WINTER– 14 EXAMINATION

Subject Code: **17406 (HE)** **Model Answer**

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.1 – (a) i) Classification of I.C engine: (Any four) 1/2 mark each

i) According to thermodynamic cycle :
Otto cycle , Diesel cycle , Dual cycle.

ii) According to cylinder arrangement
V-type engine, Radial engine. Inline engine

iii) According to fuel used
Petrol engine , Diesel engine , Gas engine

iv) According to method of cooling
Air cooled engine, Water cooled engine.

v) According to the number of strokes per cycle –
Two stoke engine, four stroke engine

vi) According to number of cylinder used –
Single cylinder engine, multi cylinder engine

viii) According to the speed of the engine –
Slow speed engine, medium speed engine, high speed engine

Q.1 – (a) ii) Following are the sources of non-conventional energy sources (Any four) 1/2 mark each

1) Solar energy ii) Wind energy iii) Biomass

iv) Geothermal energy v) Tidal energy v) Hydro energy

Q.1 – (a) iii) Limitations of first law of thermodynamics (1/2 mark each)

1. It is not clear about the direction of heat and work transfer
2. First law does not help whether or not system will undergo change.
3. No restriction on possibility of conversion energy from one form to another.
4. No clarity that how much percentage of one form of energy converted into another form of energy

Q.1 – (a) iv) Ideal gas equation is P V = m R T **(Equation 1 mark & unit 1 mark)**

Where R is characteristic gas constant

Universal gas constant unit is kJ/kg.mol.^{0}k

Q.1 – (a) v) Characteristic gas constant for air is R = 0.287 kJ/kg.^{0}k (**Value 1 mark & unit 1 mark)**

Q.1 – (a) vi) Following are the applications of compressed air- ***(Any Four)*** **1/2 mark each**

1) To drive air motors in coal mines.
2) To inject fuel in air injection diesel engines.
3) To operate pneumatic drills, hammers, hoists, sand blasters.
4) In gas turbine plants.
5) For cleaning purposes.
6) To cool large buildings and aircrafts.
7) In the processing of food and farm maintenance.
8) In vehicle to operate air brake.
9) For spray painting in paint industry.

Q.1 – (a) vii) Classification of air compressor:- (Any four) 1/2 mark for each

1) **According to number of stages:-**

   i.) Single stage :- Delivery pressure up to 10 bar ii) Multistage:- Delivery pressure above 10 bar.

2) **According to number of cylinder**:- i) Single cylinder ii) Multi cylinder.
3) **According to method of cooling**:- i) Air cooled ii) Water cooled.
4) **According to action of air:-** i) Single acting ii)Double acting.
5) **According to capacity**:- i) Low capacity ii) Medium capacity iii) High capacity.
6) **According to drive**:- i) Steam engine drive ii) Steam turbine drive iii) Electric motor drive

   iv) Internal combustion drive.

Q.1 – (a) viii) Air conditioning systems are classified as

1) Classification as to major function-

i) Comfort air-conditioning ii) Commercial air-conditioning iii) Industrial air-conditioning

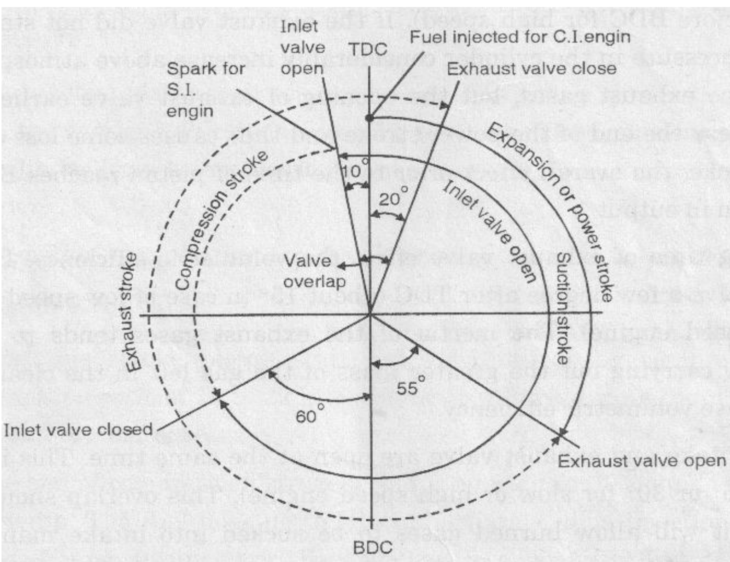
2) Classification as to season of the year-

i) Summer air-conditioning ii) Winter air-conditioning iii) Year round air-conditioning

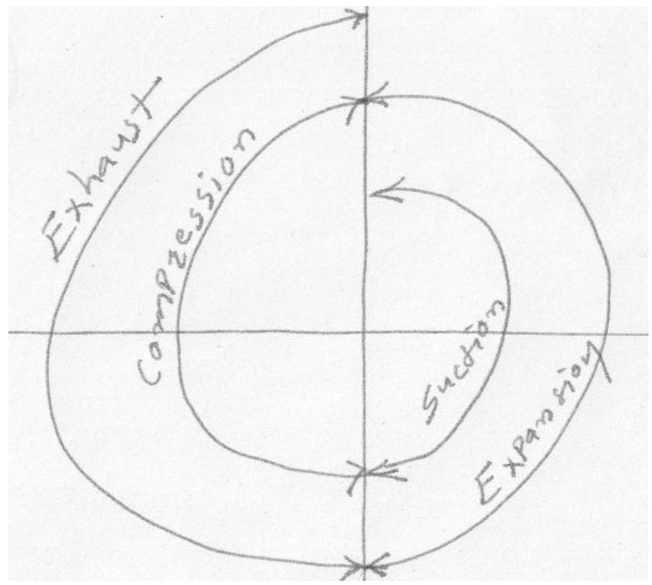
3) Classification as to Equipment Arrangement-

i) Unitary system ii) Central system

Q.1 – (b) i) (working – 2 marks, actual and theoretical valve timing diagram- 2 marks)



: Valve timing diagram for four stroke S.I. engine



Theoretical Valve timing Dig.

1. **Suction stroke**: Suction stroke starts when piston is at top dead center and about to move downwards. During suction stroke inlet valve is open and exhaust valve is closed. Due to low pressure created by the motion of the piston towards bottom dead center, the charge consisting of fresh air mixed with the fuel is drawn into cylinder. At the end of suction stroke the inlet valve closes.

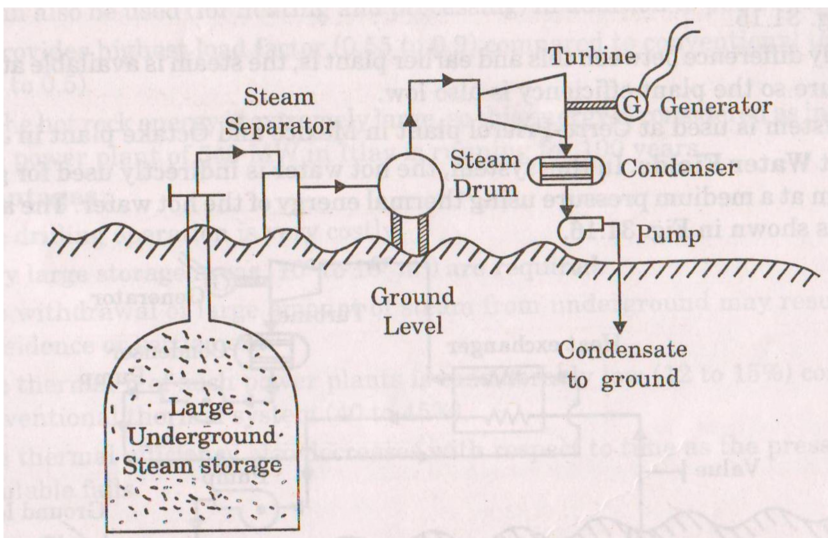
2. **Compression stroke**: During compression stroke, the compression of charge takes place by return stroke of piston, i.e. when piston moves from BDC to TDC. During this stroke both, inlet and exhaust valve remain closed. Charge which is occupied by the whole cylinder volume is compressed up to the clearance volume. Just before completion of compression stroke, a spark is produced by the spark plug and fuel is ignited. Combustion takes place when the piston is almost at TDC.

3. **Expansion or power stroke**: Piston gets downward thrust by explosion of charge. Due to high pressure of burnt gases, piston moves downwards to the BDC. During expansion stroke both inlet and exhaust valves remains closed. Thus power is obtained by expansion of products of combustion. Therefore it is also called as 'power stroke'. Both pressure as well as temperature decreases during expansion stroke.

4. Exhaust stroke: At the end of expansion stroke the exhaust valve opens, the inlet valve remains closed and the piston moves from BDC to TDC. During exhaust stroke the burnt gases inside the cylinder are expelled out. The exhaust valve closes at the end of the exhaust stroke but still some residual gases remains in cylinder.

Q.1 – (b) ii) (02 Marks for description and 02 marks for sketch)

Geothermal power Plant: This is also known as one form of nonconventional energy source. The power plant sketch is as shown in figure. It consists of availability of large amount of steam in the crust of earth. Raw steam from underground is taken into steam separator and dry steam is stored into steam drum. The dry steam is then passed through the turbine. The condenser performs the function of condensation and the condensate from the condenser is reinjected into the ground. This condensate under the ground absorbs the heat from the rock and again steam is generated.



Geothermal power Plant

Q.1 – (b) iii) **Intensive property**: - The properties which do not depend upon the mass of the system.

e.g. Pressure, Temperature, density etc. **02 m**

Extensive Property: - The properties which depends on the mass of the system.

e.g. total volume, weight ,enthalpy, entropy etc. **02 m**

Q.2– (a) **(02 Mark for each)**

i) Pure Substance: Pure substance is a substance of constant chemical composition throughout its mass. It is one component system. It may exist in one or more phases. Water, Air, Hydrogen, Nitrogen, Helium, mixture of water and steam and mixture of ice and water are the examples of pure substance

ii) Working substance: The working substance in most work producing and absorbing devices is gas or vapor, or vapor and liquid. It is a substance which is capable of absorbing and rejecting heat during the process. Freon, Ammonia is the examples of working substance

Q.2– (b) **(01 Mark for each)**

Following are the assumptions made for ideal gas

1) A finite volume of gas contains large number of molecules.
2) The collision of molecules with one another and with the walls of the container is perfectly elastic.
3) The molecules are separated by large distances compared to their own dimensions.
4) The molecules do not exert forces on one another except when they collide.

As long as the above assumptions are valid the behavior of a real gas approaches closely that of an ideal gas.

Q.2– (c) **(Any four points)** **(01 Mark for each)**

Petrol Engine	Diesel Engine
1. During suction stroke the mixture of air and petrol is sucked in the engine cylinder.	1. During suction stroke only air is sucked in the engine cylinder.
2. Petrol engine works on Otto cycle.	2. Diesel engine works on Diesel cycle.
3. Spark plug is used to ignite the charge with electric spark.	3. Fuel injector is used. The fuel burns by the heat of compressed air.
4. Compression ratio varies from 6 – 11.	4. Compression ratio varies from 14 – 22.
5. Light and less stronger.	5. Heavier and stronger.
6. There is a chance of pre-ignition.	6. No chance of pre-ignition.
7. Lower thermal efficiency.	7. Higher thermal efficiency
8. Less initial cost. 9. High running cost.	8. High initial cost. 9. Low running cost.
10. Used in cars, scooters and motorcycles.	10. Used in heavy duty vehicles like trucks, buses and locomotive engines.

Q.2– (d) **(02 Mark for each)**

Boyle's Law- The law states that the volume of a given mass of a perfect gas varies inversely with absolute pressure when the temperature remains constant.

Let,

P = Absolute pressure of the gas

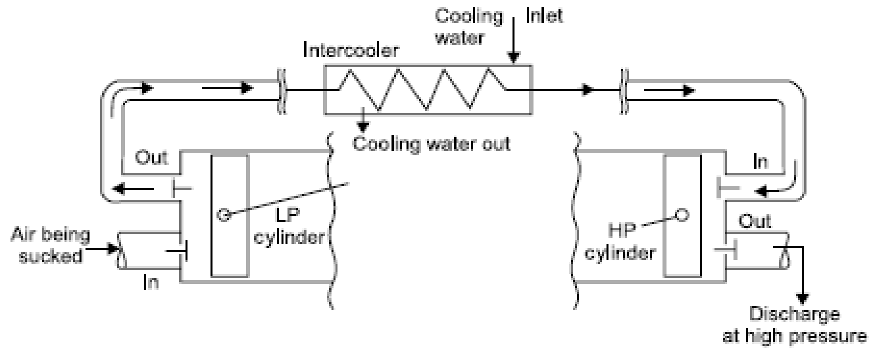
V = Volume of the gas at pressure P

Then according to this law,

$\mathbf{V \propto 1/P}$

Avagadro's Law- This law states that equal volumes of all gases at the same temperature and pressure contain the same number of molecules. In other words, it can be stated that the molecular weights of all the gases occupy the same volume at N.T.P.

Q.2– (e)



Two stage reciprocating compressor

Multistage compression refers to the compression process completed in more than one stage i.e. a part of compression occurs in one cylinder (L.P. cylinder) and subsequently compressed air is sent to subsequent cylinders (H.P. cylinder) for further compression.

Figure shows the schematic of two stage compressor with intercooler between stages. The total work requirement for running this shall be algebraic summation of work required for low pressure (LP) and high pressure (HP) stages. The size of HP cylinder is smaller than LP cylinder as HP cylinder handles high pressure air having smaller specific volume. **(Fig. 2 Marks Working – 2 Marks)**

Q.2– (f) (01 Mark for each difference)

Difference between Isothermal process and adiabatic process

Sr. No	Isothermal process	Adiabatic process
01	Temperature remains constant during the process (T=C)	Entropy remains constant during the process (S=C)
02	PV=C (n=1)	$PV^{\square}$=0 ($\square$=1)
03	Change in internal energy is zero (ΔU=o)	Change in internal energy is not zero (ΔU=o)
04	Heat transfer $Q=P_1V_1\log(V_2/V_1)$	Heat transfer Q=0
05	Work done W= $Q=P_1V_1\log(V_2/V_1)$ as ΔU=o	Work done W= ΔU
06	Isothermal process is very slow	Adiabatic process is very fast

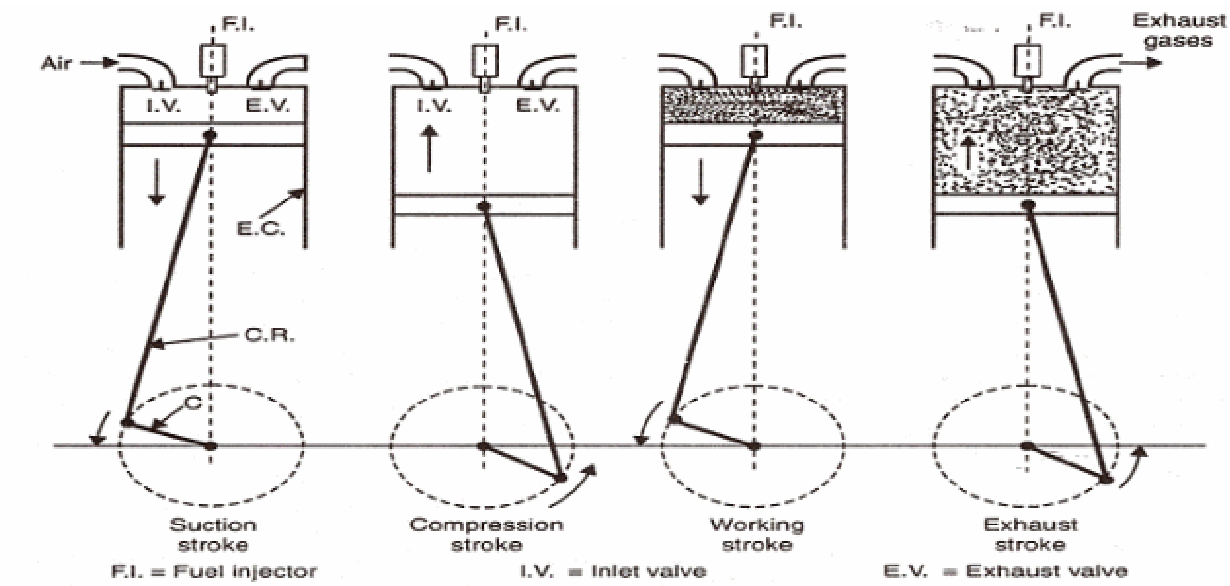
Q 3 (a) (**Any one statement 02 marks & Enthalpy definition 02 marks)**

Kelvin-Planck statement of second law of thermodynamics: “It is impossible for a device operating in a cycle to produce net work while exchanging heat with bodies at single fixed temperature”.

Clausius statement of second law of thermodynamics: “It is impossible to have a device that while operating in a cycle produces no effect other than transfer of heat from a body at low temperature to a body at higher temperature.”

Enthalpy: One of the fundamental quantities which occur invariably in thermodynamics is the sum of internal energy (u) and pressure volume product (pv). The sum is called Enthalpy (h) i.e., $h = u + pv$

Q 3 (b) **(Sketch 02 marks, Working 02 marks)**



Compression ignition (CI) engines operate generally on “Diesel”/“Dual” cycle. In these engines the combustion is realized due to excessive compression and are so called compression ignition engines. Here air alone is sucked inside the cylinder during suction stroke and compressed. Degree of compression is much more than that of spark ignition (SI) engines. After compression of air the fuel is injected into the high pressure and high temperature compressed air. Due to high temperature of air the combustion of fuel gets set on its’ own. Self ignition of fuel takes place due to temperature of air-fuel mixture being higher than self ignition temperature of fuel. Thus in CI engines, larger amount of compression causes high temperature, therefore unassisted combustion.

***Stroke 1**:* Piston travels from TDC to BDC and air is sucked.
***Stroke 2**:* Piston travels from BDC to TDC, while air is compressed with inlet and exit passages closed.
***Stroke 3**:* Piston reaches TDC and air gets compressed. Fuel injector injects fuel into compressed air for certain duration. Ignition of fuel also takes place simultaneously as air temperature is much higher than self ignition temperature of fuel. Burning of fuel results in release of fuel chemical energy, which forces piston to travel from TDC to BDC. Contrary to SI engine where heat addition gets completed near instantaneously, in CI engines fuel injection and thus heat addition is spread in certain stroke travel of piston i.e. heat addition takes place at constant pressure during which piston travels certain stroke length as decided by cut-off ratio. This is expansion process and piston comes down to BDC with both inlet and exit valves closed.
***Stroke 4**:* After expansion piston reverses its motion upon reaching BDC and travels up to TDC with exit passage open. During this piston travel burnt gases are expelled out of cylinder i.e. exhaust stroke. Completion of above four strokes requires two revolutions of crankshaft.

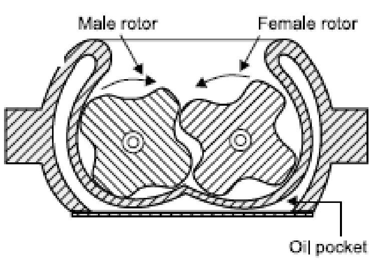
Q 3 © **(understanding 02 marks, usefulness 02 marks)**

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called transesterification. Most biodiesel produced at present is produced from waste vegetable oil sourced from restaurants, chip shops, industrial food producers such as Birdseye etc.

Biodiesel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean-burning fuel and can be a fuel component for use in existing, unmodified diesel engines. This means that no retrofits are necessary when using biodiesel fuel in any diesel powered combustion engine. It is the only alternative fuel that offers such convenience. Biodiesel acts like petroleum diesel, but produces less air pollution, comes from renewable sources, is biodegradable and is safer for the environment. Producing biodiesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of biodiesel already exist at the local, state and national level. Biodiesel is designed for complete compatibility with petroleum diesel and can be blended in any ratio, from additive levels to 100 percent biodiesel. In the United States today, biodiesel is typically produced from soybean or rapeseed oil or can be reprocessed from waste cooking oils or animal fats such as waste fish oil. Because it is made of these easily obtainable plant-based

Worldwide, energy security is becoming a hot topic in government and society. Nearly every country in the world depends on imports of various forms of fossil fuel energy, including oil, coal and natural gas. Without a steady supply of affordable energy a country's economy grinds to a halt, with no fuel for transportation, energy to run power plants and factories, or heat homes. Biodiesel can improve energy security wherever it is produced in several ways: materials, it is a completely renewable fuel source.

Q 3 (d) **(Sketch 02 marks, Working 02 marks)**



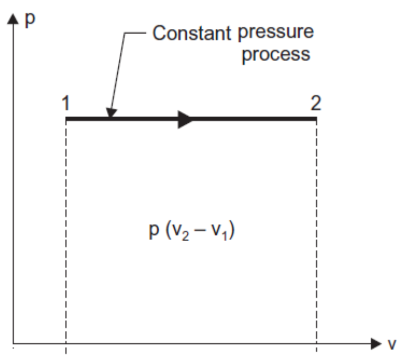
Screw type compressor: Screw type compressor is very much similar to roots blower. These may have two spiral lobed rotors, out of which one may be called male rotor having3–4 lobes and other female rotor having 4–6 lobes which intermesh with small clearance. Meshing is such that lobes jutting out of male rotor get placed in matching hollow portion in female rotors. Initially, before this intermeshing the hollows remain filled with gaseous fluid at inlet port. As rotation begins the surface in contact move parallel to the axis of rotors toward the outlet end gradually compressing the fluid till the trapped volume reaches up to outlet port for getting discharged out at designed pressure. Since the number of lobes is different so the rotors operate at different speed.

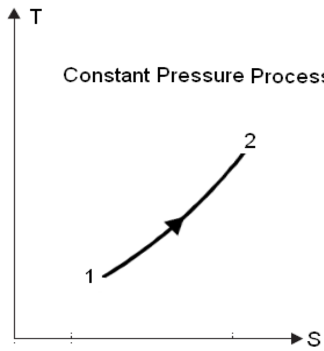
Two rotors are brought into synchronization by the screw gears. Thrust upon rotors is taken care of by oil lubricated thrust bearings. These compressors are capable of handling gas flows ranging from 200 to 20000 m3/h under discharge pressures of 3 bar gauge in single stage and up to 13 bar gauge in two stages. Even with increase in number of stages pressures up to 100 bar absolute have been obtained with stage pressure ratio of 2.Mechanical efficiency of these compressors is quite high and their isothermal efficiencies are even more than vane blowers and may be compared with centrifugal and axial compressors. But these are very noisy, sensitive to dust and fragile due to small clearances.

Q 3 (e) **(Definition 02 marks, each diagram 01 marks)**

Isobaric Process: A process in which the pressure of the gas remains constant before and after heating is known as constant pressure process. **or**

It refers to the thermodynamic process in which there is no change in pressure during the process. Such type of processes are also known as isobaric processes.





Q 3 (f) **Classification of steam turbine.** **(Any four – 4 marks)**

(i) According to working principles:
(a) Impulse turbine
(b) Reaction turbine
(c) Impulse – reaction turbine
(ii) According to no. of stages of expansion of steam.
(a) Single stage turbine
(b) Multi stage turbine
(iii) According to position of shaft axis
(a) Horizontal axis turbine
(b) Vertical axis turbine
(iv) According to their nature of steam supply
(a)High pressure turbine
(b) Low pressure turbine
(v) According to direction of steam flow
(a)Axial flow turbine
(b) Radial flow turbine
(c) Tangential flow turbine
(vi) According to exhaust steam pressure
(a)Condensing type steam turbine
(b)Non - Condensing type steam turbine

Q 4 (a) **Air conditioning systems are classified as**

1) Classification as to major function-

i) Comfort air-conditioning - air conditioning in hotels, homes, offices etc.

ii) Commercial air-conditioning- air conditioning for malls, super market etc

ii) Industrial air-conditioning – air conditioning for processing, laboratories etc

2) Classification as to season of the year-

i) Summer air-conditioning - These system control all the four atmospheric conditions for summer comfort.

ii) Winter air-conditioning – This system is designed for comfort in winter.

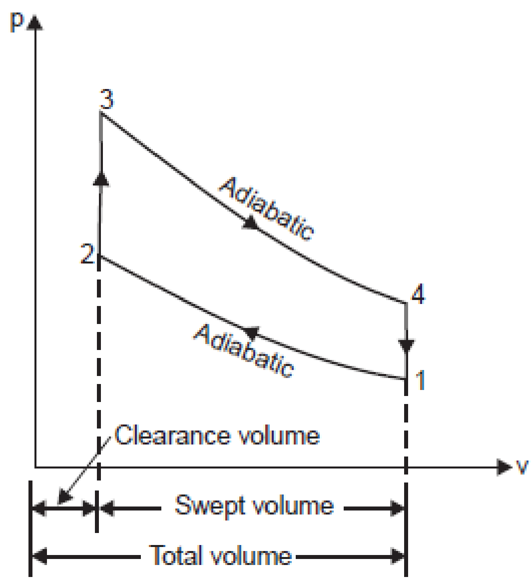
iii) Year round air-conditioning – These system consists of heating and cooling equipments with automatic control to produce comfortable condition throughout the year

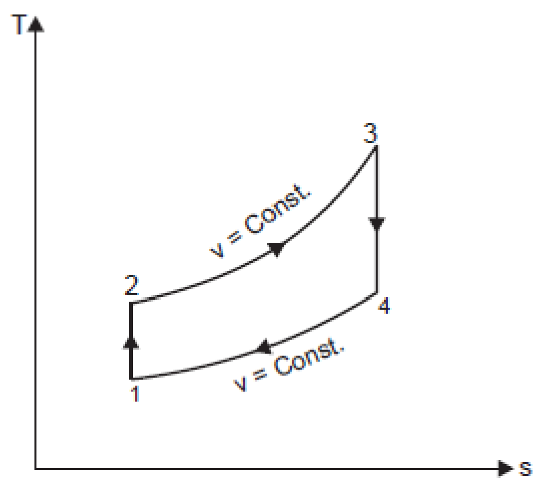
3) Classification as to Equipment Arrangement-

i) Unitary system

ii) Central system

Q 4 (b) (Cycle explanation 02 marks, PV & TS diagram 01 marks each & derivation 04 marks)





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 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.

Consider 1 kg of air (working substance) :

Heat supplied at constant volume = $c_v(T_3 - T_2)$.

Heat rejected at constant volume = $c_v(T_4 - T_1)$.

But, work done = Heat supplied – Heat rejected

$$= c_v(T_3 - T_2) - c_v(T_4 - T_1)$$

$$\therefore \quad \text{Efficiency} = \frac{\text{Work done}}{\text{Heat supplied}} = \frac{c_v(T_3 - T_2) - c_v(T_4 - T_1)}{c_v(T_3 - T_2)}$$

$$= 1 - \frac{T_4 - T_1}{T_3 - T_2} \quad \ldots(i)$$

Let compression ratio, $r_c\ (= r) = \frac{v_1}{v_2}$

and expansion ratio, $r_e\ (= r) = \frac{v_4}{v_3}$

(These *two ratios are same* in this cycle)

As $\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{\gamma - 1}$

Then, $T_2 = T_1 \cdot (r)^{\gamma - 1}$

Similarly, $\frac{T_3}{T_4} = \left(\frac{v_4}{v_3}\right)^{\gamma - 1}$

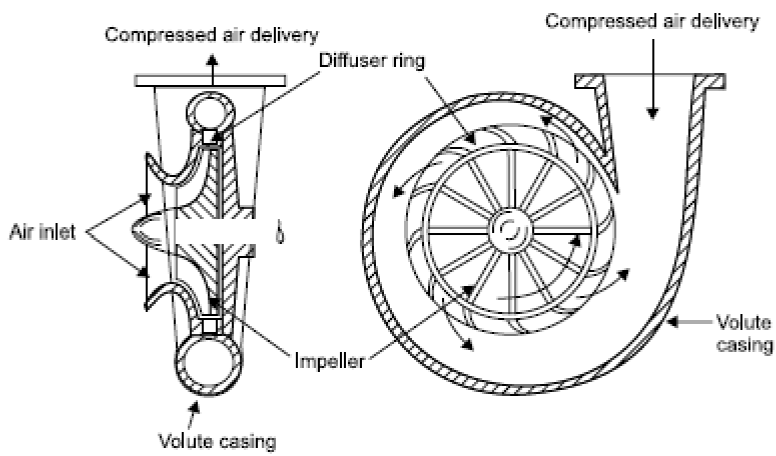
or $T_3 = T_4 \cdot (r)^{\gamma - 1}$

Inserting the values of T_2 and T_3 in equation (*i*), we get

$$\eta_{otto} = 1 - \frac{T_4 - T_1}{T_4 \cdot (r)^{\gamma - 1} - T_1 \cdot (r)^{\gamma - 1}} = 1 - \frac{T_4 - T_1}{r^{\gamma - 1}(T_4 - T_1)}$$

$$= 1 - \frac{1}{(r)^{\gamma - 1}}$$

Q 4 © **(Working Principle 04 marks, Sketch 04 marks)**



CENTRIFUGAL COMPRESSORS

Centrifugal compressor is a radial flow machine compressing the fluid due to the dynamic action of impeller. Centrifugal compressors have impeller mounted on driving shaft, diffuser and volute casing. Centrifugal compressors have air inlet at the centre of impeller. The portion of impeller in front of inlet passage is called impeller eye.

Impeller is a type of disc having radial blades mounted upon it. Compressor casing has a diffuser ring surrounding impeller and the air enters the impeller eye and leaves from impeller tip to enter diffuser ring. Volute casing surrounds the diffuser ring. Volute casing has cross section area increasing gradually up to the exit of compressor. These impellers of centrifugal compressors may also be of double sided type such that air can enter from two sides (both) of impeller.

Air enters the impeller eye axially and flows radially outwards after having entered compressor. Radial flow of air inside compressor is due to impeller (blades) rotating about its axis. These impeller blades impart momentum to the air entering, thereby rising its pressure and temperature. Subsequently the high pressure fluid leaving impeller enters the diffuser ring where the velocity of air is lowered with further increase in pressure of air. Thus in diffuser ring the kinetic energy of air is transformed into pressure head. High pressure air leaving diffuser is carried by volute casing to the exit of compressor. Due to increased cross section area of volute casing some velocity is further reduced causing rise in its pressure, although this is very small. Total pressure rise in compressor may be due to 'impeller action'and 'diffuser action' both. Generally, about half of total pressure rise is available in impeller and remaining half in diffuser.

Centrifugal compressors are used in aircrafts, blowers, superchargers, etc. where large quantity
of air is to be supplied at smaller pressure ratios. Generally, pressure ratio up to 4 is achieved in single stage centrifugal compressors while in multistage compressors the pressure ratio up to 12 can be achieved. These compressors run at speed of 20,000–30,000 rpm.

Q.No. 5 a) Mass of gas = 1 kg

$T_1 = 30\ ^0C$

$T_2 = 250\ ^0C$

dH,dU = ?

Assume for the given gas $C_p = 1.005$ kJ/kg^{0}K

$C_v = 0.728$ kJ/kg^{0}K **(2Marks)**

We know,

Heat added dh = m x C_p x $(T_2 - T_1)$

= 1 x 1.005 (250-30)

=221.1 kJ **(2Marks)**

Work done = dW = 0 (As the process is constant pressure process) **(2Marks)**

Change in internal energy = m x C_v x $(T_2 - T_1)$ **(2Marks)**

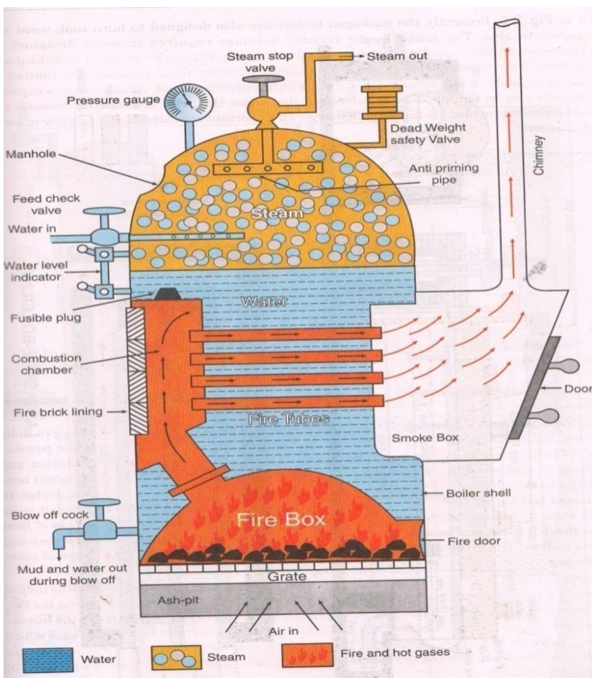
= 1 x 0.0728 x (250-30)

=160.16 kJ

Q.No. 5 b)

Cochran Boiler (Four marks for figure and Four for explanation)

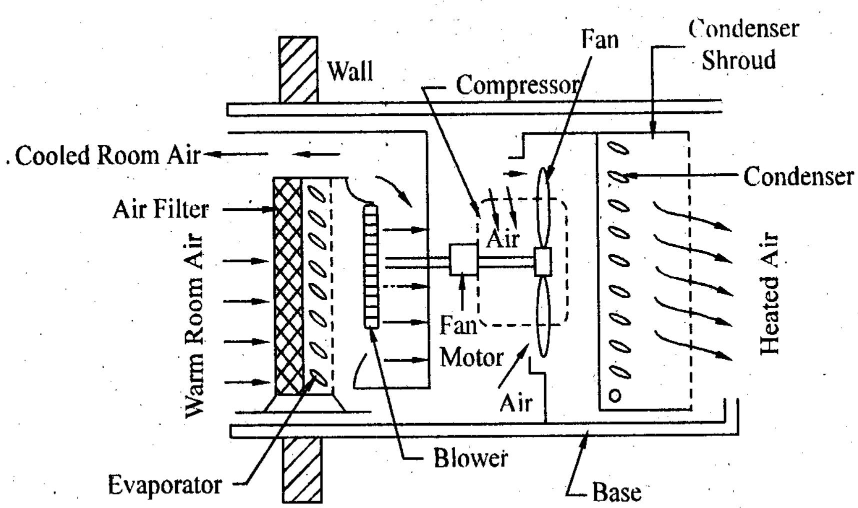
Cochran boiler is a vertical, multi tube boiler, commonly used for small capacity steam generation. Figure shows the arrangement of boiler. It consists of a cylindrical shell with the crown having hemispherical shape. The grate is placed at the bottom of the furnace and ash pit is below the grate. The furnace and the combustion chamber are connected through a pipe. The hot gases from the combustion chamber flow through the nest of horizontal fire tubes. The hemispherical crown of the boiler shell gives maximum strength. Coal or oil can be used as fuel. The smoke box is provided with doors for cleaning of the interior of the fire tubes. This boiler is very compact and requires minimum floor area. It gives 70% thermal efficiency.



COCHRAN BOILER

Q.No. 5 c

Window Air- conditioner (04 marks for fig. with sketch-04 marks for labeling



Q.No. 6 a) **(2 Mark for law and 02 mark for equation)**

viii) First Law of Thermodynamics: - It states that if a system executes a cycle , transferring work and heat through its boundary, the net heat transfer is equivalent to the net work transfer.

$$\text{or} \qquad \oint dQ = \oint dW$$

where $\oint$ represents the sum for a complete cycle.

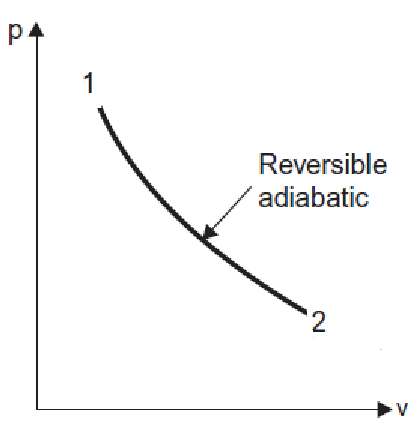
Q.No. 6 b) **(01 Mark for each difference)**

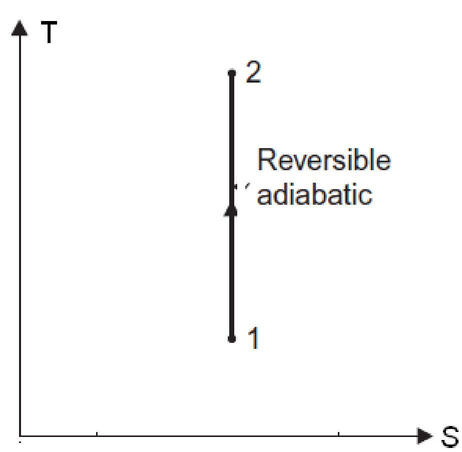
Differentiate between fire tube boilers and water tube boilers (Any four)

Sr. No	**Fire tube boilers**	**Water tube boilers**
01	Hot flue gases flow in the tubes surrounded outside by the water	Water flows in the tubes surrounded outside hot gases
02	Slower in operation and have low evaporation rates	faster in operation and have low evaporation rates
03	Failure due to Temperature stress causing failure of feed water arrangement is minimum	Failure due to Temperature stress causing failure of feed water arrangement is more
04	It can work upto 20 bar pressure only	It can work upto 200 bar pressure
05	Simple and rigid construction	Complex construction
06	More maintenance and operation cost	less maintenance and operation cost
07	Smaller sizes and hence not suitable for large power houses	Bigger sizes and hence suitable for large power houses
08	Installation is difficult	Installation is easy
09	Requires less floor area	Requires more floor area

Q.No. 6 c) Adiabatic process

(2 marks each)





Q.No. 6 d) (01 mark for definition and 01 mark for unit)

i) Entropy: Entropy is a thermodynamics property of a working substance which increases with the addition of heat and decreases with the removal of heat. Entropy means "transformation" and is a measure of extent of irreversibility of the process undergone by the system. It is denoted by "S" or "□". The units of entropy is kJ/kg ^{O}K

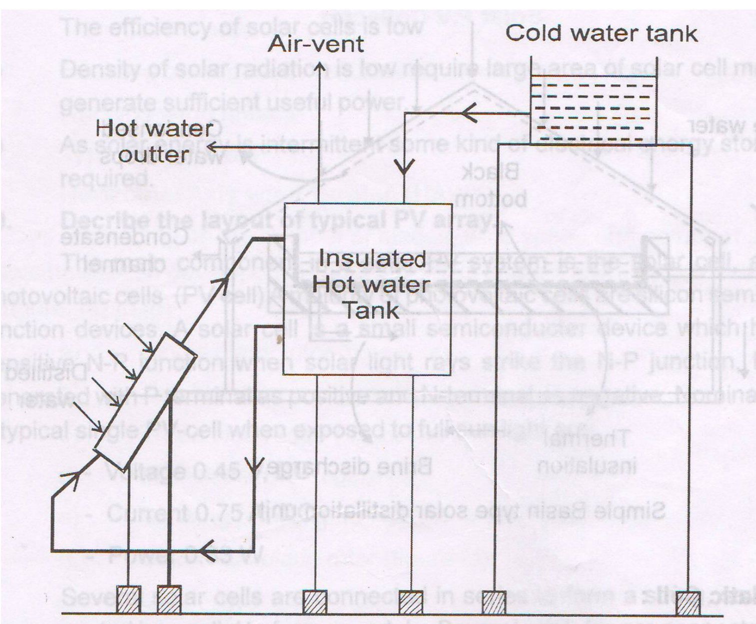
ii)Heat: Heat is the energy interaction driving forces caused by the temperature difference between the system and surrounding . It is a low grade energy. **(1 Mark)**

Work: In thermodynamics, work is considered as interaction occurring between the system and the surrounding. Work is said to be done by a system if sole effect on things external to the system can be reduced to the raising of a weight.

(1Mark)

Q.No. 6 e) (02 Mark for description and 02 marks for sketch)

Solar water heater: A tilted flat plate solar collector with water as heat transfer fluid is used in solar water heater system. A thermally insulated hot water storage tank is mounted above the collector. The heated water of the collector raises up to the hot water tank and equal quantity of cold water enters the collector. The cycle repeats, resulting in all the water of the hot water tank getting heated up. When water is taken out from hot water outlet, the same is replaced y cold water from cold water tank, fixed above the hot water tank.



Solar water heater

Q.No. 6 f))

The main components of VCC are: (2 Marks)

1) **Compressor:** Compressor is the most important component of VCC refrigeration system and is considered being the heart of the system. The function of compressor is to compress the low pressure refrigerant from evaporator to condenser pressure at a temperature more than saturation temperature corresponding to condenser pressure.
2) **Condenser:** condenser is heat rejection component in vapour compression system.
   Function of condenser in refrigeration system is to superheat and condense the compressor discharged vapour and frequently to sub-cool the liquid with minimum pressure drop.
3) **Expansion Device:** It is the pressure reducing component in vapour compression system. Its function is to reduce pressure of refrigerant from condenser pressure to evaporator pressure by throttling and to control mass flow rate of refrigerant entering in evaporator as per load on evaporator.
4) **Evaporator:** It is a component in which refrigerating effect is obtained. Refrigerating effect is produced in evaporator. The liquid at low pressure enters in evaporator, by absorbing heat it converts into vapours. These vapours are drawn in suction line of compressor.

Applications of V.C.C. (2 Marks)

1) Water cooler
2) Domestic refrigerator
3) Ice plant
4) Cold storage
5) Air Conditioner