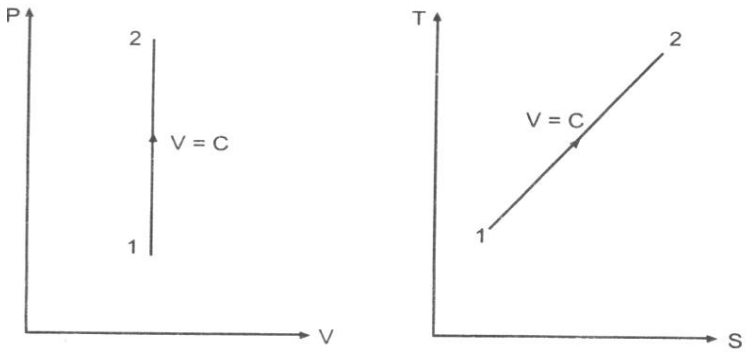
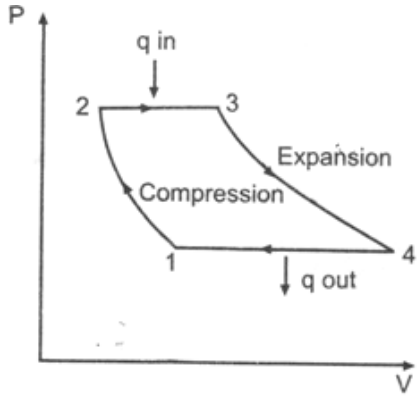
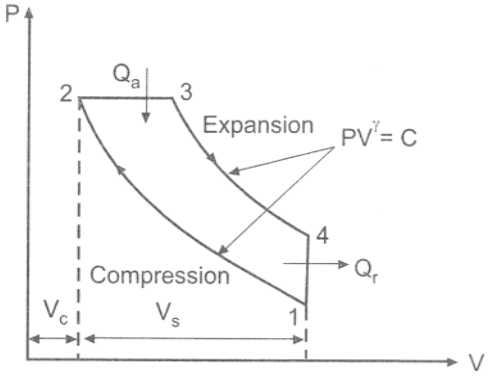
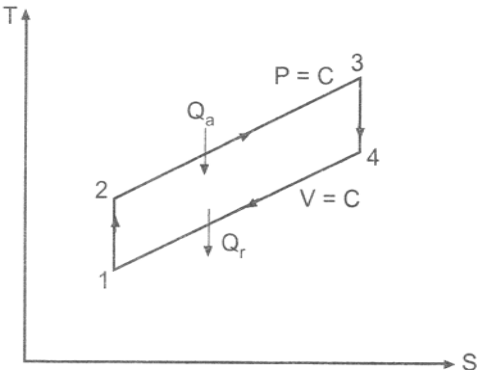
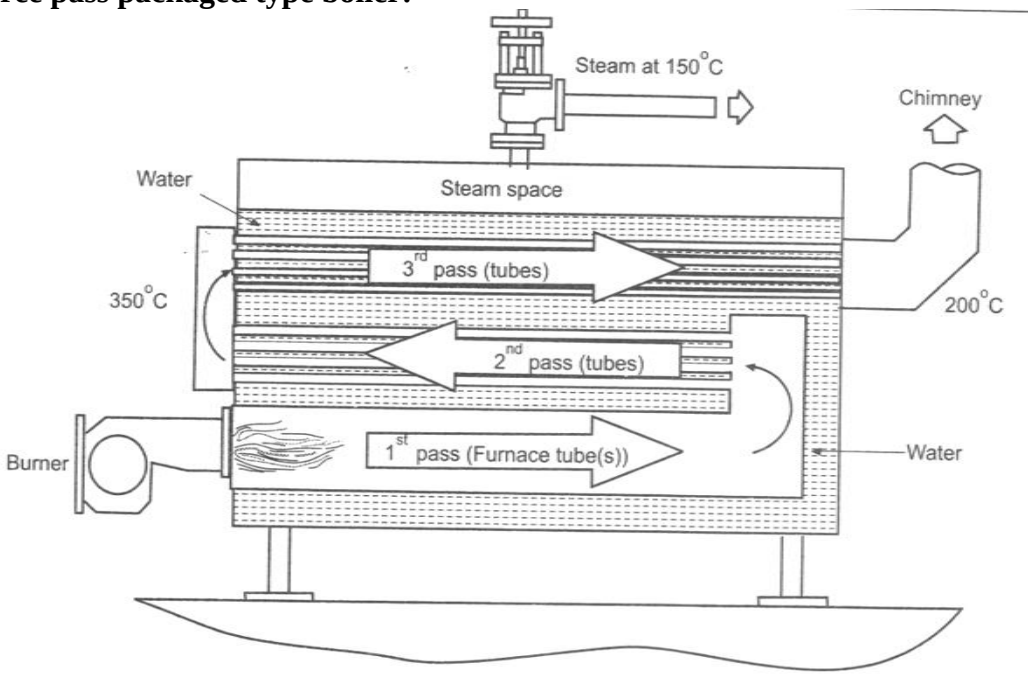
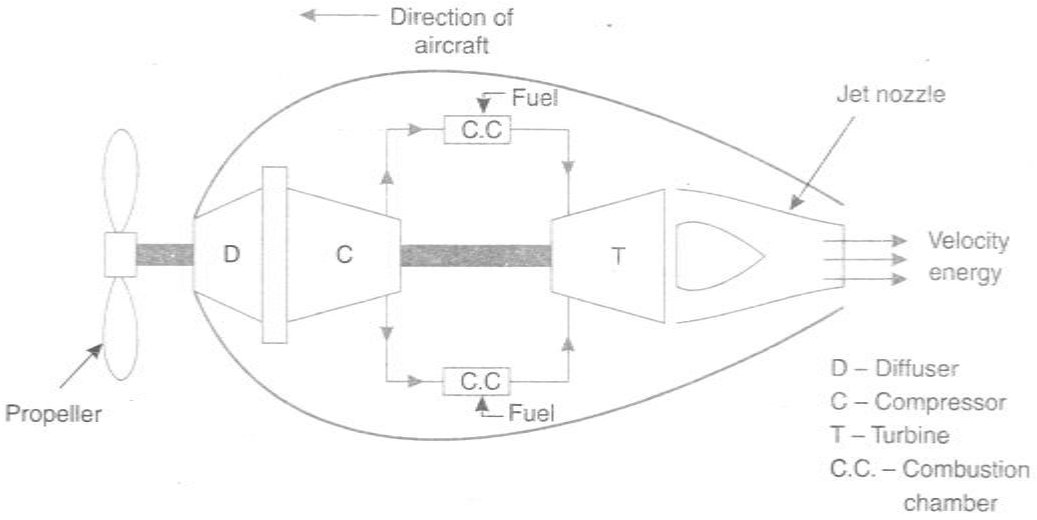
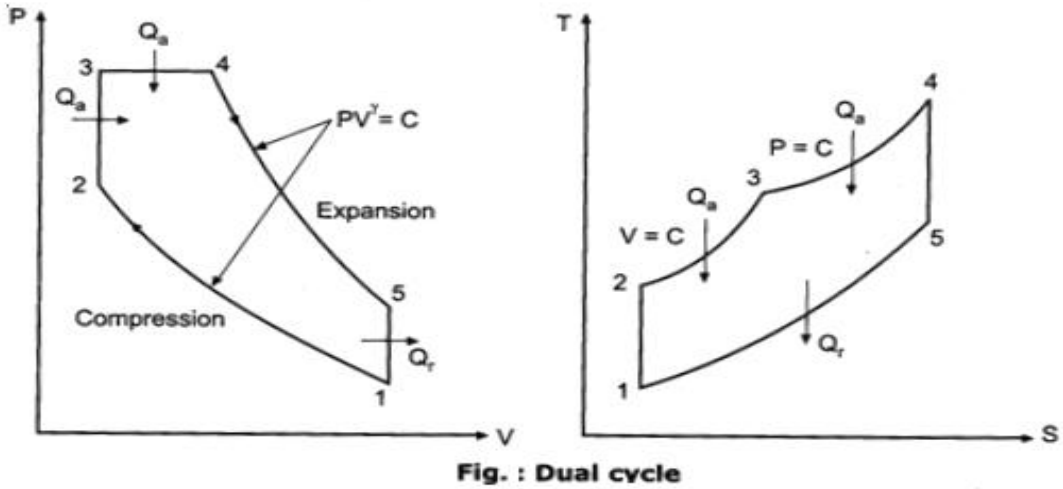
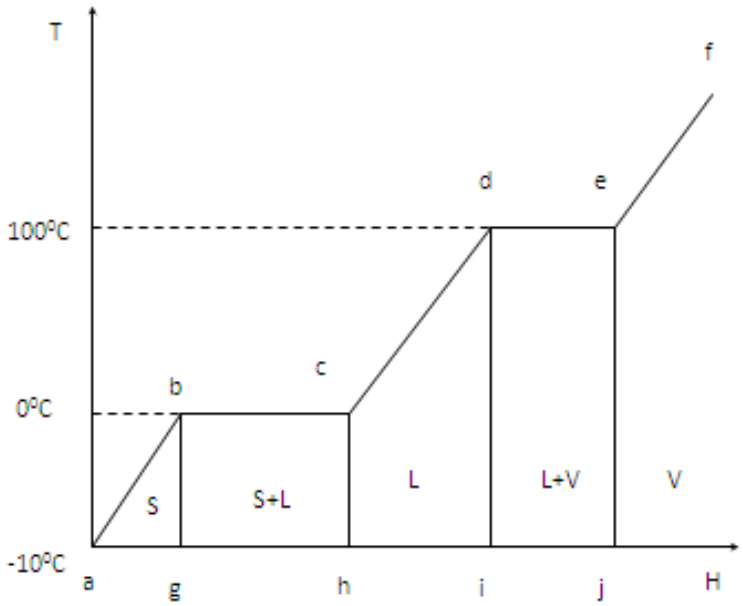
Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language 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.

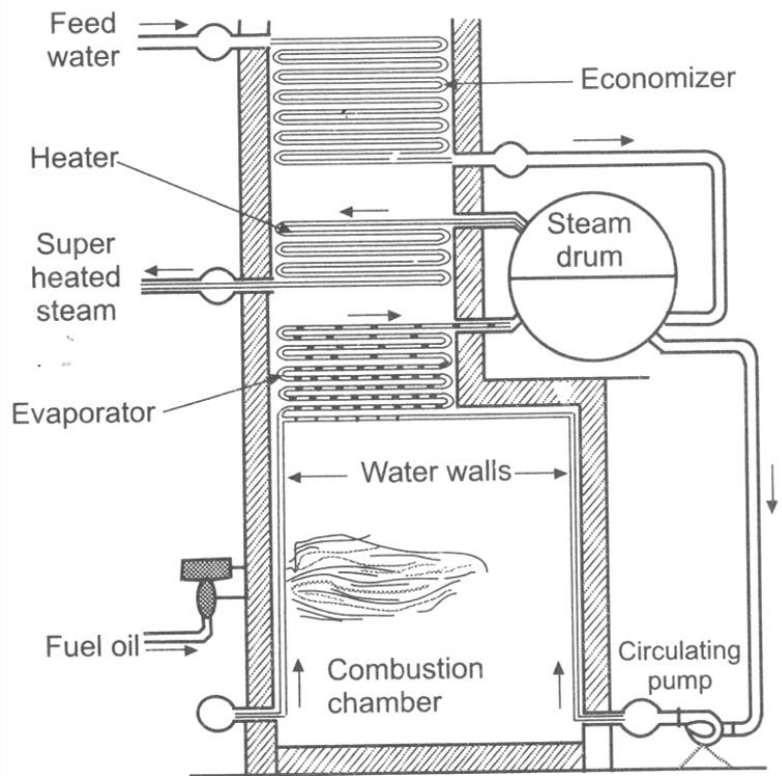
	Marks
1. a) Attempt any SIX of the following-	12
i) Plot P-V and T-S diagrams for Isochoric process.	02
Answer : Isochoric Process:  P-V Diagram T-S Diagram	02
ii) Define – Sensible heat and Latent heat.	02
Answer: **Sensible heat**: It is defined as the quantity of heat which can be sensed by the thermometer. OR The amount of heat added up to saturation temperature is called sensible heat. **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.	01 01
iii)Define overall isothermal efficiency of air compressor. Give mathematical expression for it.	02
Answer: Overall isothermal efficiency of air compressor: It is the ratio of the isothermal power to the shaft power or brake power of the motor or engine to drive the compressor. $\eta_o = \frac{\text{Isothermal Power}}{\text{Shaft or Brake Power}}$	01 01

iv) State two applications of compressed air in automobile workshop.	02
Answer: Application of compressed air: *(Any two)* 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	02
v) Draw P-V diagram of Brayton cycle.	02
Answer:  Fig. Brayton cycle P-V diagram	02
vi) List two conventional and two non- conventional sources of energy.	02
Answer: Conventional sources of energy: *(Any two)* i) Petrol ii) Diesel iii) Kerosene iv) Oil **Non-conventional sources of energy:** *(Any two)* i) Solar energy ii) Wind energy iii) Geothermal energy iv) Tidal energy v) Biomass	01 01
vii) What is meant by calorific value of fuel ? State its unit**.**	02
Answer: Calorific value of fuel: It is defined as the amount of heat liberated during complete combustion of 1 kg of fuel. **Unit:** It is expressed in terms of KJ/kg.	01 01
viii) State function of condenser in steam power plant.	02
Answer: Function of condenser in steam power plant: 1. To condense the steam coming out from turbine after doing work in steam power plant. 2. It also maintains low pressure for securing high efficiency. 3. To supply pure feed water to the hot well from where it is pumped back to the boiler.	02

b) Attempt any TWO of the following:	08
i) Represent the diesel cycle on P-V and T-S diagram. Define cut-off ratio and compression ratio.	04
Answer: Diesel cycle on P-V and T-S diagram: (*Note: P-V and T-S diagram with notation - 1 mark each, Definition -1 mark each.)*  P - V diagram  T-S diagram **Cut-Off ratio:** During the process 2-3 heat added at constant pressure. During this addition of heat let volume increases from V_2 to V_3 and temperature T_2 to T_3, corresponding to point 3. This point (3) is called as point of Cut-off. i.e. Cut-Off ratio = $\frac{V_3}{V_2}$ **Compression ratio:** It is defined as the ratio of total volume to clearance volume. **i.e** Compression ratio = $\frac{V_1}{V_2}$	02 01 01
ii) Draw a neat labeled sketch of three pass packaged type boiler.	04
Answer: Three pass packaged type boiler:  Fig. Three pass packaged type boiler	04

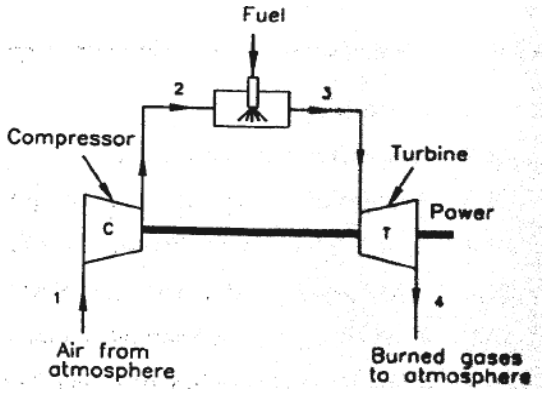
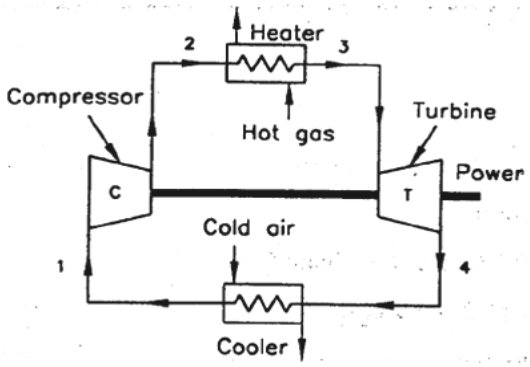
iii) Describe working of turboprop engine.	04
Answer: Turboprop engine: (*Note: Working: 2 marks and Diagram: 2 marks.)*  Fig : Turbo Prop Engine **Working:** Figure shows a turboprop system employed in aircrafts. Here the expansion of gases takes place partly in turbine 80% and partly 20% in the nozzle. 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 turboprop entails the advantages of turbojet (i.e. low specific weight and simplicity in design) and propeller (i.e. high power for takeoff and high propulsion efficiency at speeds below 600km/h). 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. This type of compression is known as "ram effect".	02 02
2. Attempt any FOUR of the following	16
a) Represent dual cycle on P-V and T-S diagram and clearly indicate the process in it.	04
Answer : Dual Cycle: P-V and T-S diagram  **Fig. : Dual cycle**	04

b) Explain conduction and convection with suitable examples.	04
Answer : **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 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.	1 1 1 1
c) Describe phases of steam formation.	04
Answer: (*Note: Description:2 marks and Diagram:2 marks.)* **Different phases of Formation of steam-** Consider formation of steam from ice at -10^0 C **i) Solid phase-** When the heat is added in ice which is at -10^0 C, the temperature of ice increases to 0^0 C 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 c-further heat is added up to 1000 C, in this region no phase change takes place, there is only liquid phase present. **iv) Liquid+ Vapour phase-** Point d is saturation point; further addition of heat will not increase the temperature but liquid phase change into vapors phase. In this region only liquid and vapour is present. **v) Vapour phase**- Point e 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 02

d) Describe construction and working of La-mont boiler.	04
Answer: La-Mont Boiler:  Fig : La-Mont Boiler *(Note: Credit should be given to relevant figure)* **Construction and 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 obtained is then supplied to the prime mover.	02 02
e) What are the factors affecting volumetric efficiency of air compressor?	04
Answer: Factors affecting volumetric efficiency of reciprocating air compressor: *(Any 4 points)* 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.	04

f) Differentiate between open and closed cycle gas turbines. 04

Answer: Difference between open cycle and closed cycle gas turbine: *(Any 4 points)* 04

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 due 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 circulated water, it is best suited for stationary installation, marine use.

3. Attempt any FOUR of the following: 16

a) Explain working principal of single stage reciprocating air compressor. 04

Answer: Single stage reciprocating air compressor: (*Note: Working: 2 marks,Diagram:2 marks.)*

A reciprocating compressor consists of a cylinder, piston, inlet and outlet valves. The arrangement of compressor is shown in figure. During downward motion of piston, the pressure inside the cylinder falls below the atmospheric pressure and inlet valve is opened due to the pressure difference. The air is taken into the cylinder until the piston reaches bottom dead centre position.

As the piston starts moving upwards, the inlet valve closed and pressure starts increasing continuously until the pressure inside the cylinder is above the pressure of the delivery side which is connected to the receiver. At the end of delivery stroke small volume of high pressure air is left in the clearance space. The high pressure air left in the clearance space expands as the piston starts moving downwards and pressure of air falls until it is just below the atmospheric pressure. The inlet valve opens as the pressure inside the cylinder falls below the atmospheric pressure and the air from outside is taken in and the cycle is repeated. 02

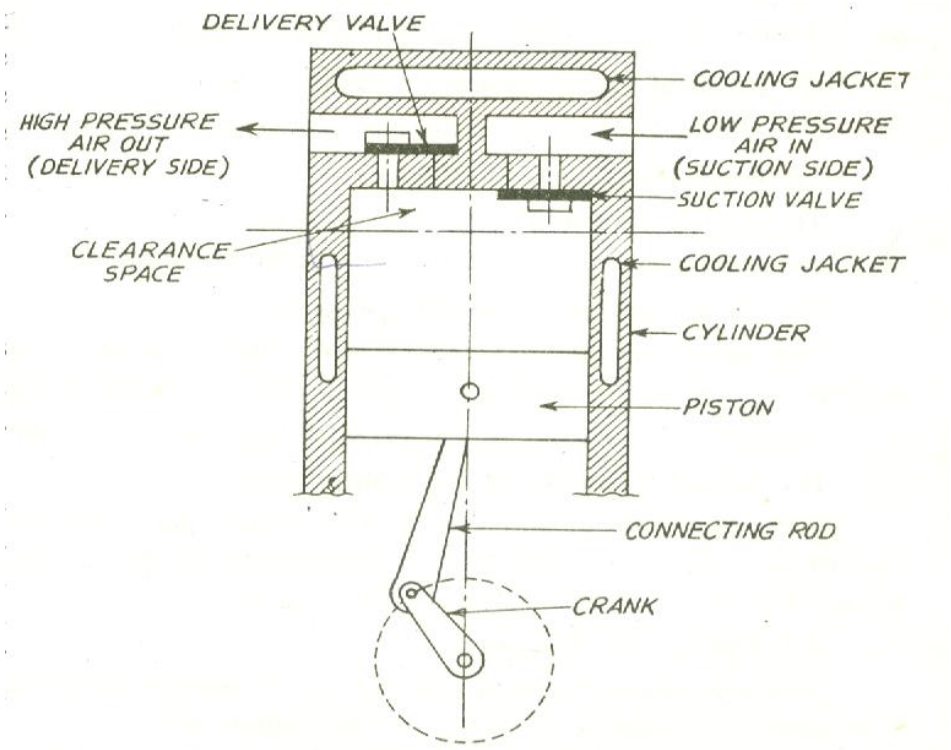


Figure: Single Stage Reciprocating Compressor — 02

b) Give classification of gas turbines. — 04

Answer: Classification of gas turbine: (*Note: Any four points.)* — 04

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

c) Draw a neat sketch of thermal power plant.	04
Answer: Thermal power plant: (*Note: Credit should be given to relevant figure)*	04

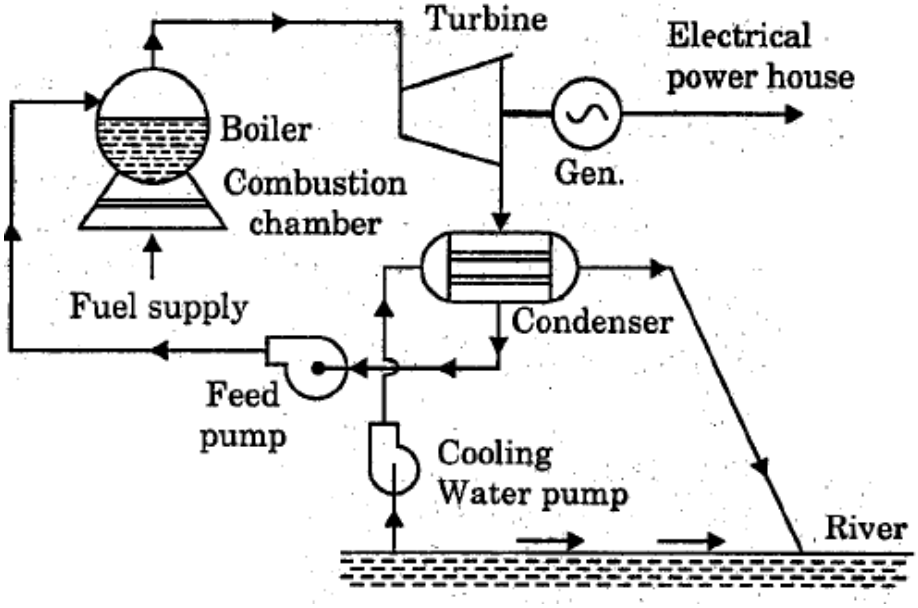


Fig : Thermal Power Plant

OR

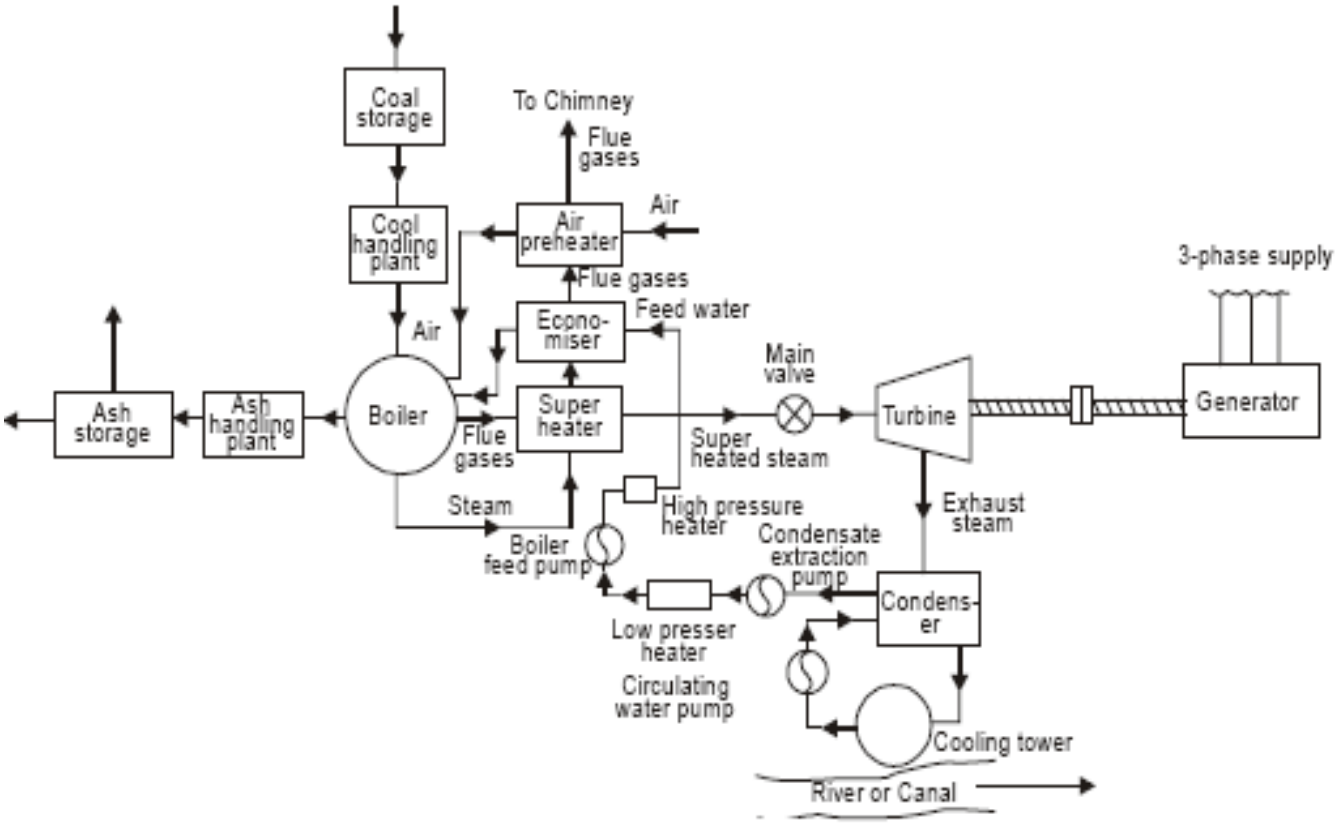
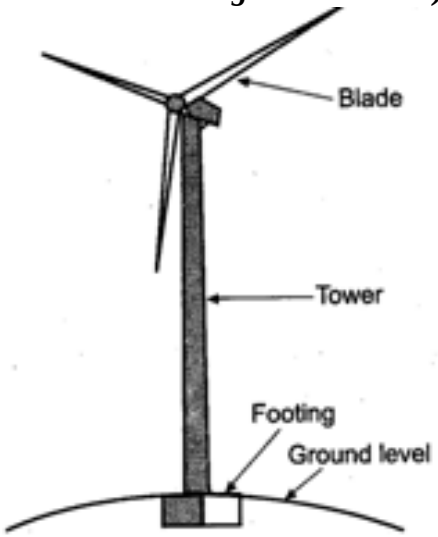
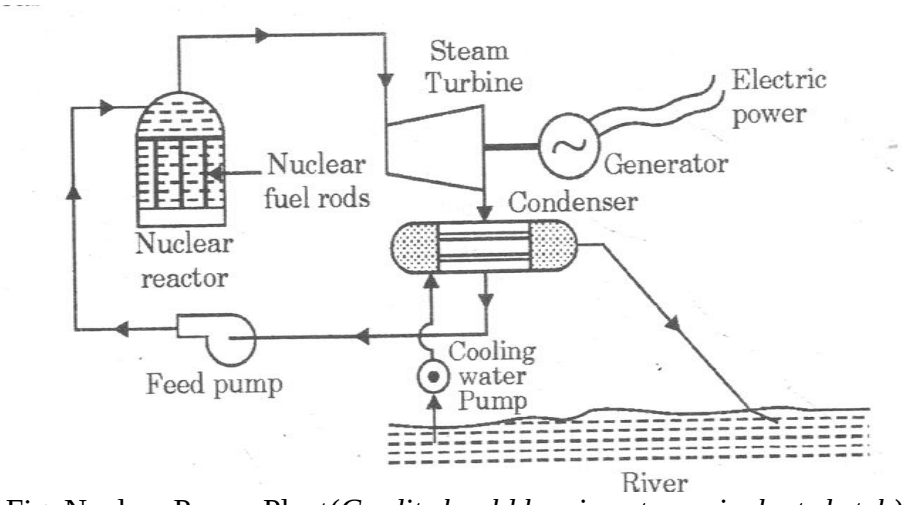


Figure: Thermal Power Plant

d)Describe working of wind mill.	04
Answer: Wind mill: (*Note: Working: 2 marks and Diagram: 2 marks.)*  Fig. Wind Mill **Working:** Fig. shows wind mill. It consists of main parts such as blades, tower, generator and gear box. Wind flows due to the pressure difference in atmosphere. This pressure difference cause due to solar energy. Blades are started to rotate due to velocity of wind. The kinetic energy of wind is converted into the mechanical energy. This mechanical energy is converted into electrical energy by using generator. This generator is connected to blade by shaft through gear box. For power generation by using wind mill wind speed of 8 m/s is required.	02 02
e) Write four advantages of liquid fuels over gaseous fuels used in boilers.	04
Answer: Advantages of liquid fuels over gaseous fuels used in boilers: (*Note: Any four points)* **i)** Comparatively Less space required to storage. **ii)** Comparatively Less chance of explosion. **iii)** There is no loss of heat during storage. **iv)** Comparatively less inflammable. **v)** Comparatively easy to handle. **vi)** Comparatively low cost.	04
f) A coal has the following compositions by mass – carbon 80%, Hydrogen – 5%, Oxygen – 6%, Nitrogen – 2.5%, Sulphur – 1.5% and 5% ash. Calculate HCV and LCV per kg of fuel.	04
Answer: **H.C.V. of coal** = 33800 C + 144500 (H2 - O2/8) + 9300 S KJ / Kg = 33800 x 0.8 + 144500 (0.05 - 0.06/8) + 9300 x 0.015 = 33320.75 KJ / Kg **L.C.V. of coal** = H.C.V.- 9H2 x 2442 KJ / Kg = 33320.75 – 9 x 0.05 x 2442 = 32221.85 KJ / Kg	02 02

4. Attempt any TWO of the following:	16
a) Describe with neat sketch construction and working of Nuclear Power Plant.	08
Answer: Nuclear Power Plant: (*Note: Construction and Working: 4 marks, Diagram: 4 marks).*  Fig. Nuclear Power Plant(*Credit should be given to equivalent sketch)*	04
Construction and working: The Nuclear Power Plant is shown in the fig. It consists of nuclear reactor, Steam turbine, Generator, condenser, cooling water pump and feed pump. Steam is generated in the nuclear reactor of Nuclear Power Plant by using heat generated by nuclear reaction. The steam generated is passed through steam turbine where part of its thermal energy is converted into mechanical energy which is further used for generating electric power. The steam coming out of steam turbine is condensed in condenser and condensate is supplied back to the nuclear reactor with the help of feed pump and cycle is repeated.	04
b) Describe the combustion chemistry of Carbon, Hydrogen and Methane.	08
Answer*:* *(Note: Combustion chemistry of Carbon: 4marks, Hydrogen:2marks and Methane:2marks)* **Combustion chemistry of Carbon:** Burning of carbon to carbon dioxide (complete combustion) $C + O_2 \rightleftharpoons CO_2$ *i.e.* $12 + (16 \times 2) = 12 + 16 \times 2$ *i.e.* $12 + 32 = 44$ *Or* $1 + 2.67 = 3.67$ That means 1 kg of carbon needs 2.67 kg of oxygen and produces 3.67 kg of carbon dioxide. Burning of carbon to carbon monoxide (incomplete combustion). $2C + O_2 \rightleftharpoons 2CO$ *i.e.* $2 \times 12 + (16 \times 2) = 2(12 + 16)$ *i.e.* $24 + 32 = 56$ *Or* $1 + 1.33 = 2.33$ That means 1 kg carbon takes 1.33 kg of O_2 and produces 2.33 kg of CO.	04

Combustion chemistry of Hydrogen:

The union of hydrogen with oxygen produces stems it is represented by the following equations.

$$2H_2 + O_2 = 2H_2O$$

$$2(1\times 2) + (16\times 2) = 2(1\times 2+16)$$

i.e. $4+32=36$

Or $1+8=9$

In above equation positive sign indicates that chemical reactions have taken place.

And equation reads that 1 kg of hydrogen combines with 8 kg of oxygen to produce 9 kg steam. — 02

Combustion chemistry of Methane:

Method (CH_4) Burning of methane with oxygen to carbon dioxide and water /steam.

$$CH_4 + 2O_2 \rightleftharpoons 2O_2 + 2H_2O$$

i.e. $(12+1\times 4)+2(16\times 2)=(12+16\times 2)+2(1\times 2+16)$

i.e. $16+64=44+36$

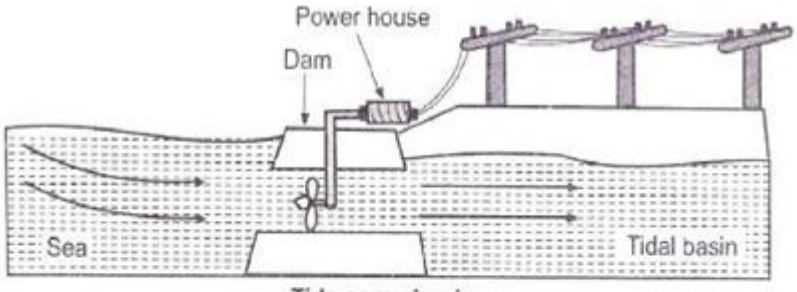
Or $1+4=\frac{11}{4}+\frac{9}{4}$

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. — 02

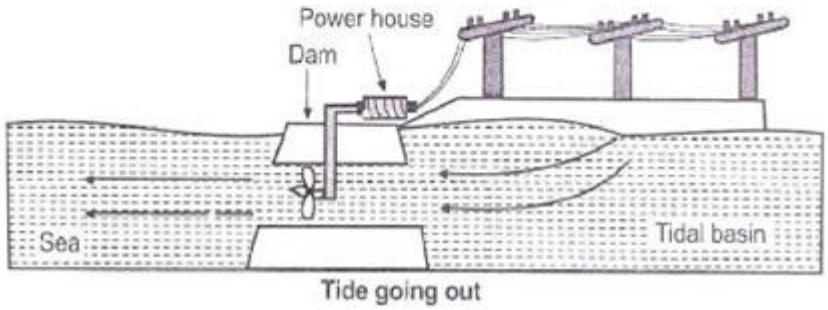
c) (i) Describe concept of Tidal Power plant. — 04

Answer: Concept of Tidal power plant: (*Note: Concept: 2 marks, Diagram: 2 marks).*

During high tide the water flow from sea into the tidal basin through water turbine as the level of water in sea is more than tidal basin. This operates the turbine and generator and power is produced. Potential energy of sea water converted into mechanical energy by turbine and it converts into electrical by generators. During low tide water flow from tidal basin into sea as water level in the sea is lower than basin level in both cases generation of power is same. Only difference in that rotation of turbine blade is opposite. — 02



Tide comming in — 02



Tide going out

Fig. Tidal Power Plant (***Credit should be given to equivalent sketch)***

c) (ii) Describe with sketch working of Bomb calorimeter.	04

Answer: Bomb calorimeter: (*Note: Working: 2 marks, Diagram: 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.

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 0.001^0 C is fitted through the lid of the calorimeter. 02

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. 02

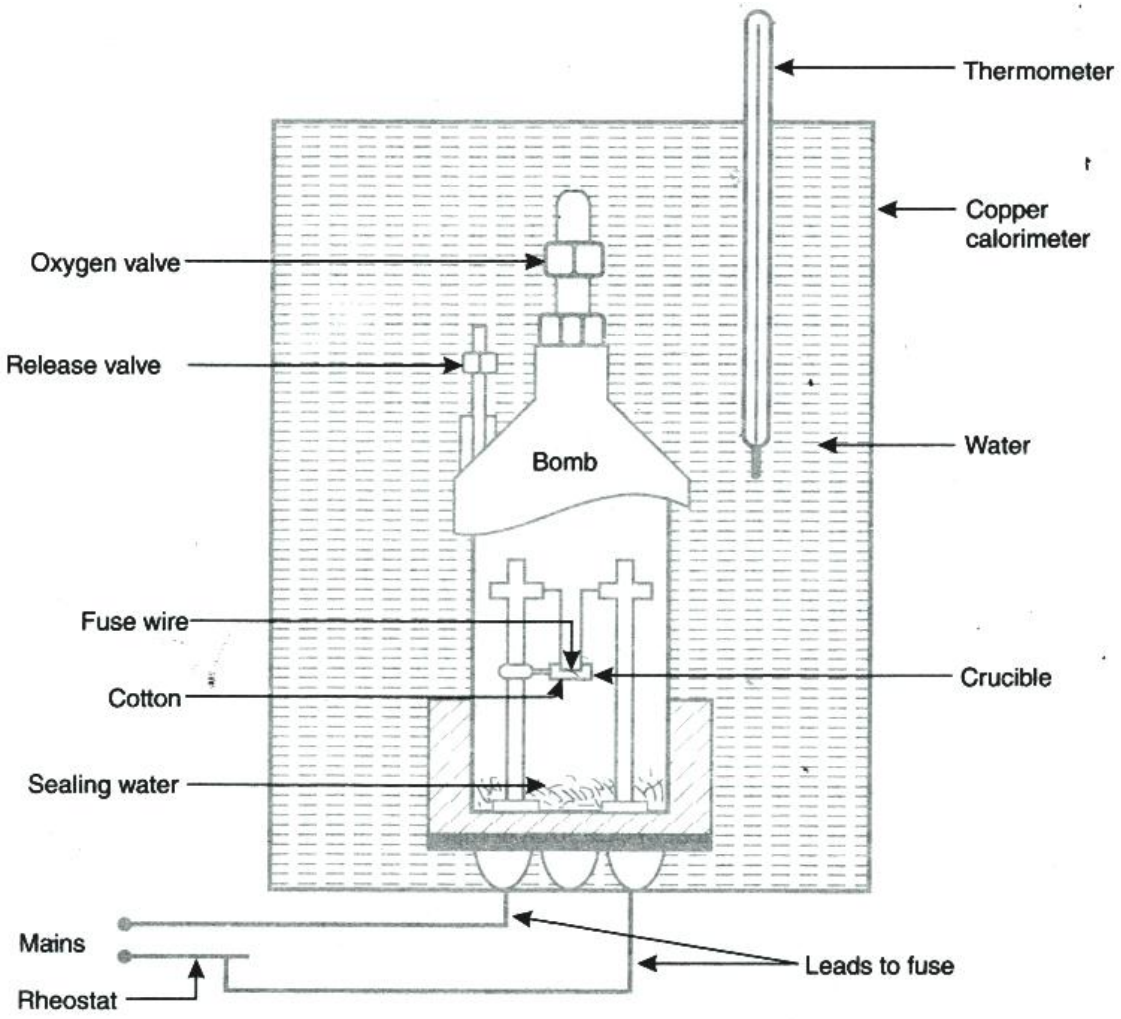


Fig : Bomb calorimeter ***(Credit should be given to equivalent sketch)***

5. Attempt any TWO of the following:	16
a) Derive the relation between P, V and T for adiabatic process.	8
Answer: Pressure (P) , Volume (V) & Temperature (T) relation for adiabatic process: For adiabatic Process, $PV^{\gamma} = C$ $P_1 v_1^{\gamma} = P_2 v_2^{\gamma}$ $\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma}$ …… (1) From general gas equation, $\frac{PV}{T} = C$ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{T_2}{T_1} = \frac{P_2V_2}{P_1V_1}$ ……(2) From (1) $\frac{V_2}{V_1} = (\frac{P_1}{P_2})^{1/\gamma}$ …….. (3) Put equation (3) into equation (2) $\frac{T_2}{T_1} = \frac{P_2}{P_1}(\frac{P_1}{P_2})^{1/\gamma}$ $\frac{T_2}{T_1} = (\frac{P_2}{P_1})^{\frac{\gamma-1}{\gamma}}$ $\frac{P_2}{P_1} = (\frac{T_2}{T_1})^{\frac{\gamma}{\gamma-1}}$ ……(4) From equation (1) & (4) $\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma} = (\frac{T_2}{T_1})^{\frac{\gamma}{\gamma-1}}$ $\boxed{\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma} = (\frac{T_2}{T_1})^{\frac{\gamma}{\gamma-1}}}$	1 1 1 1 2 2
b) Draw a neat sketch of two pass down flow type surface condenser. Describe its construction and Working.	08
Answer: Two pass down flow surface condenser: (*Construction and Working: 4 marks, Diagram: 4 marks)* **Construction:** 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.	02

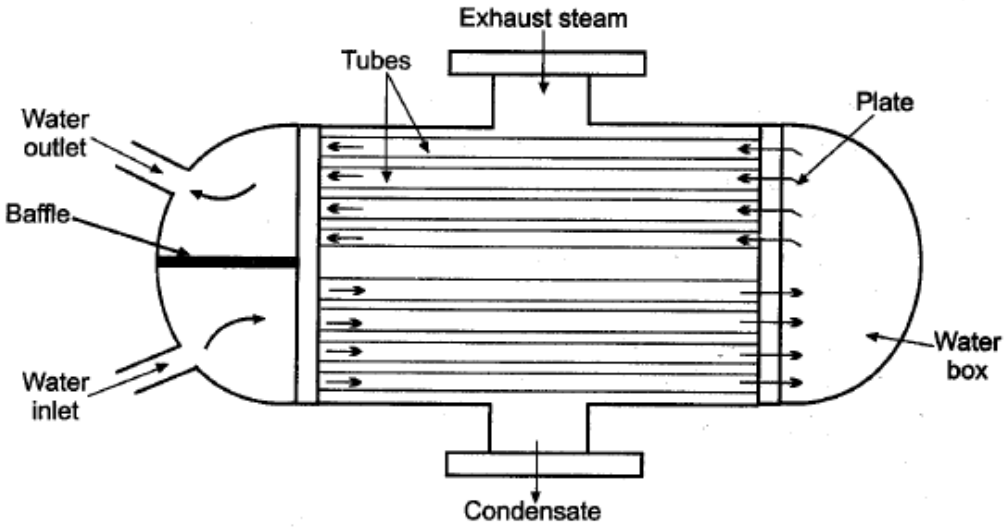


Fig. Two pass down flow surface condenser *(Credit should be given to equivalent sketch)* — 04

Working: 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 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. — 02

It is used to increase the turbine output by maintaining backpressure on exhaust side of steam engine or turbine & the secondary function of condenser is to supply pure and hot feed water to boiler.

c) Describe with neat sketch construction and working of centrifugal compressor. State its four advantages. — 08

Answer: Centrifugal compressor: (*Note: Construction and Working: 3 marks, Diagram: 3 marks and advantages:2 marks)* — 03

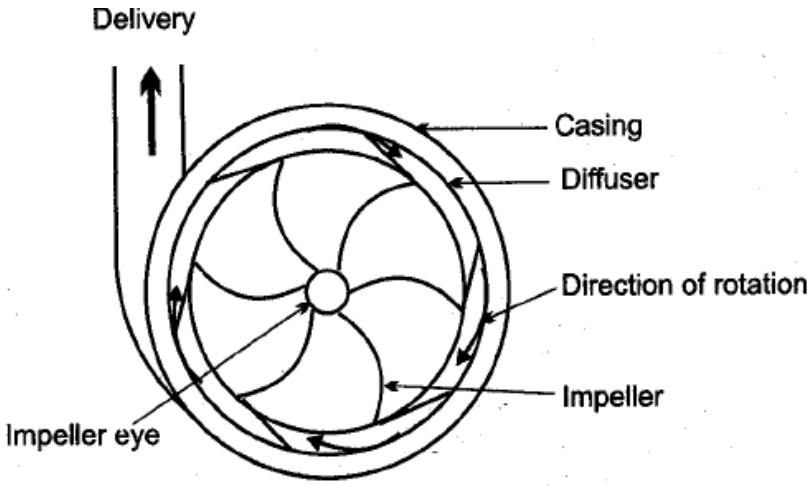
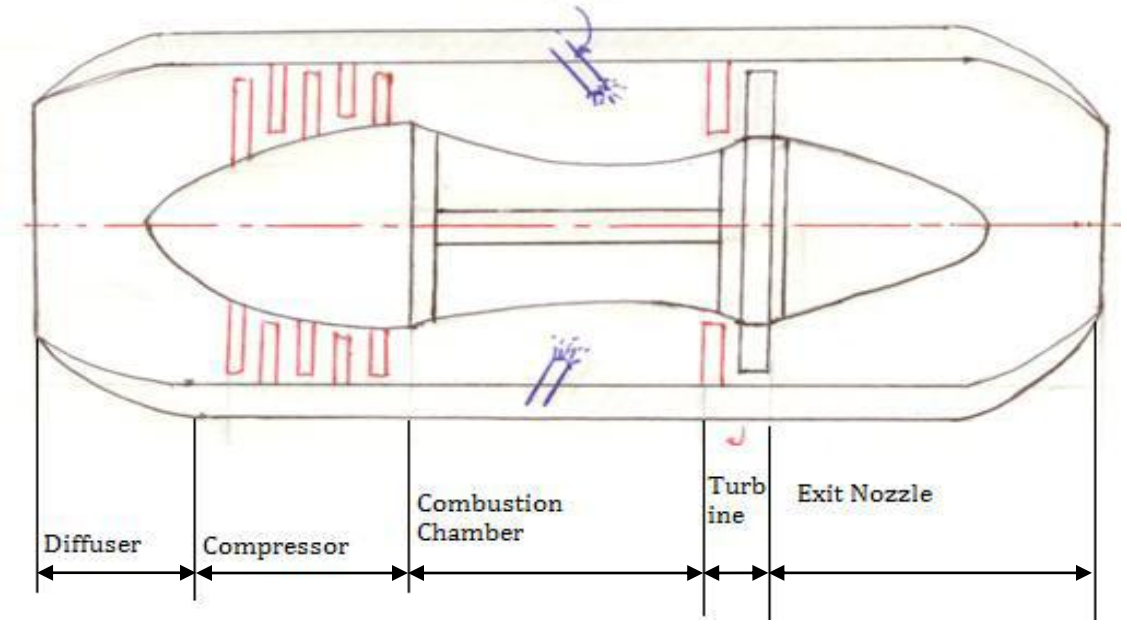


Fig. Centrifugal Compressor

Working: Fig. shows centrifugal compressor, it is simple in construction. It consists of rotor (i.e. impeller), impeller eye and diffuser. In impeller number of curved vanes is fitted symmetrically. Impeller rotates in an air tight volute casing. The casing is designed that the kinetic energy of the air is converted into pressure energy before it leaves the casing. Mechanical energy is provided to impeller by some external means. As impeller rotates it sucks air from impeller eye, increases its pressure due to centrifugal force and forces the air to flow over diffuser. The pressure of air further increases during its flow over diffuser. Finally, the air at high pressure is delivering to receiver. The air enters in the impeller radially and leaves vanes axially.	03
Advantages: ***(any four)*** 1) Low manufacturing and running cost. 2) Requires low starting torque. 3) It handles large volume of air. 4) Free from vibration and noise. 5) Isentropic efficiency is high. 6) Only few parts required lubrication. 7) It can be directly coupled to motor or prime mover.	02
6. Attempt any FOUR of the following.	16
a) State equations of air standard efficiency of otto and diesel cycle. Write meaning of terms Involved.	04
Answer: Equations of air standard efficiency of otto and diesel cycle: 1) $\eta = 1 - \frac{1}{r^{\gamma-1}}$ ----------Equation of air standard efficiency for Otto cycle. 2) η = 1- $\frac{1}{(r)^{\gamma-1}}\left[\frac{\rho^{\gamma}-1}{\gamma(\rho-1)}\right]$------ Equation of air standard efficiency for diesel cycle. Where, r = compression ratio γ = Ratio of specific heat (Adiabatic constant) ρ = Cut off ratio	01 02 01
b) Calculate the enthalpy of 1 kg of steam at a pressure of 8 bar and dryness fraction of 0.8. How much heat would be required to raise 3 kg of this steam from water at 20°C? Take Sp. Heat of water = 4.2 kJ/kgK, h_F= 720.9 kJ/kg, h_{Fg}= 2046.5 kJ/kg	04
Answer: *Given*:- 1) for 1 kg of steam $m = 1kg$ $x = 0.8$ $h_f = 720.9KJ/kg$ $h_{fg} = 2046.5KJ/kg$ $h = m(h_f + xh_{fg})$ $h = 1(720.9 + 0.8 \times 2046.5) = 2358.1$ *Enthalpy*, $h = 2358.1KJ$	1 1

2) Heat required for 3 kg of steam from 20 ^0c of water $m = 3Kg$ $C_p = 4.2\ KJ/KgK$ This value is of enthalpy at 0^0C. For 20^0C heat in the water =Specific heat of water × Rise in temperature = 4.2 × 20 = 84 KJ Heat required per kg of steam = 2358.1 - 84 = 2274.1KJ And Heat required of 3 kg of steam = 3 × 2274.1 = 6822.3 KJ	01 01
c) What is meant by multi-staging in compressor? Write its advantages. (any two)	4
Answer: **Multi-staging in compressor:** Multi-staging compression is a series arrangement of cylinders in which compressed air from previous cylinder becomes the intake air for next cylinder & Intercooler is provided in between two cylinders, such arrangement is called multi-staging in compressor. **Advantages of multi-staging in compressor:-*(any two)*** 1) Work required per kg of air is reduced if it is use with intercooler. 2) Volumetric efficiency will improve. 3) Reduces leakage loss considerably 4) Gives more uniform torque hence smaller size of flywheel is required. 5) Provides effective lubrication. 6) Cost of compressor is reduced.	02 02
d) Describe working of turbojet engine.	04
Answer: Turbo-jet Engine: (*Note: Working: 2 marks, Diagram: 2 marks)*  Fig. Turbo-jet Engine	02

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

e) Describe with sketch construction and working of open cycle gas turbine. — 04

Answer: Open cycle gas turbine: (*Note: Construction and Working: 2 marks, Diagram: 2 marks)* — 02

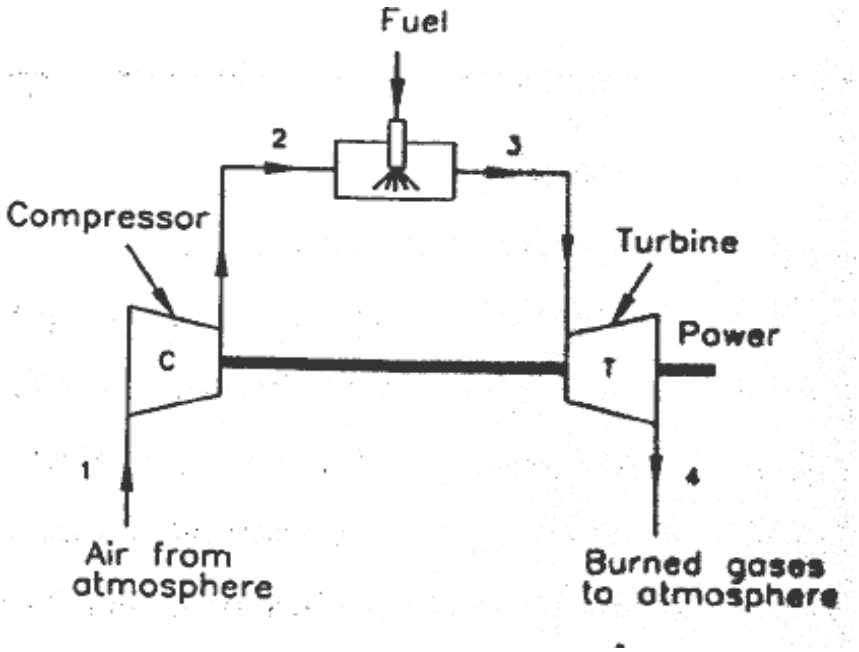


Fig. Open cycle gas turbine

Construction and Working:

Fig. shows open cycle gas turbine which consists of compressor, combustion chamber, turbine, generator. The compressor and turbine are mounted on same shaft. Combustion chamber is placed in between compressor and turbine for combustion of fuel. Generator is coupled with turbine shaft for generation of power.

Fresh air enters the compressor at ambient temperature at point 1 and it is compressed to point 2 where its pressure and temperature are increased. The high pressure air enters the combustion chamber where the fuel is burned at constant pressure. Heat is added by directing burning the fuel into combustion chamber at constant pressure during process 2 to 3. The high temperature (and pressure) gas enters the turbine where it expands during process 3 to 4 to ambient pressure and produces work. Finally exhausted to atmosphere. — 02

f) Compare centrifugal compressor with axial flow compressor.(any four points) — 04

Answer: Comparison of Centrifugal and Axial flow compressor: *(any four)* — 04

Sr.	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
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.