WINTER – 19 EXAMINATION

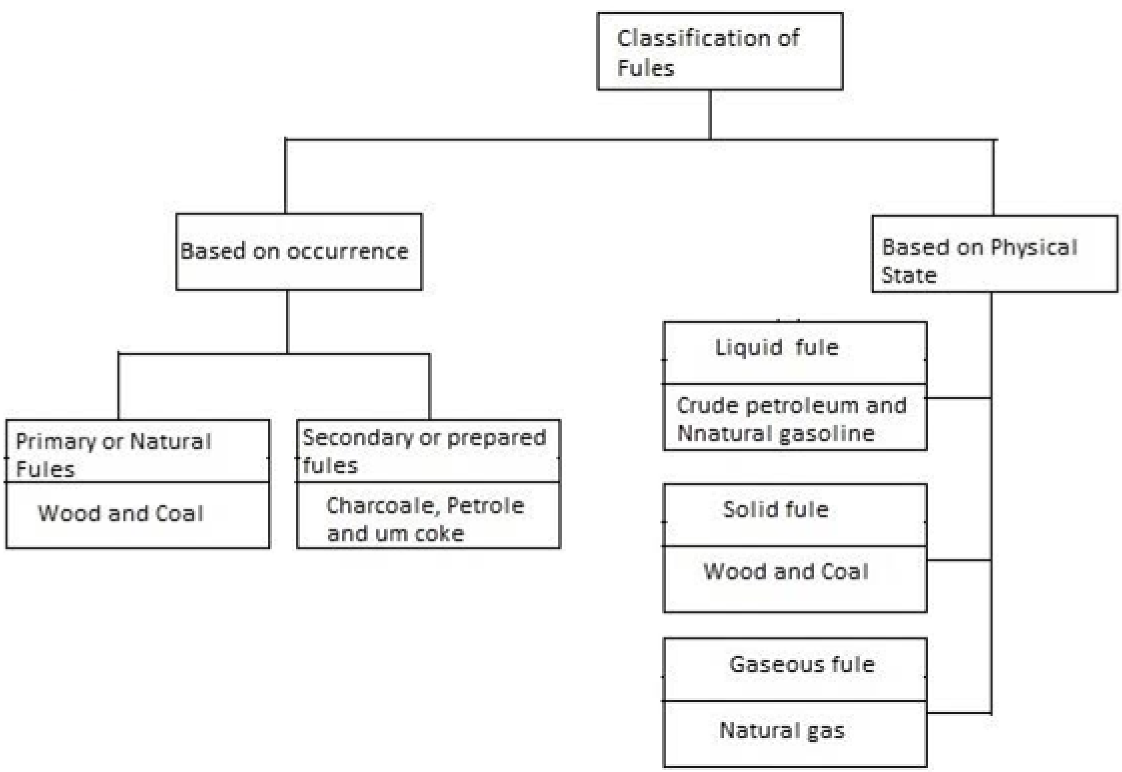
Subject Name: Heat power Engineering **Model Answer** Subject Code: 17407

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 judgement 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.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any Six of the following.**	12
	i	**List different types of ideal gas processes**	02
		Answer: **Following are the different types of ideal gas processes** *(Any four)* 1. Isochoric (constant volume process) 2. Isobaric (constant pressure process) 3. Isothermal (constant temperature process) 4. Isentropic (constant entropy process) 5. Polytropic process	02
	ii	**Define sensible heat and latent heat**	02
		Latent heat: It is defined as the quantity of heat required for phase change of working substance at saturation temperature. OR The amount of heat added at saturation temperature is called latent heat. **Sensible heat:** It is defined as the quantity of heat which can be sensed by the thermometer. OR The amount of heat added up to saturation temperature is called sensible heat.	01 01

	iii	**Define free air delivered of compressor**	**02**
		Free Air Delivered (FAD): any two points • It is the actual volume of air delivered by the compressor when reduced to NTP. • FAD is a flow rate of air derived from measurement at the outlet of the compressor. • Free Air delivered is the amount of compressed air delivered at the outlet of a compressor, converted back to the actual inlet (free air) conditions before it was compressed.	**02**
	iv	**List down the uses of compressed air**	**02**
		Application of compressed air: (Any four) 1. Operating tools in factories 2. Operating drills and hammers in road building 3. Starting diesel engines 4. Operating brakes on buses, trucks and trains 5. Spray painting 6. Excavating 7. To clean the large workshops Etc.	**½ mark for each**
	v	**Give the classification of gas turbine**	**02**
		Answer: Classification of gas turbine: *(Any two)* **1. According to the path of the working substance:** i) Open cycle gas turbine ii) Close cycle gas turbine iii) Semi-closed cycle gas turbine **2. According to process of combustion:** i) Constant pressure gas turbine ii) Constant volume gas turbine **3. According to direction of flow:** i) Radial flow ii) Axial flow iii) Tangential flow 4. **According to principle of action of expanding gases:** i) Impulse turbine ii) Reaction turbine **5. According to their usage:** i) Constant speed ii) Variable speed	**02**

	vi	**Enlist conventional and non-conventional energy sources.**	**02**
		Conventional energy source: Any two **1)** Coal **2)** natural gas **3)** oil **4)** fire wood. **Non-conventional energy sources: Any two** **1)** Solar power **2)** Hydro-electric power **3)** Wind power **4)** Tidal power **5)** Ocean wave power **6)** Geothermal power **7)** Ocean thermal power **8)** Biomass, Bio-fuel etc.	**½ mark for each**
	vii	**Give the classification of Fuels.**	**02**
		 	**02**
	viii	**List properties of Fuels**	**02**
		Properties of fuels: *(any four)* 1. It should possess high calorific value. 2. It should have proper ignition temperature. The ignition temperature of the fuel should either be neither too low nor too high. 3. It should not produce poisonous products during combustion. In other words, it should not cause pollution o combustion.	**1/2 mark each**

		4. It should have moderate rate of combustion. 5. Combustion should be easily controllable i.e., combustion of fuel should be easy to start or stop as and when required. 6. It should not leave behind much ash on combustion. 7. It should be easily available in plenty. 8. It should have low moisture content. 9. It should be cheap. 10. It should be easy to handle and transport.	
1.	b	**Attempt any TWO of the following**	**08**
	(i)	**Represent Isobaric, Isochoric, Isothermal, Adiabatic process on P-V and T-S diagram.**	

½ mark for P-V diagram and ½ mark for T-S diagram for each process

Isobaric process

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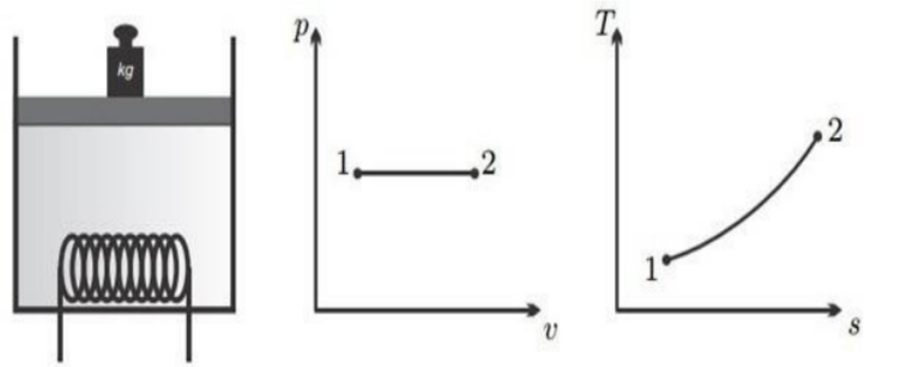

Fig. Isobaric process: Realization, p-v- and T-s-diagrams

01

Isothermal process

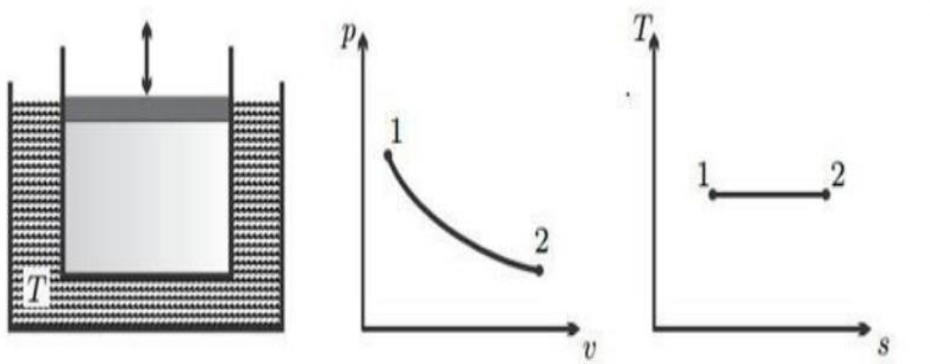

Fig. Isothermal process: Realization, p-v- and T-s-diagrams

Isochoric process

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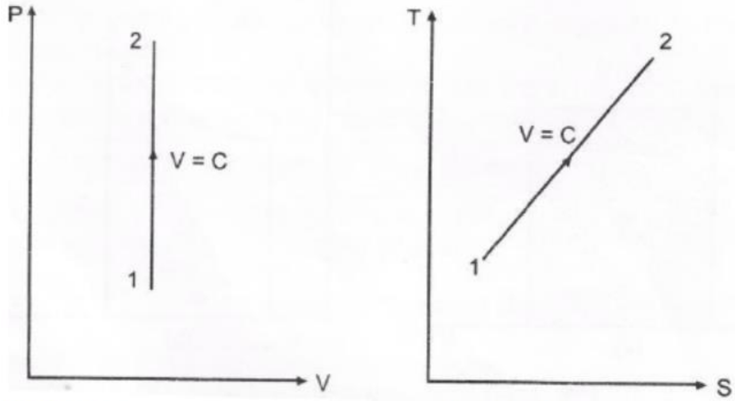
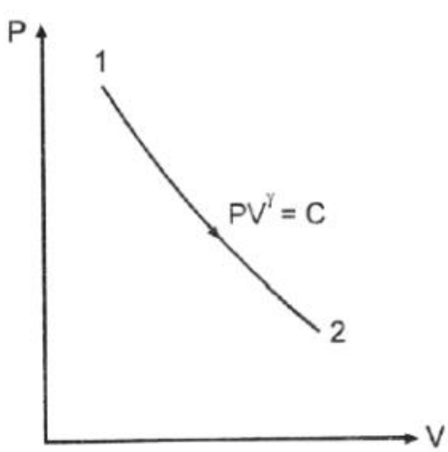
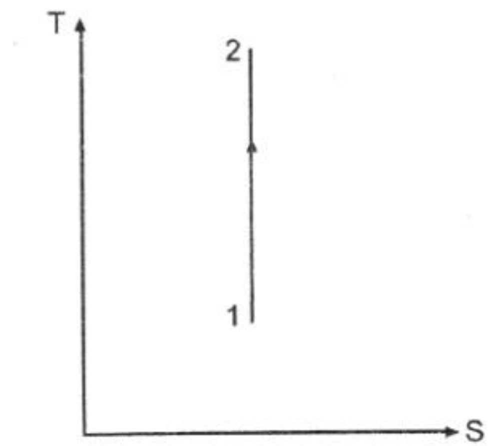
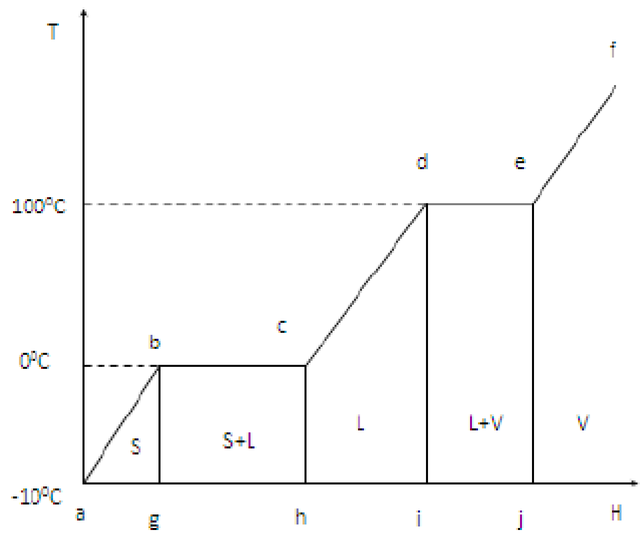
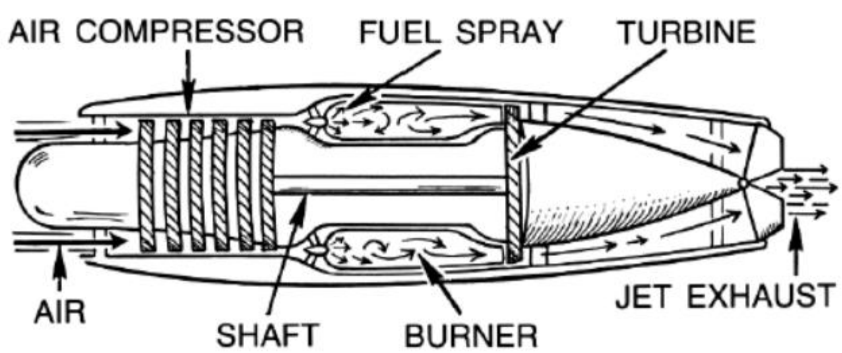
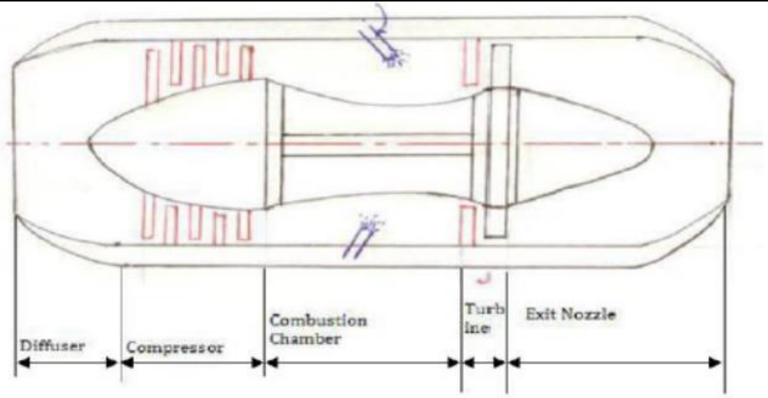
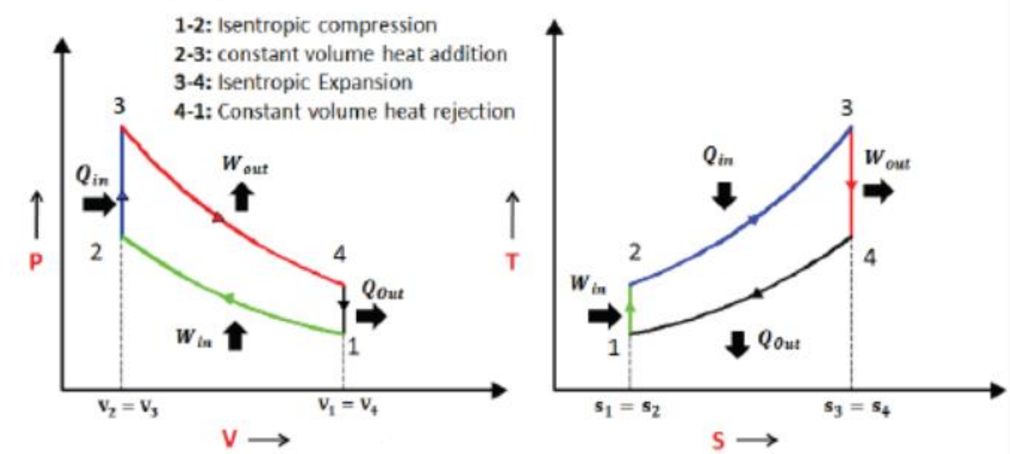
		 P-V Diagram T-S Diagram **Adiabatic process:**  P-V Diagram  T-S Diagram	**01**
	(ii)	**Explain the phases of formation of steam.**	
		Answer: (Explanation 2 Marks, Figure 2 Marks) **Different phases of Formation of steam** Consider formation of steam from ice at -200 C **i)Solid phase-** When the heat is added in ice which is at -20 0C, the temperature of ice increases to 00C as shown in figure by process A-B.in this stage solid phase exists. **ii) Solid+ Liquid phase-** The point B is called is saturation point when heat is further added this heat cannot increase the temperature but ice is converted into water that means phase transformation takes place, thus in-between region B-C, solid and liquid phase exists. **iii) Liquid phase**- From point further heat is added up to 1000 C, in this region no phase	**02**

		change takes place, there is only liquid phase present. **iv) Liquid+ Vapour phase**- Point is saturation point; further addition of heat will not increase the temperature but liquid phase change into vapors phase. In this region liquid and vapour is present. **v) Vapour phase**- Point is called as saturation point, further adding heat increase the temperature of steam which is called as superheating and in this region only vapour is present.  **Fig. Formation of steam**	**02**
	(iii)	**Describe the working of Turbojet Engine**	
		Turbojet Engine(Working 2 Marks, Figure 2 Marks)  Fig. Turbo-jet Engine OR	**02**

		 **Fig. Turbo-jet Engine** **Working** :Turbo-jet engine consists of diffuser, compressor, combustion chamber turbine and nozzle. At entrance air diffuser causes rise in pressure in entering air by slowing it down. A rotary compressor, which raises the pressure of air further to required value and delivers to the combustion chamber. The compressor is axial or radial type driven by turbine. In the combustion chamber, fuel is sprayed, as result of this combustion takes place at constant pressure and the temperature of air is raised. Then this product of combustion passes into the gas turbine gets expanded and provides necessary power to drive the compressor. The discharge nozzle in which expansion of gases is completed and thrust of propulsion is produced. The velocity in the nozzle is grater then flight velocity.	02
2		**Attempt any FOUR of the following:**	16
	a)	**Explain Otto cycle with P-V and T-S diagram.**	
		(Explanation 2 Marks, Figure 2 Marks) **P V and T S diagram of Otto cycle**  P-V and T-S Diagram of Otto Cycle This cycle is so named as it was conceived by 'Otto'. On this cycle, petrol, gas and many types of oil engines work. It is the standard of comparison for internal combustion engines. Figs. shows the theoretical p-V diagram and T-s diagrams of this cycle respectively. The point 1 represents that cylinder is full of air with volume V1, pressure p1 and absolute temperature T1. Line 1-2 represents the adiabatic compression of air due	02

		to which p1, V1 and T1 change to p2,V2 and T2, respectively. Line 2-3 shows the supply of heat to the air at constant volume so that p2 and T2 change to p3 and T3 (V3 being the same as V2). Line 3-4 represents the adiabatic expansion of the air. During expansion p3, V3 and T3 change to a final value of p4, V4 or V1 and T4, respectively. Line 4-1 shows the rejection of heat by air at constant volume till original state (point 1) reaches.	02
	b)	**Describe the different modes of heat transfer.**	
		Answer: Mode of heat transfer:- 1) Conduction 2) Convection 3) Radiation **1) Conduction-** It is the mode of heat transfer from one part of substance to another part of same substance or one substance to another without displacement of molecules or due to the vibrations of molecules. **Example-**Heat transfer in between metal rod. **2) Convection:** It is the mode of heat transfer from one part of substance to another part of same substance or one substance to another with displacement of molecules or due to the fluid flowing. **Example:** Heat flow from boiler shell to water. **3) Radiation:** It is the transfer of heat through space or matter. For Radiation there is no need of medium as like convection and conduction. It passes through vacuum in the form of electromagnetic waves. **Example:** The heat energy receives from sun to the earth surface.	01 01 01 01
	c)	**Draw neat and labeled sketch of three pass packages type boiler.**	
		Answer:(Explanation 2 Marks, Figure 2Marks) Each set of tubes that hot combustion flue gas travels through before making a turn within the boiler, is considered a "pass." A 3-pass fire tube boiler design consists of three sets of horizontal tubes, with the stack outlet located on the rear of the boiler. A downdraft design keeps the cooler water from having an effect on the hot surfaces within the boiler. A boiler with more passes provides more opportunities for hot gasses to transfer heat to the water in a boiler and operate more efficiently; however, boiler efficiency is highly affected by tube design, and not simply the number of passes. It is possible for a 3-pass boiler with a tube design that allows more heat transfer time to deliver the same or higher efficiency rating.	02

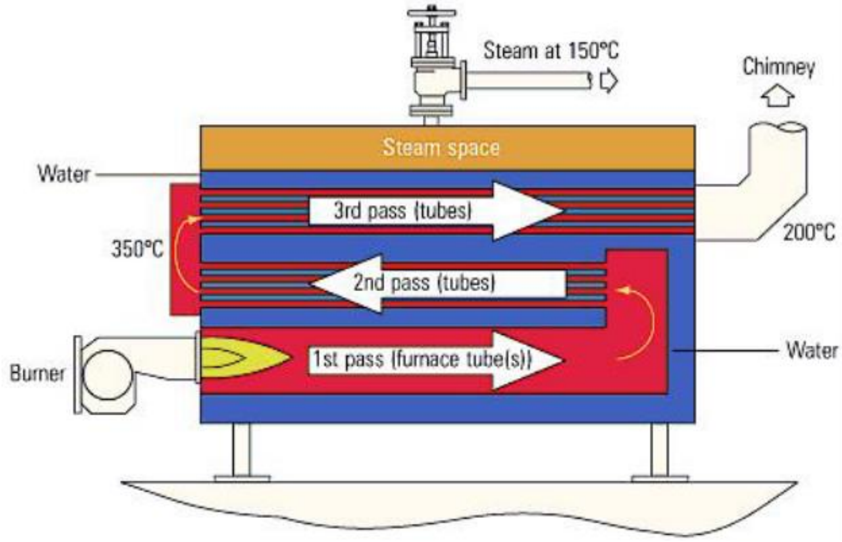
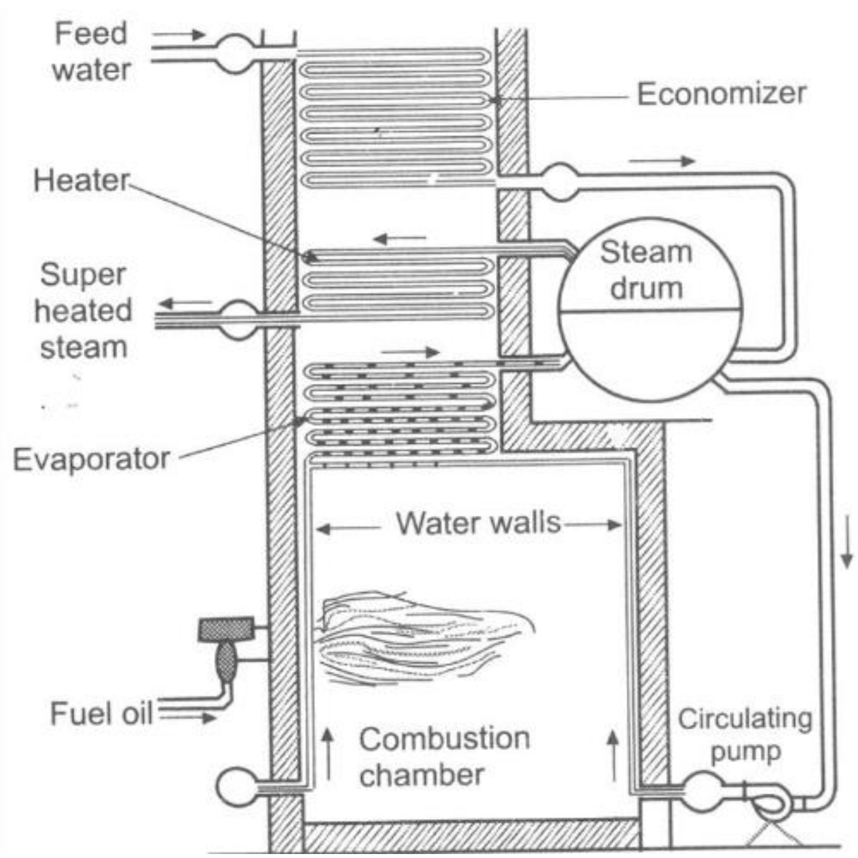


Fig. Three pass package boiler — 02

	d)	**Explain the working of La-mont boiler**	
		La-mont boiler: (Working 2 Marks, Figure 2 Marks)	**02**



Working: The La-mont boiler consists Boiler shell, combustion chamber, evaporator, economizer, circulating pump, super heater, and steam drum. This is modern high pressure boiler; it is water tube steam boiler working on forced circulation. Circulation is maintained by the centrifugal pump. The feed water passes through the economizer to the drum from which it is drawn to the circulating pump. The pump delivers the water to the evaporating section which in turn sends a mixture of steam and water to the drum. The steam in the drum is then drawn through the super heater. The superheated steam so — **02**

obtained is then supplied to the prime mover.

e) Explain the factors affecting volumetric efficiency of reciprocating air compressor.

Factors affecting volumetric efficiency of reciprocating air compressor:

1) Clearance Volume
2) Restricted passage and leakage at inlet valves
3) Speed of rotation
4) Piston ring leakages
5) If fresh air comes in contact with hot wall, it get expanded, which decreases the charge taken in therefore volumetric efficiency decreases.

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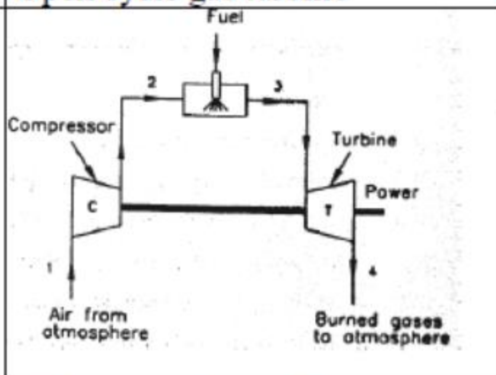
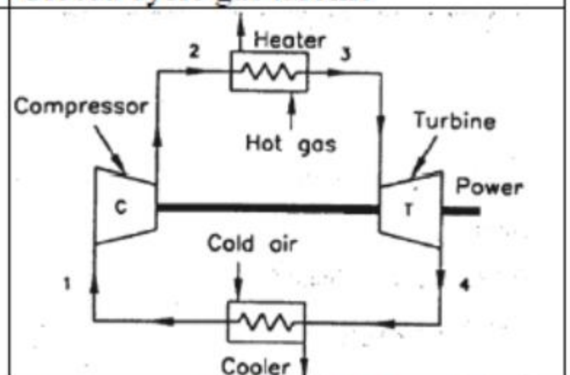
f) Differentiate between open cycle and closed cycle gas turbine.

Sr	Open cycle gas turbine	Closed cycle gas turbine
1.		
2.	Only air can be used as a working fluid.	Any type of working fluid with better thermodynamic properties can be used.
3.	Maintenance cost is low.	Maintenance cost is high.
4.	Working fluid replaced continuously.	Working fluid circulated continuously.
5.	Mass of installation per KW is less.	Mass of installation per KW is more
6.	Pure form of fuel should be used.	Any type of fuel is used.
7.	Heat exchanger is not used.	Heat exchanger is used.
8	The turbine blades wear away earlier as it gets contaminated with air.	It avoids erosion of turbine blade du to contaminated gases.
9	The exhaust gas from the turbine is exhausted to the atmosphere.	The exhaust gas from the turbine is passed into cooling chamber.
10	This system required less space.	This system required more space.
11	Since turbine exhaust is discharged into atmosphere, it is best suited for moving vehicle.	Since exhaust is cooled by circulatec water, it is best suited for stationary installation, marine use.

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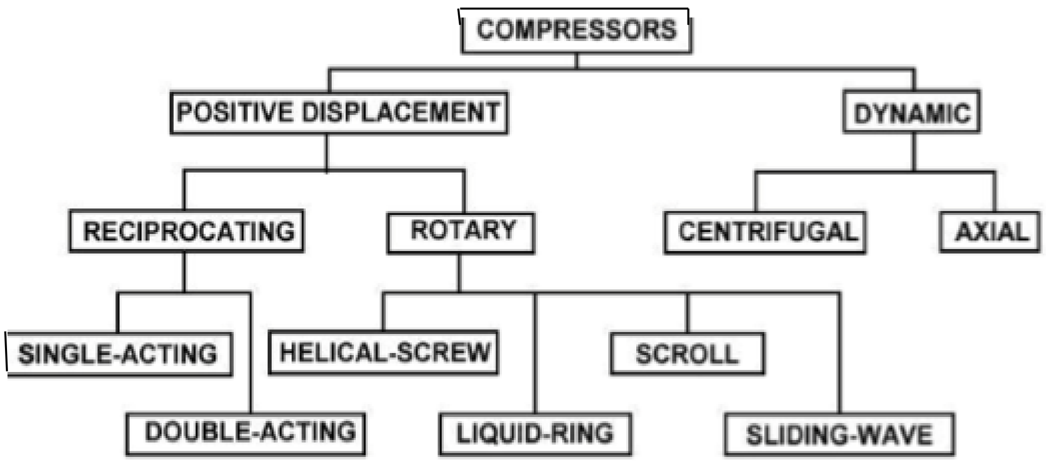
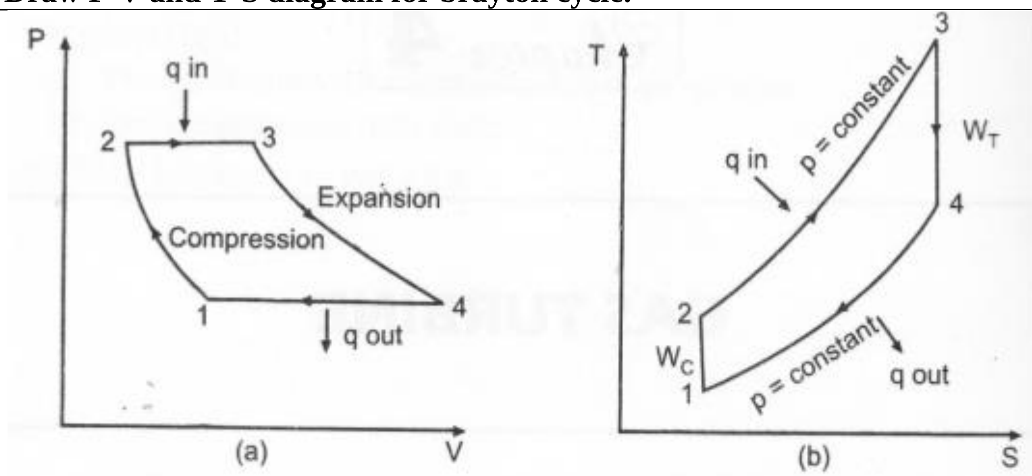
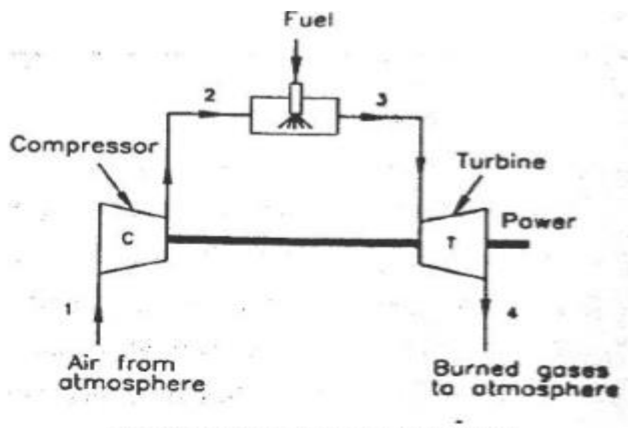
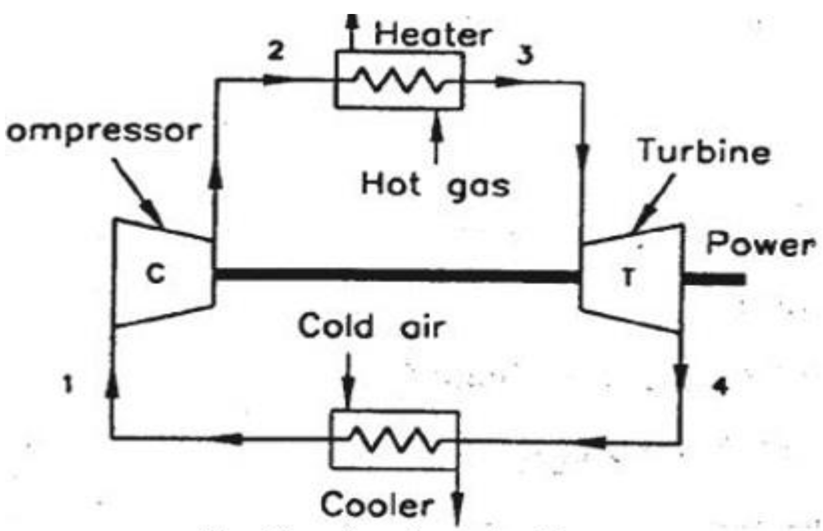
Any FOUR points

3.		**Attempt any FOUR of the following:**	**16**
	a)	**Give classification of air compressor.**	**04**
			**04**
	b)	**Draw P-V and T-S diagram for brayton cycle.**	**04**
		 **Fig. Brayton cycle on P-V and T-S diagram**	**02 mark for each dia.**
	c)	**Explain working of thermal power plant.**	
		Ans: Working of thermal power plant: **(Working 3 Marks, Figure 1 Marks)** In this power plant, coal is used as a fuel for combustion in combustion chamber. After combustion of fuel the heat is generated and this heat is given to the water in the boiler. Due to this heat, water start to boil and steam is generated. The generated steam is used to run the steam turbine. Turbine is mounted on the shaft which is coupled to the generator and electricity is produced. After passing the turbine, steam is supplied to the condenser and gets condensed by using cooling water and this condensate again used for the boiler with the help of feed pump.	**04**

	d)	**Draw and label the gas turbine power plant**	
		 **Fig. Open Cycle Gas Turbine** **OR**  **Fig. Closed cycle gas turbine**	**04**
	e)	**Compare liquid fuels with solid fuels.**	
		Any FOUR points	**1 mark each**

S.N.	Solid fuel	Liquid fuel
1	Require more space for storage.	Require less space for storage.
2	Lower calorific value	Higher calorific value
3	Difficult control of consumption	Easy control of consumption
4	ash produced	No ash produced
5	deterioration of the oil in storage	Non-deterioration of the oil in storage

	f)	**Explain combustion chemistry of carbon, hydrogen and methane.**	
		ANS: Combustion chemistry of carbon, methane and hydrogen: **i) Carbon:** Burning of carbon to carbon dioxide (complete combustion) $C + O_2 \rightleftarrows CO_2$ i.e. $12 + (16\times 2) = 12 + 16\times 2$ i.e. $12 + 32 = 44$ $1 + 2.67 = 3.67$ That means 1 kg of carbon needs 2.67 kg oxygen and produces 3.67 kg of carbon dioxide. **ii) Methane (CH4):** Burning of methane with oxygen to carbon dioxide and water/ steam $CH_4 + 2O_2 \rightleftarrows CO_2 + 2H_2O$ i.e. $(12 + 1\times 4) + 2(16\times 2) = (12 + 16\times 2) + 2(1\times 2 + 16)$ $16 + 64 = 44 + 36$ $1 + 4 = \frac{11}{4} + \frac{9}{4}$ That means 1 kg of methane needs 4 kg of oxygen to produce 11/4 kg of carbon dioxide and 9/4 kg of water /steam **iii) Hydrogen:** The union of hydrogen with oxygen produces steam it is represented by the following equitation $2H_2 + O_2 = 2H_2O$ $2(1\times 2) + (16\times 2) = 2(1\times 2 + 16)$ $1 + 8 = 9$ 1 kg of hydrogen combines with 8 kg of oxygen to produce 9 kg of steam.	**01** **02** **01**

4.		**Attempt any TWO of the following:**	**16**
	a)	**Compare conventional and non-conventional energy sources.**	**08**

Sr. No.	conventional source of energy	Non-conventional source of energy
1	These are non-renewable energy sources	These are renewable energy sources
2	Creates pollution	Does not creates pollution
3	It is not clean energy source	It is clean energy source
4	Harnessing cost is more	Harnessing cost is less
5	Efficiency is more	Efficiency is less
6	Fuel is required	Fuel is not required
7	Exhaustible energy source	Non-Exhaustible energy source
8	Affects on ozone layer	Does not affects on ozone layer
9	Ex.-Petrol, Diesel, Kerosene etc.	Ex.-Solar, Wind, Tidal, Geothermal, Biomass, Etc.

(8 points 1 mark each)

b) A coal has the following combination of mass C=90%, H_2=3% O2=2%, S=1%,N2=2% and remaining is ash. Find HCV and LCV of the fuel.

Ans: Given data Carbon C=90%=0.90
Hydrogen =H_2=3%=0.03
Oxygen=O_2=2%=0.02
Nitrogen=N_2=2%=0.02
Sulphur=S=1%=0.01
Ash=2%=0.02

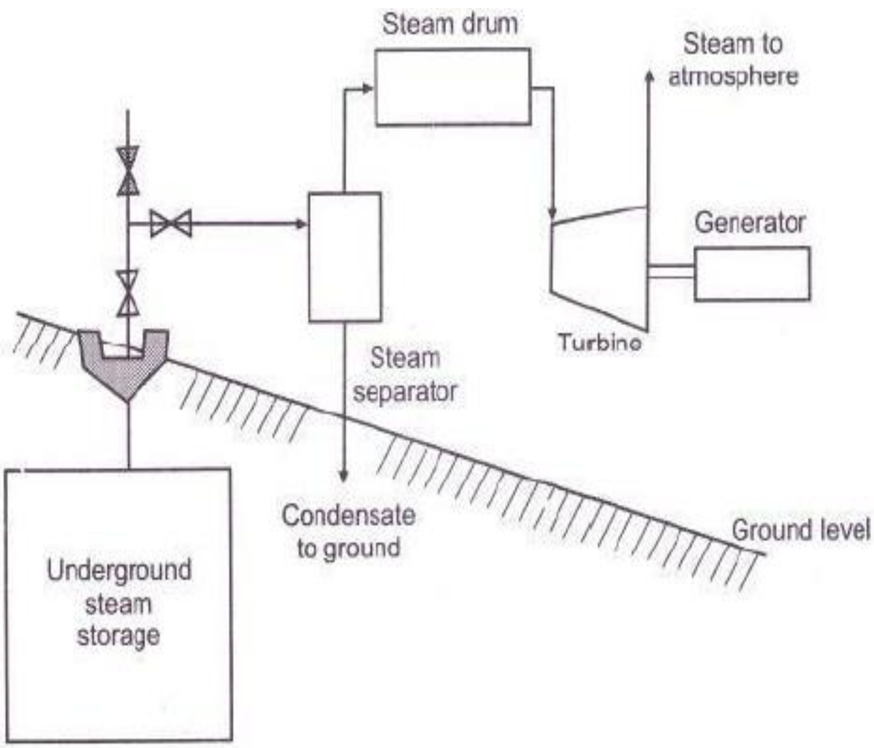
Dulong's formula: H.C.V. of coal — **04**
=33800C+144500(H_2-O_2/8)+9300S KJ/Kg
=33800*0.90+144500(0.03-0.02/8)+9300*0.01 KJ/Kg
=34486.75 KJ/Kg

L.C.V of coal
=HCV – 9H_2*2442 KJ/Kg — **04**
=34486.76-9*0.03*2442
=33827.41 KJ/Kg

c) (i) Explain construction and working of geothermal power plant.
(ii) Explain the construction and working of bomb calorimeter.

ANE:(i)Geothermal power plant: : — **04**
(Construction 1 Marks, Working 2 Marks, Figure 1 Marks)
Construction and Working: geothermal power plant which consists of the following main components: Underground steam storage, steam separator, steam separator, turbine and Generator. Steam is present in the earth crust at 10 km depth is about 2000 C. It is stored in the underground steam storage tank.
This steam is taken out through pipe and valve and passed through steam separator. In steam separator moisture content in the steam is taken out and dry steam is allowed to pass in steam drum where steam is stored. The moisture content in steam is then injected into the ground. As per requirement steam is passed over the turbine and kinetic energy of steam is converted into mechanical work. Turbine is connected to the generator by shaft which generates power. Mechanical energy of shaft is converted in to electrical

energy by generator.



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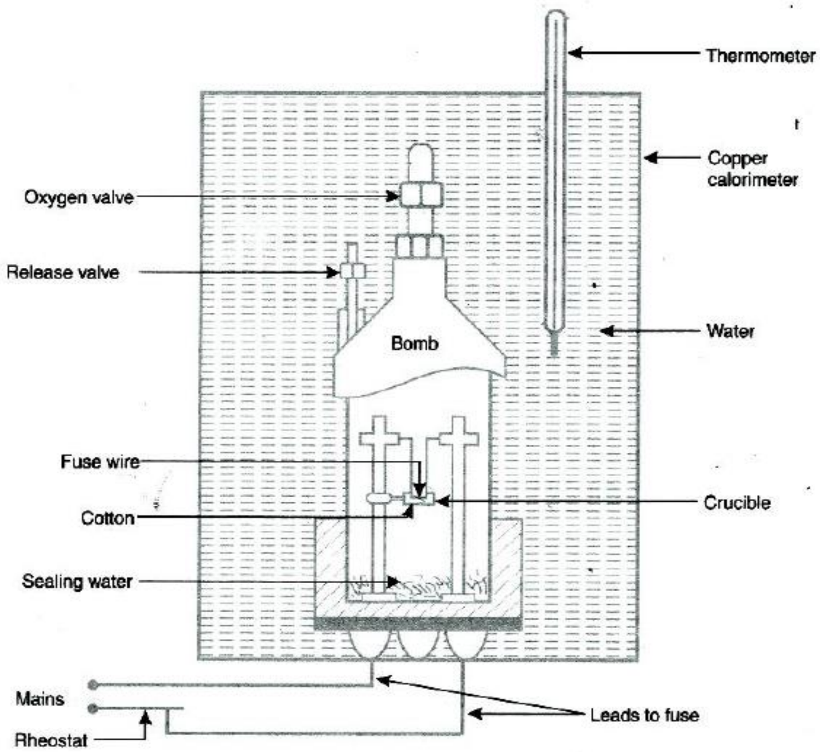
(ii) Bomb calorimeter: (Note: Construction: 2 marks Working: 2 marks,)

The calorific valve of solid and liquid fuels is determined in the laboratory by „Bomb calorimeter". It is so named shape resembles that of bomb .Fig shows the schematic sketch of bomb calorimeter.

Construction and Working: The calorimeter is made of austenitic steel which provides considerable resistant to corrosion and enables it to withstand high pressure. In the calorimeter use of a strong cylindrical bomb in which combustion occurs. The bomb has two values at the top.

One supplies oxygen to the bomb and other releases the exhaust gases. A crucible in which a weighed quantity of fuel sample is burnt is arranged between the two electrodes as shown in fig. The calorimeter is fitted with water jacket which surrounds the bomb To reduce the losses due to radiation calorimeter is further provided with a jacket of water and air. A stirrer for keeping the temperature of water uniform and a thermometer the temperature up to accuracy of 0.0010 C is fitted through the lid of the calorimeter. The heat released by the fuel on combustion is absorbed by the surrounding water and the calorimeter. From the above data the calorific value of the fuel can be found.



5.		**Attempt any TWO of the following:**	**16**
	a)	**Derive relation between P, V and T for adiabatic process.**	
		Pressure (P) , Volume (V) & Temperature (T) relation for adiabatic process:	

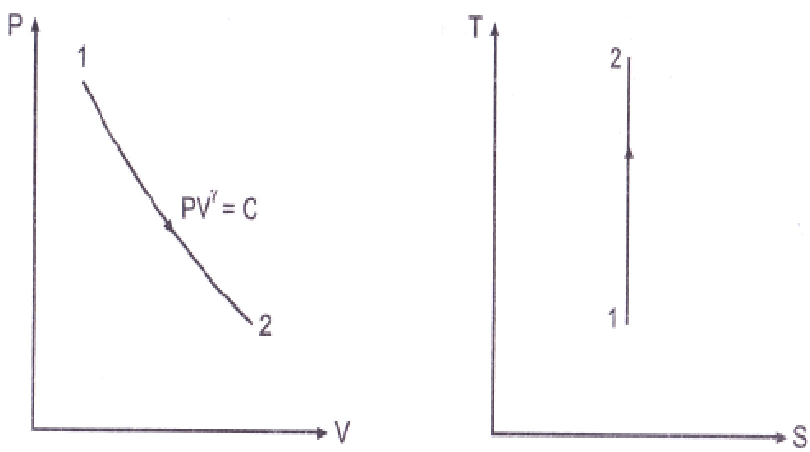


Figure: adiabatic process

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		$PV^{\gamma} = C$ $P_1 v_1^{\gamma} = P_2 v_2^{\gamma}$ $\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma}$ …………… (1) From general gas equation $\frac{PV}{T} = C$ $\frac{T_2}{T_1} = \frac{P_2 V_2}{P_1 V_1}$ ……………..(2) From (1) $\frac{V_2}{V_1} = (\frac{P_1}{P_2})^{1/\gamma}$……………… (3)	**02** **02** **02**

		Put equation (3) into equation (2) $\frac{T_2}{T_1} = \frac{P_2}{P_1}\left(\frac{P_1}{P_2}\right)^{1/\gamma}$ $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$ $\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma}{\gamma-1}}$ ....(4) From equation (1) & (4) $\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma}{\gamma-1}}$ $\boxed{\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma}{\gamma-1}}}$	01
	b)	**Explain two pass down flow surface condenser with a neat sketch.**	
		Two pass down flow surface condenser: :(Explanation 4 Marks, Figure 4 Marks) It consists of horizontal cast iron cylindrical vessel pack with tubes, through which the cooling water flows. The ends of the condenser are cut off by vertical perforated type plates in to which water tubes are fixed. This is done in such a manner that the leakage of water in to the center condensing space is prevented. The water tubes pass horizontally through the main condensing space for the steam. The steam enters at the top & is forced to flow downwards over the tubes due to the suction of the extraction pump at the bottom. The cooling water flows in one direction through lower half of the tubes & return in opposite direction through the upper half as shown in figure. The main advantage of surface condenser is condensate does not mix with cooling water which is used for cooling steam & convert into water; therefore whole condensate can be the reused in the boiler.	04

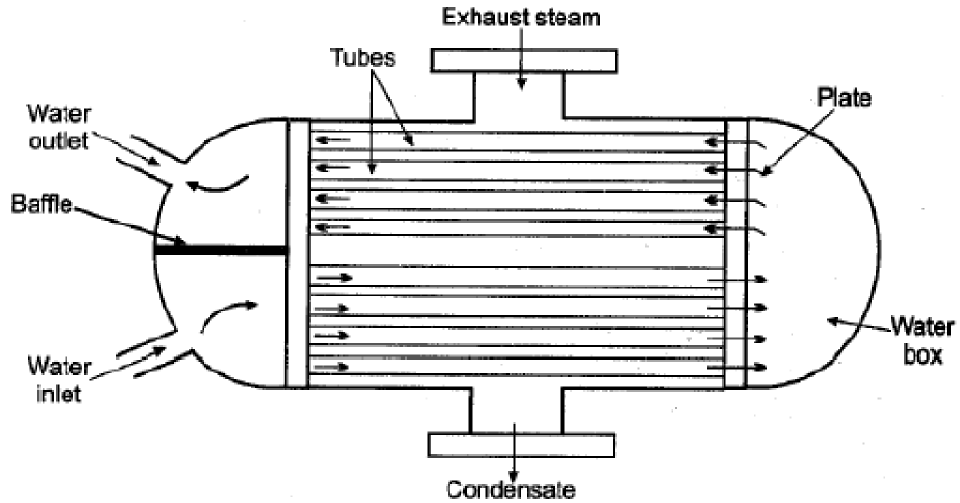

Fig. Two pass down flow surface condenser

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c) **Differentiate between :**

(i) Reciprocating and rotary air compressor

(ii) Centrifugal and axial flow compressor

(i) Reciprocating and rotary air compressor: (Any Four pts)

Sr. No.	Reciprocating air compressor	Rotary air compressor
1	It is having to and fro motion.	It is having rotary motion
2	Air supply is intermittent.	Air supply is continuous.
3	Lubrication system is complicated.	Lubrication system is simple.
4	Maximum delivery pressure is upto 1000 bar.	Maximum delivery pressure is upto 10 bar.
5	Maximum free discharge is about 300 m3/min.	Maximum free discharge is about 3000 m3/min
6	Speed is lesser	Speed is higher
7	Balancing is major problem	No balancing problem
8	Frictional losses are more	Frictional losses are less
9	Size of compressor is large for the given discharge	Size of compressor is small for the given discharge
10	It is suitable for low discharge and high pressure	It is suitable for high discharge and low pressure
11	Application- Auto workshop, service stations, air brake system etc.	Application- Torbocharger, supercharger, Blower, Hair Drier etc.

04

(ii) Centrifugal and axial flow compressor:(Any Four pts)

Sr. No	Centrifugal compressor	Axial Flow Compressor
1	Flow is perpendicular to axis of compressor.	Flow of air is parallel to the axis of compressor.
2	Low manufacturing and running cost.	High manufacturing and running cost.
3	Requires low starting torque.	Requires high starting torque.
4	Not suitable for multi-staging.	Suitable for multi-staging.
5	Requires large frontal area for given rate of flow.	Requires less frontal area for given rate of flow.
6	Pressure ratio per stage is4:1.	Pressure ratio is 1.1 to 1.2

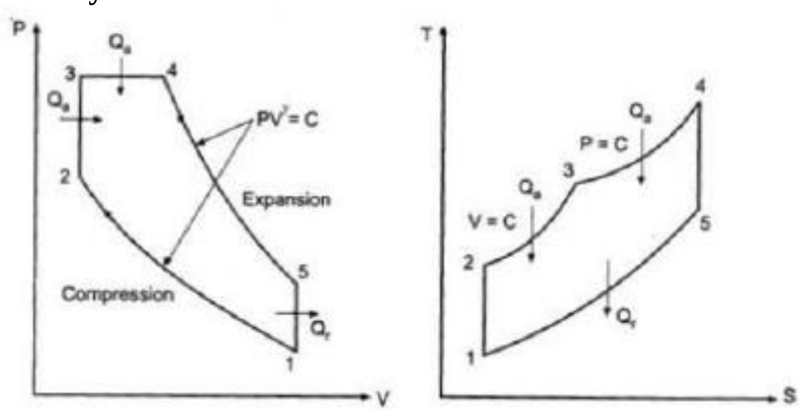
04

7	Isentropic efficiency is 70%	Isentropic efficiency is 80%
8	Used in supercharging I.C. engine and for refrigerants and industrial gases.	Used universally with large gas turbine.

6. **Attempt any FOUR of the following:** **16**

a) **Draw P-V and T-S diagram of dual combustion cycle.**

Dual combustion cycle:



02

1-2 Isentropic compression of air
2-3 the combustion of fuel at constant volume.
3-4 the combustion of fuel at constant pressure
4-5 Isentropic expansion during which work is done by the system.
5-1 Heat rejection at constant volume.

02

b) **Explain the sources of air leakage in condenser.**

Sources of air leakage in condenser

1. Air leak through joints and packing. Air leaks into condenser as pressure inside falls below atmospheric pressure.
2. Air also comes in condenser with the steam. The feed water supplied to the boiler contains certain amount of air dissolved in it. The dissolved air gets liberated when steam is formed and is carried with the steam into the condenser.
3. In jet condensers dissolved air in the cooling water enters the condenser. The dissolved air gets separated at low pressure in the condenser
4. Air leaks if any bypass seal is broken.

04

c) **State necessity of multistaging and Intercooling of air compressor.**

Necessity of multistaging –

For producing high pressure i.e. more than 8 bar, single stage air compressor suffers fallowing drawbacks-
i) Size of cylinder is too large
ii) Rise in temperature of air is very high.
To avoid this difficulty multi-staging is necessary.

02

Necessity of intercooling –

In two stage air compressor air is compressed in first cylinder and the temperature of air is increased. If this high temperature air is not passed through intercooler and sent directly to second stage then because of high temperature volume of air increases so amount of air taken inside decreases and pressure is also automatically decreased and volumetric efficiency is also decreases. To avoid this intercooling is necessary.

02

d) Explain the construction and working of Turbo-prop engine.

Turboprop Engine: :(Explanation 2 Marks, Figure 2Marks)

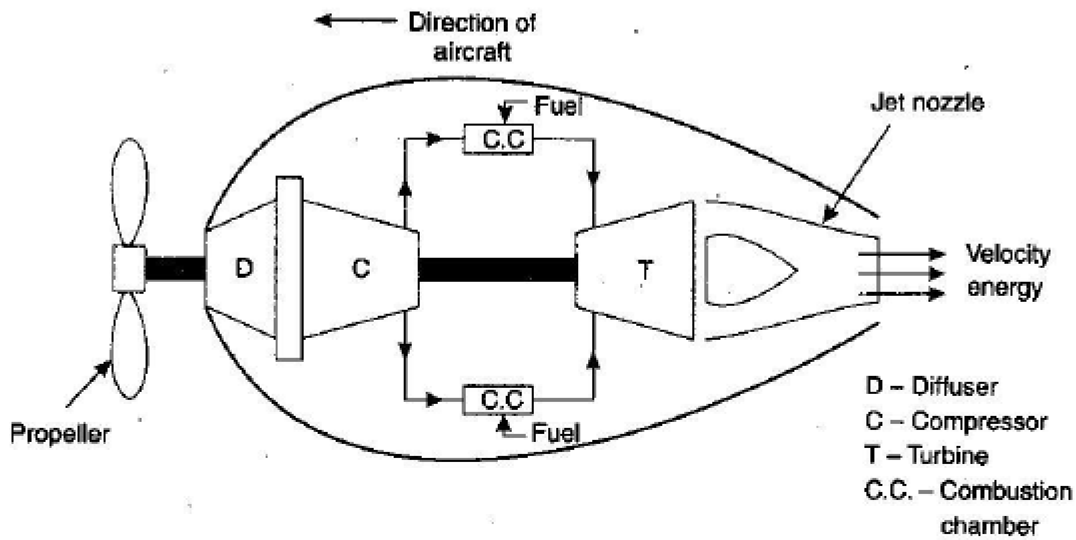


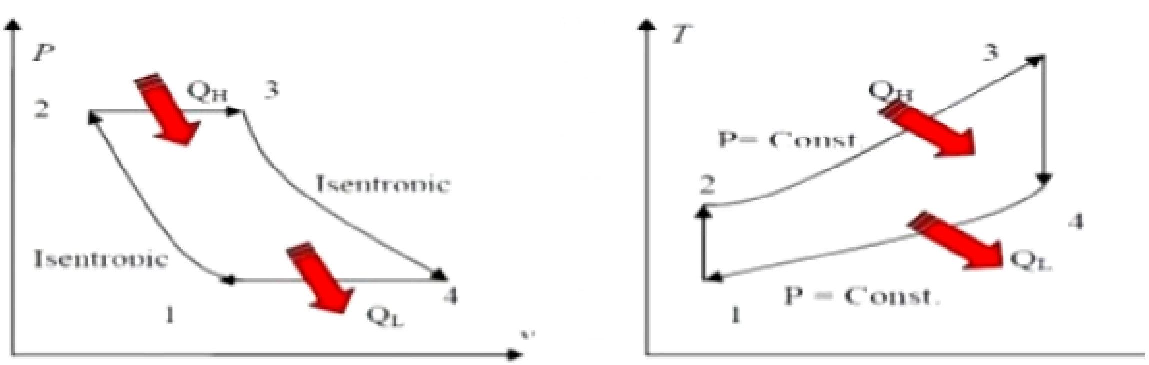
Figure: Turbo- Prop Engine — 02

Construction and working:

It consists of diffuser, compressor, combustion chamber, turbine, nozzle and propeller. — 02

Figure shows a turboprop system employed in aircrafts. Here the expansion of gases takes place partly in turbine 80% and partly 20% in the nozzle. The power developed by the turbine is consumed in running the compressor and the propeller. The propeller and jet produced by the nozzle give forward motion to the aircraft. The overall efficiency of the turbo prop is improved by providing the diffuser before the compressor as shown. The pressure rise takes place in the diffuser. This pressure rise take due to conversion of kinetic energy of the incoming air (equal to aircraft velocity) into pressure energy by diffuser.

e) Describe construction and working of closed cycled gas turbine.



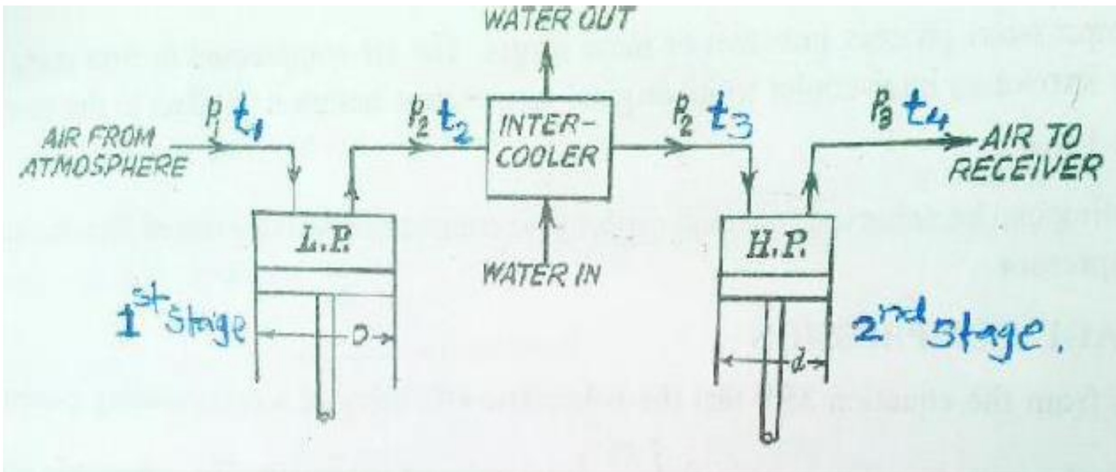
PV and TS Diagram for Closed cycle gas turbine — 02

Construction:

In above figure shows a closed cycle gas turbine which consists of compressor, heating chamber gas turbine which drives the generator, compressor and a cooling chamber.

Working : — 02

In this turbine air is compressed isentropically and then passed into heating chamber. The compressed air is heated with the help of some external source and made to flow

		over turbine blades. The gas while flowing over the blades gets expand from the turbine gas is passed to cooling chamber where it is cooled at constant pressure with the help of circulating air is circulated through compressor. **(Explanation 2 Marks, Figure 2Marks)**	
	f)	**Explain construction and working of two stage reciprocating air compressors.**	
		Ans:(Explanation 2 Marks, Figure 2Marks)  **Figure: Two Stage Reciprocating air compressor** **Construction and Working :** It consists of two cylinders (L.P. and H.P.) with water cooled intercooler and air receiver. First of all fresh air is sucked from atmosphere in low pressure (L.P) cylinder during its suction stroke at inlet pressure P1 and temp T1.The air after compression in L,P cylinder (I st stage) from 1 to 2 is delivered to intercooler at pressure P2 and temp T2.Now air is cooled in intercooler from 2 to3 at constant pressure P2 and from temp T2 to T3.After that air is sucked in high pressure (H.P) cylinder during its suction stroke. Finally air after further compression in H.P. cylinder (ie second stage) from 3 to 4 is delivered by the compressor at pressure P3 & Temp T4.	**02** **02**