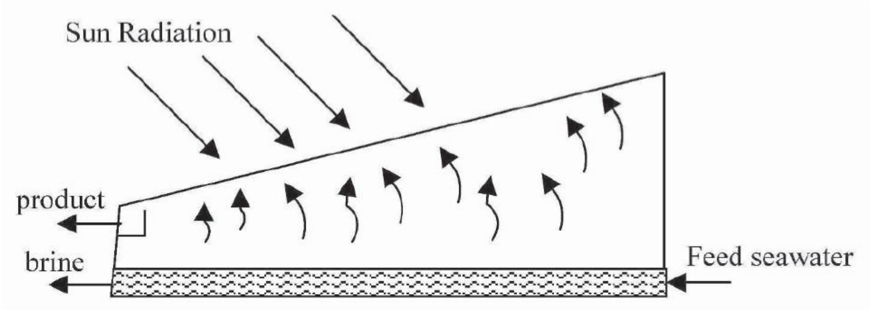
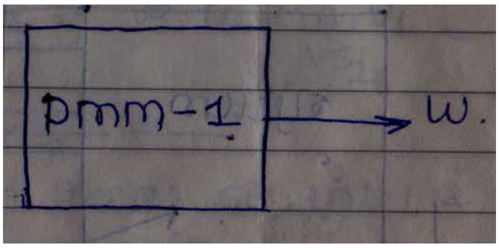
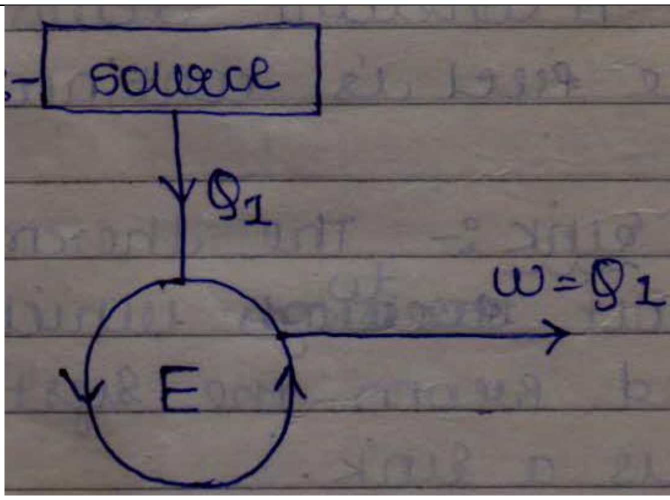
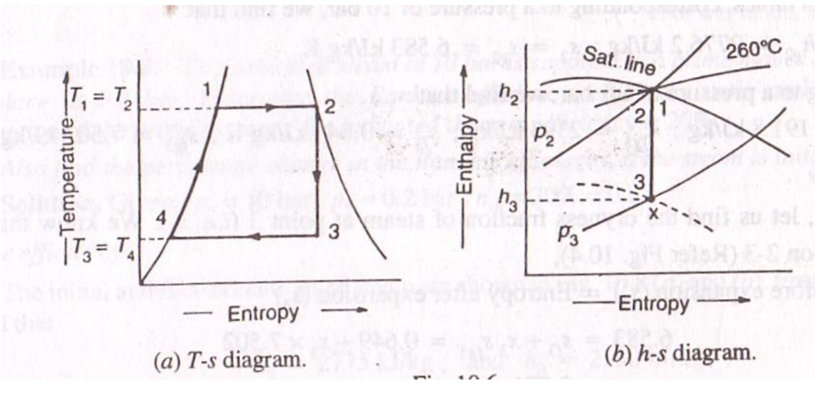
ANS F)	Cross-flow heat exhchanger:  A cross-flow heat exchanger exchanges thermal energy from one airstream to another in an air handling unit (AHU). Unlike a rotary heat exchanger, a cross-flow heat exchanger does not exchange humidity and there is no risk of short-circuiting the airstreams. A cross-flow heat exchanger is used in a cooling and ventilation system that requires heat to be transferred from one airstream to another. A cross-flow heat exchanger is made of thin metal panels, normally aluminium. The thermal energy is exchanged via the panels. A traditional cross-flow heat exchanger has a square cross-section. It has a thermal efficiency of 40–65%. A counter-flow or dual cross-flow heat exchanger can be used if greater thermal efficiencies are required – typically up to 75–85 %. In some types of exchanger, humid air may cool down to freezing point, forming ice. A cross-flow is typically less expensive than other types of heat exchanger. It is normally used where hygienic standards require that both airstreams are kept completely separate from one another. It is often used in heat recovery installations in large canteens, hospitals and in the food industry. Unlike a rotary heat exchanger, a cross-flow heat exchanger does not exchange humidity.	**1M DIAG. 3M EXPL.**	**4M**

Q.5.	Attempt any two		**16M**
ANS A)	SFEE: $h_1+V_1^2/2+gZ_1+q_{12}= h_2+V_2^2/2+gZ_2+W_{12}$ i)For boiler  It is a device which supplies heat to water and generates steam. 1) No change in kinetic energy 2) No change in potential energy 3) No work done. SFEE $q_{12}=h_2-h_1$ ii)Turbine:  It is devices which convert energy of working substance into a work. The turbine is insulated so. 1) $Q_{12} = 0$ 2) No change in kinetic energy 3) No change in potential energy SFEE: $W_{12}= h_2-h_1$	**2M** **2M** **2M**	**8M**

	iii)Nozzle  It is a a device which increses the velocity of working substance,the nozzle insulated so that no het transfer take place. 1.$q_{12} = 0$ 2.$w_{12} = 0$ 3.Potential energy change is zero. SFEE; $(h2-h1) + \{(v_2^2)/2 - (v_1^2)/2)\} = 0$ $v_2 = \sqrt{\{v_1^2 + 2(h_1 - h_2)\}}$	**2M**	
ANS B)	La-Mont Boiler  This is a modem high pressure water tube steam boiler working on a forcedcirculation. The circulcrtion is maintained by a centrifugal pump,driven 'by a steam turbine, using steam from the boiler. The forced circulation causes the feed water to circulate through the Water walls and drums equal to ten timesthe mass of steam evaporated. This prevents the tubes from being overheated. A diagrammatic sketch of La-Mont steam, boiler is shown in Fig.The feed water passes through the economiser to an evaporating drum.It is then drawn to the	**4M sketch 4M EXPL.**	**8M**

	circulating pump through the tube. The pump delivers the feed to the headers, at a pressureabove the drum pressure; The header distributes water through nozzles into the generating tubes acting in parallel. The water and steam from these tubes passes into the drum, The steam in the drum is then drawn through the superheater.		
ANS C)	Functions of cooling tower: 1. The function of cooling tower is to cool the water (hot) coming from the condenser by exposing it to the atmospheric air. The water so cooled may be recirculated in the condenser. (a) In a cooling tower, water is made to trickle down drop by drop, so that, it comes in contact with the air moving in opposite direction. (b) As a result of this, some water gets evaporated and is taken away with air. (c) In evaporation, the heat is taken away from the bulk of water, which is thus cooled. 2. In case of shortfall, the water from cooling tower is also used as feed water for steam turbine power plant. Induced draught cooling tower: In this cooling tower the circulation of air is provided by means of fans placed at the top of the tower  	**6M(3M EACH FUNCT.)** **2M**	**8M**

Q.6.	Attempt any four		**16M**
ANS A)	Solar distillation: Solar distillation is the use of solar energy to evaporate water and collect its condensate within the same closed system. Unlike other forms of water purification it can turn salt or brackish water into fresh drinking water (i.e.desalination). The structure that houses the process is known as a solar still and although the size, dimensions, materials, and configuration are varied, all rely on the simple procedure wherein an influent solution enters the system and the more volatile solvents leave in the effluent leaving behind the salty solute behind. Solar distillation differs from other forms of desalination that are more energy-intensive, such as methods such as reverse osmosis, or simply boiling water due to its use of free energy.A very common and, by far, the largest example of solar distillation is the natural water cycle that the Earth experiences.  	**2M EXPL.** **2M DIA.**	**4M**
ANS B)	PMM -1(Perpetual motion machine of first kind) A machine which violates the first law of thermodynamics is known as PMM -1.It is a machine which produced a work without consuming an equivalent of energy in any other form. Such machine is impossible to construct.  PPM – 2 A heat engine which violates the second law of thermodynamics is known as Perpetual motion machine of second kind. It is 100% efficient machine. It converts whole of heat energy into mechanical work. It is impossible to obtain in actual practice.	**2M EACH**	**4M**

	 		
ANS C)	There are four processes in the Rankine cycle. These states are identified by numbers (in brown) in the T-s diagram. • **Process 1-2**: The working fluid is pumped from low to high pressure. As the fluid is a liquid at this stage, the pump requires little input energy. • **Process 2-3**: The high pressure liquid enters a boiler where it is heated at constant pressure by an external heat source to become a dry saturated vapour. The input energy required can be easily calculated graphically, using an enthalpy-entropy chart(aka h-s chart or Mollier diagram), or numerically, using steam tables. • **Process 3-4**: The dry saturated vapour expands through a turbine, generating power. This decreases the temperature and pressure of the vapour, and some condensation may occur. The output in this process can be easily calculated using the chart or tables noted above. • **Process 4-1**: The wet vapour then enters a condenser where it is condensed at a constant pressure to become a saturated liquid.  (a) T-s diagram. (b) h-s diagram.	**2M EXPL.** **2M DIA.**	**4M**
ANS D)	A steam turbine is a prime mover in which rotary motion is obtained by gradual change of momentum of the steam. The basic principle of operation of a steam turbine is generation of high velocity jet by expansion of high pressure steam and then conversion of kinetic energy in to mechanical work. Classification of Steam turbine: The turbines are classified as follows. 1. According to the mode of steam action. a. Impulse turbine	**1M DEF.** **3M Classif.**	**4M**

	b. Reaction turbine 2. According to the direction of steam flow a. Axial flow b. Radial flow 3. According to the exhaust condition of steam a. Condensing turbine b. Non-condensing turbine 4. According to pressure of steam a. High pressure b. Medium pressure c. Low pressure 5. According to the number of stages a. Single stage b. Multi-stage		
ANS E)	We know that for isentropic compression 3-4 (Refer Fig. 6.9), $\frac{T_3}{T_4} = \left(\frac{v_4}{v_3}\right)^{\gamma - 1} = \left(\frac{1}{r}\right)^{1.4-1} = \frac{1}{(r)^{0.4}}$ $\therefore \quad (r)^{0.4} = \frac{T_4}{T_3} \text{ or } r = \left(\frac{T_4}{T_3}\right)^{\frac{1}{0.4}} = \left(\frac{596}{316}\right)^{2.5} = 4.885$ **Ans.** *Air standard efficiency* We know that air standard efficiency, $\eta = 1 - \frac{1}{(r)^{\gamma - 1}} = 1 - \frac{1}{(4.885)^{1.4-1}} = 1 - \frac{1}{1.886}$ $= 1 - 0.53 = 0.47$ or 47% **Ans.**	**2M** **2M**	**4M**
ANS F)	Detonation: Detonation (also called "spark knock") is an erratic form of combustion that can cause head gasket failure as well as other engine damage. Detonation occurs when excessive heat and pressure in the combustion chamber cause the air/fuel mixture to autoignite. This produces multiple flame fronts within the combustion chamber instead of a single flame kernel. When these multiple flames collide, they do so with explosive force that produces a sudden rise in cylinder pressure accompanied by a sharp metallic pinging or knocking noise. The hammer-like shock waves created by detonation subject the head gasket, piston, rings, spark plug and rod bearings to severe overloading. Mild or occasional detonation can occur in almost any engine and usually causes no harm. But prolonged or heavy detonation can be very damaging. So if you hear knocking or pinging when accelerating or lugging your engine, you probably have a detonation problem. Preignition: This occurs when a point within the combustion chamber becomes so hot that it becomes a source of ignition and causes the fuel to ignite before the spark plug fires. This, in turn, may contribute to or cause a detonation problem. Instead of the fuel igniting at the right instant to give the crankshaft a smooth kick in the right direction, the fuel ignites prematurely (early) causing a momentarily backlash as the piston tries to turn the crank in the wrong direction. This can be very damaging because of the stresses it creates. It can also localize heat to such an extent that it can partially melt or burn a hole through the top of a piston.	**2M EACH**	**4M**