SUMMER – 2022 EXAMINATION

Subject Name: Basic Mechanical Engineering **Model Answer:** **22214: BME**

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 FIVE of the following:**	**10 Marks**
	a)	Define enthalpy and state its unit. **Ans:** **Enthalpy:** Enthalpy of a substance can be defined as a thermodynamic property which indicates the total heat content of the substance. It can also be defined as thermodynamic property which is the sum of internal energy (u) and product of pressure and volume (pv). Its unit is J or kJ. Unit of specific enthalpy is J / kg or kJ / kg.	1 mark for def. and 1 mark for unit.
	b)	Define i) superheated steam and ii) wet steam **Ans:** **i) Superheated steam:** The steam which is at a temperature higher than its saturation temperature is known as superheated steam. **ii) wet steam:** The steam which contains moisture or water particles in suspension is known as wet steam.	1 mark for each definition
	c)	State the use of piston in I.C. Engine. **Ans:** The function of piston in I.C. Engine is to transmit the force exerted by burning of high pressure high temperature charge (i.e air fuel mixture) to the connecting rod.	2 marks for correct answer
	d)	Define i) Degree of superheat ii) dryness fraction **Ans:** **i) Degree of superheat:** The difference between temperature of superheated steam and saturated steam is known as Degree of superheat. Thus, degree of superheat= T_{sup}- T_{sat} **ii) Dryness fraction:** Dryness fraction of steam is defined as ratio of mass of dry vapour (steam) present in the sample taken to total mass of sample. Thus, mathematically, dryness fraction x= m_s / (m_s+m_w) where m_s is the mass of dry vapor or dry steam in the sample and m_w is the mass of water in suspension.	1 mark for each definition
	e)	State the function of the turbine and list any two applications.	

Ans:

The function of the turbine is to convert the heat energy of the gas or steam(if it is gas or steam turbine) into mechanical work .In case of water turbine, its function is to convert potential energy of water into mechanical work.

Main application of turbine is in power plants e.g steam turbines are used in thermal power plants, gas turbines in Gas turbine power plants and water turbines in hydroelectric power plants.

1 mark for function and 1 mark for application

f) What did you understand by the term "Ton of refrigeration."?

Ans:

The cooling capacity of any refrigerating machine is measured in Ton (TR) just like the capacity of an engine or electric motor is measured in kW.

One Ton (1TR) of refrigeration is defined as the quantity of heat required to be removed to form one tonne (1000 kg) of ice within 24 hours when initial condition of water is 0^0C.

A refrigerating machine capable of doing this is said to have capacity of one ton (1TR)

It is approximately equal to 3.5 kJ/s.

2 marks for correct answer

g) State the function of evaporator and condenser in refrigerator.

Ans:

Function of evaporator:

The function of evaporator is to obtain cooling effect. It is placed in the space where cooling effect is required. Low pressure and low temperature refrigerant when passes through evaporator coils, it gets evaporated and heat required for evaporation is absorbed from surroundings and thus cooling effect is obtained.

Function of condenser:

The function of condenser is to condense the high pressure and high temperature refrigerant coming from the compressor and convert it into liquid form by using some cooling media such as air or water.

1 mark each for the function of condenser and evaporator

2. Attempt any THREE of the following: 12 Marks

a) Differentiate between boiler mountings and boiler accessories

Ans:

Sr. No.	Boiler mountings	Boiler accessories
1	These are safety devices mounted on the boiler for the purpose of boiler safety.	These are attached to the boiler for increasing its efficiency.
2	They are compulsory as they are related to safety.	They are not compulsory
3	These are mounted on the boiler.	These are attached to the boiler.
4	These are not heat recovery systems.	These are heat recovery systems.
5	Examples: water level indicator, safety valves, fusible plug	Examples : Air preheater, super heater, economizer

Any four points , 1 mark for each correct point = 4 Marks

b) State the necessity of compounding the steam turbine.

Ans:

In the recent years, high pressure (100 to 140 bar) and high temperature steam is used in the power plants to increase thermal efficiency. If the entire pressure drop from the boiler

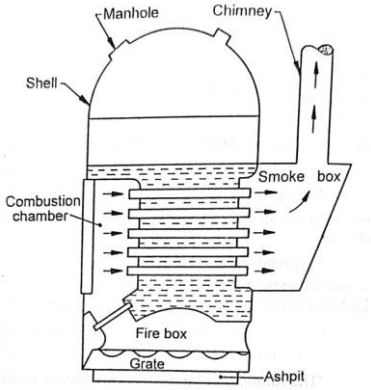
pressure to condenser pressure say from 125 bar to 1 bar, is carried out in one stage only, then the velocity of the steam entering into the turbine will be very high resulting in very high rotor rpm approximately up to 30,000 rpm. As such a high speed is not practicable, it is necessary to reduce this speed to normal value otherwise large reduction gearing would be required to reduce the speed. Hence, various methods adopted to reduce the speed of a simple impulse turbine are known as compounding of the steam turbine. In compounding, multiple stages are arranged one after another and steam is expanded step by step to control the turbine speed.

4 marks for appropriate answer

c) Draw the neat sketch of Cochran boiler.

Ans:

Cochran boiler:

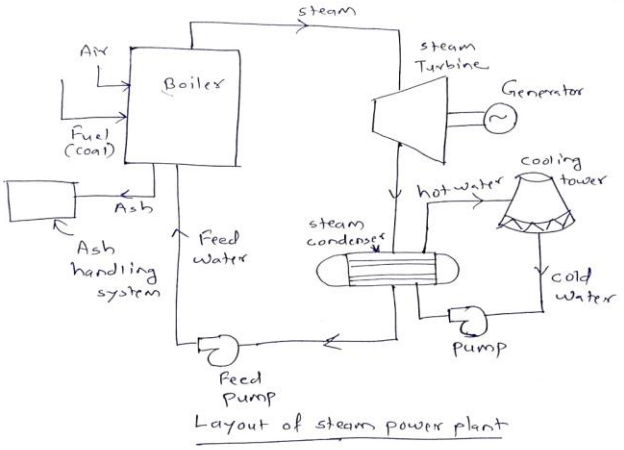


3 marks for sketch, one marks for labeling

d) Draw the layout of steam power plant and state the function of any two major components.

Ans:

Layout of steam power plant:



2 marks for diagram and one mark each for the function

1. **Steam turbine:** The function of steam turbine is to convert heat energy of steam into mechanical work.
2. **Steam condenser:** Its function is to condense low pressure and low temperature steam coming from the turbine into water which is known as condensate.
3. **Steam Boiler:** Its function is to generate steam by boiling feed water.
4. **Cooing Tower :** Its function is to cool hot cooling water coming from the condenser and giving back to condenser after cooling.
5. **Feed pump :** Its function is to pump feed water to boiler from condenser.

3. Attempt any THREE of the following: 12 Marks

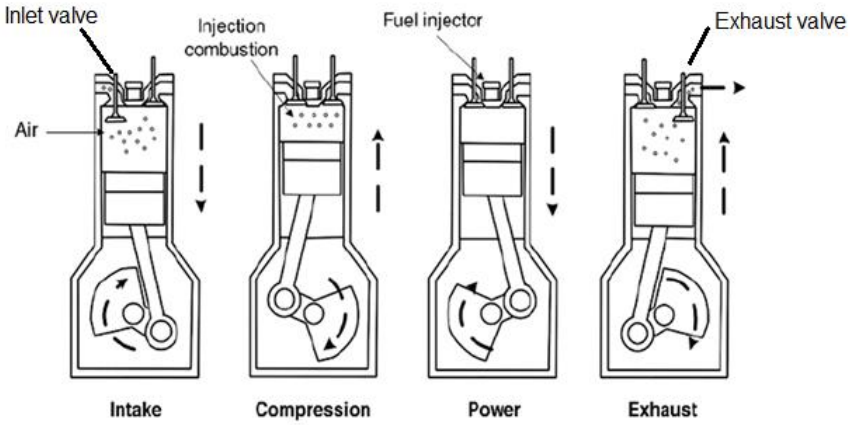
a) Define the terms:
(i) Indicated power (ii) Brake power (iii) Brake thermal efficiency

Ans:

i) Indicated power: Indicated power is the total power developed inside the engine cylinder. 1 Mark
ii) Brake power: Brake power is the actual or useful power available at the crank shaft. 1 Mark
iii) Brake thermal efficiency: Brake thermal efficiency is the ratio of heat equivalent of brake power per unit time to total heat Supplied to the engine per unit time by combustion of fuel . 2 Marks

b) Explain the working of 4 stroke diesel engine with neat sketch.

Ans:



2 marks for Sketch

Working of four stroke diesel engine- In four stroke cycle diesel engines, working cycle completes within four strokes of the piston or two revolutions of the crank shaft.

Intake (suction stroke):- Here piston moves from TDC to BDC, the inlet valve opens and fresh atmospheric air is drawn inside the engine cylinder. The exhaust valve remains closed during this stroke.

Compression:-At the beginning of compression piston is at BDC. When piston starts moving from BDC to TDC, the air inside the engine cylinder is compressed to high pressure and high temperature.

Power or Expansion stroke: - After the completion of compression stroke, diesel is injected into the cylinder in the form of fine spray by fuel injector. The high temperature of compressed air is sufficient to ignite the diesel leading to its combustion at constant pressure.

Due to combustion of fuel high pressure hot gases are produced and expand inside the engine cylinder. During expansion these gases forces the piston to move again from TDC to BDC. Thus work is produced.

Exhaust stroke: - After the completion of power stroke, the piston moves from BDC to TDC. Exhaust valve opens and the burnt gases are driven outside the engine cylinder by the piston through the exhaust valve. When piston reaches at TDC, the exhaust valve get closed and cycle completes.

2 marks for explanation of working

c) Mention any two faults and its remedies regarding I.C. engine with its justifications.

Ans:

1) Fault:-Engine does not start.
Remedies: - i) Check ignition coil, contact breaker point and spark plug. If defective

Replace
ii) Check fuel system. Also check whether there is fuel in tank.
iii) Check battery, if it is discharged then charge it or replace with new One.

2) Fault: - Engine overheating.
Remedies: - i) Check the coolant level. If less then add the coolant.
ii) Inspect the cooling system. If required repair it.
iii) Defective thermostat. Replace it.
iv) Clean the radiator.
v) Adjust injection timing. It may be incorrect.

3) Fault: - Less power developed.
Remedies:-i) Run the engine smoothly.
ii) Clean or replace the air filter.
iii) Check fuel supply system.

4) Fault: - High fuel consumption.
Remedies: - i) Inspect the piston rings and cylinder liners. If faulty then replace.
ii) Check valves and valve mechanism. If wear in valves, replace it.
iii) Check and adjust clearance between rocker arm and valve.
iv) Check fuel pump, fuel injectors, air filter, if faulty then clean or replace
v) Check the oil level. If it is too high then drain the excess oil.

5) Fault:- Smokey exhaust of diesel engine.
Remedies: - i) Check the fuel injection pump. If it is faulty then service it or replace it
ii) Check fuel injectors. Change or repair it.
iii) Check the oil level in the sump. Do the correct level.
iv) Check the air filter. Clean or replace it.

6) Fault: - Engine turns slowly.
Remedies: - i) Check fuel injection pump. If there is some restrictions then clean it.
ii) Engine may be seized, if so then repair it.
iii) Check electrical system. If any problem then repair it.

2 marks for each of any two faults and its remedies. = 4 Marks

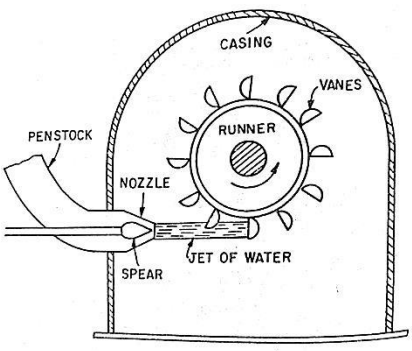
NOTE: Examiner is requested to give credit to those students also, who writes other faults and their remedies with justification.

d) State the working principle of Pelton turbine giving two applications.

Ans:

Pelton Turbine Working principle:

The Pelton turbine is tangential flow impulse turbine. In impulse turbine the pressure energy of water is converted into kinetic energy when passed through nozzle and forms high velocity jet of water. The jet is used to drive the wheel. Thus pressure energy is converted into kinetic energy which is further converted into mechanical energy(rotary motion).



Applications:

Pelton turbines are used as prime mover to generate electricity in hydroelectric projects. Pelton turbines are suitable where head available is high.

For Ex. i) Koyana hydroelectric project (Maharashtra),
ii) Sharavati hydroelectric project (Karnataka).

1 mark for sketch , 2 marks for correct principle and 1 mark for applications.

4. Attempt any THREE of the following: **12 Marks**

a) Differentiate between centrifugal compressor and reciprocating compressor.

Ans:-

Sr.No.	Centrifugal Compressor	Reciprocating Compressor
1	It uses centrifugal force to compress the air	It uses reciprocating motion of the piston to compress the air.
2	It gives continuous output of compressed air.	It gives intermittent output of compressed air.
3	No vibrations	Heavy vibrations
4	Less wear and tear	High wear and tear
5	Longer life	Shorter life
6	Less noisy	Noisy operation
7	Runs at high speed	Runs at low speed
8	Large volume of air is handled	Less volume of air is handled
9	High efficiency	Low efficiency
10	Increase in pressure per stage is less	Increase in pressure per stage is high
11	It is compact	It is bulky
12	Needs less floor area	Needs large floor area

Any 8 points (8 ×½ mark) =4 Marks

b) List any four applications of compressed air.

Ans:-

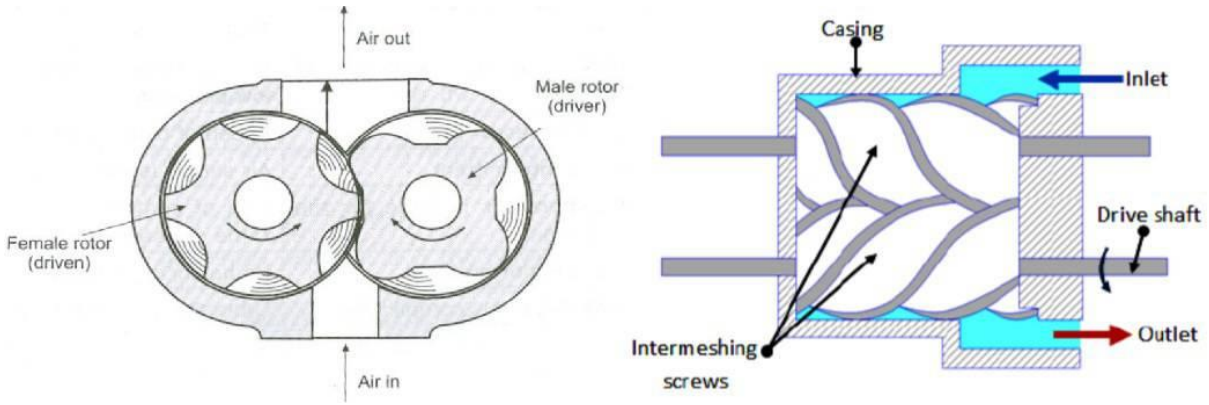
1) For filling air in the tyres of automobile
2) For spray painting
3) Cleaning of automobiles
4) Supercharging of I.C. engines
5) Automobile braking system
6) In pneumatic tools
7) In sand blasting.

1 mark for each of any 4 applications = 4 Marks

c) Draw the neat sketch of screw compressor and label it.

Ans:

Screw compressor:



2 marks for sketch
2 marks for labels.
(Any one view)

d) Name the hazardous pollutants in a steam power plant with their effect on human body.

Ans :

Hazardous pollutants in a steam power plant with their effect on human body:

The names of hazardous pollutants in a steam power plant and their effects on human body are given in the table below.

Sr. No.	Name of the pollutant	Effect on human health
1	SO_2 (Sulphur dioxide)	Suffocation, irritation of throat and eyes, respiratory, asthma. lung cancer
2	NOx (Nitrogen oxides)	Irritation ,Bronchitis ,Oedema of lungs
3	CO (carbon monoxide)	Poisoning cardiovascular diseases, increases accident liability
4	Particulates(Dust, fume, mist and soot (0.1 to 10 μ size)	Respiratory diseases like silicosis (cough, cold, sneezing)asbestosis
5	CO_2 (Carbon Dioxide)	Greenhouse gas, responsible for global warming and climate change. This is the biggest challenge today for human life.

1 mark for each of any four pollutants = 4 marks

e) Mention the corrective actions to reduce the electricity bill due to air compressor.

Ans:-

Following are some of the corrective actions to reduce the electricity bill due to air Compressor—

1) Use of multistage compression. It consumes less power for the same output than that of a single stage compressor.
2) Use of inter cooler between two stages.
3) Water jacketing—By this water is kept circulating around the cylinder of the compressor. Due to this, heat generated during the compression is removed, so the rise in temperature in compressor is less.
4) Cold water spray--- By spraying the cold water into the compressor cylinder at the end of the compression stroke reduces temperature rise which reduces energy required to compress the air.
5) Fins--- By providing the fins on the external surface of the compressor cylinder, heat transfer rate from cylinder to atmosphere increases, which reduces energy for compression and hence electricity bill.
6) Keep the compressor at high altitude.
7) Proper pipe size and regular cleaning of filter elements minimizes the pressure losses, which saves energy.

1 Mark for each of any four corrective actions = 4 Marks

5 Attempt any TWO of the following: 12 Marks

5 a) Explain centrifugal pump with its neat sketch and constructional features.

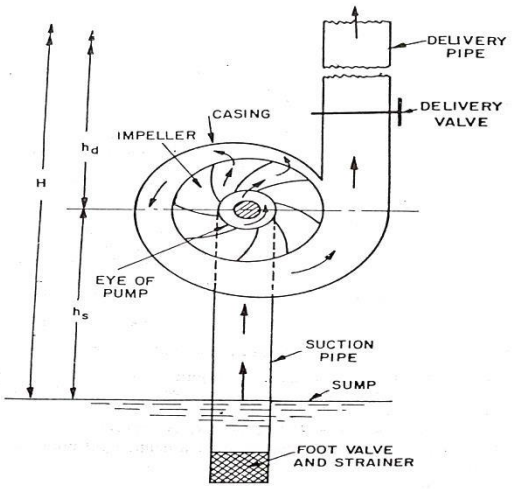
Ans: Constructional features of Centrifugal Pump:

Centrifugal pump consist of following main components. i)Impeller, ii) Casing iii) Suction pipe with foot vale and strainer and iv) Delivery pipe

Constructional features of Centrifugal Pump are shown in the figure**.**

i) Impeller: An impeller is a wheel (rotor) with a series of backward curved vanes (blades).It is mounted on a shaft which usually coupled to an electric motor.

ii) Casing: The casing is an airtight chamber surrounding the impeller. It is designed in such a way that the kinetic energy of the water discharged at the outlet of the impeller is converted into pressure energy before the water enters s the delivery pipe. The casing supports suction and discharge arrangement, provides housing to impeller.



2 marks for sketch and 4 Marks for correct constructional features = 6 Marks

iii) Suction pipe with foot vale and strainer:
The pipe connects the centre /eye of the impeller to sump from which liquid to be lifted is known as suction pipe. A foot valve which is non-return valve is fitted at the lower end of the suction pipe. The foot valve opens only in the upward direction and it does not permit the liquid drain out through suction pipe when pump is not in working and helps in priming. A strainer is also fitted at lower end of suction pipe to prevent entry of solid particles.

iv) Delivery pipe: A pipe whose one end is connected to the outlet of the pump and other end delivers the water at required height is known as delivery pipe.

5 b) Describe Francis Turbine with its neat sketch. Also mention any two applications of Francis Turbine.

Ans:

Francis Turbine:

Francis turbine is inward mixed flow reaction turbine. Water under pressure enters the runner from the guide vanes towards the centre in radial direction and discharge out of the runner axially. Francis turbine operates under medium head. Water is brought down to the turbine through the penstock and directed to a number of stationary guide vanes.

The schematic diagram of Francis turbine is as shown in the figure. The main parts of the turbine are:

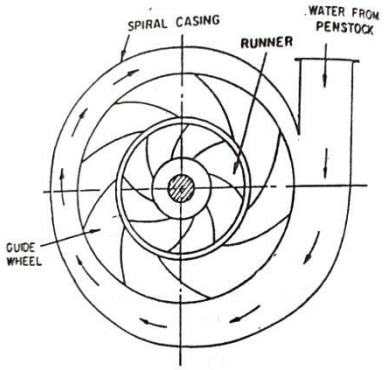
i) Penstock: It is large size conduit which conveys water from upstream of the reservoir to the turbine runner.

ii) Spiral casing: It constitutes a closed passage whose cross sectional area gradually decreases along the flow direction.

iii) Guide vanes: These vanes direct the water onto the runner at an angle appropriate to the design.

iv) Governing mechanism: It changes the position of the guide vanes to affect a variation in water flow rate.

v) Runner and runner blades: The driving force on runner is both due to impulse and reaction effects.



2 marks for sketch and 3 marks for correct description and 1 mark for any two applications.

vi) Draft tube: It is gradually expanding tube which discharges water passing through the runner to tail race.

Applications: Francis turbines are used as prime mover to generate electricity in hydro - electric projects. Francis turbines are suitable where head available is medium and also quantity of water is medium.

For Ex. i) Bhakhra hydroelectric project(Punjab),
ii) Cauvery hydroelectric project (Karnataka).
iii) Chambal hydroelectric project (Rajasthan).
iv) Hirakud hydroelectric project (Orissa).

5 c) Explain window air conditioning system with neat sketch.

Ans:

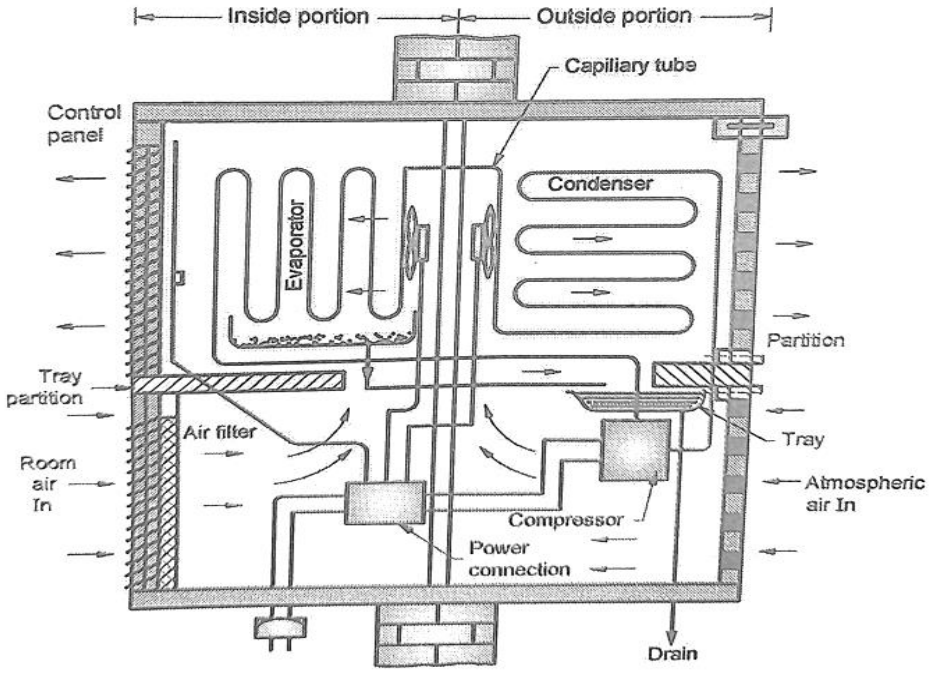
The casing of the window air conditioner is divided into two parts by a partition. The part which extends outside of the room is outdoor part and which extends in the room is called as indoor part. Outdoor part contains hermetically sealed compressor .condenser, fan and tray, while indoor part contains evaporator, fan, control panel, an air filter, power connection and tray. Outdoor portion is again divided into two parts by a partition with opening at left hand side. Indoor portion is also divided into two parts with opening at right hand side. The whole unit is fitted in the window such that outdoor part remains outside the window and indoor part in the room.

Sketch 3 marks and explanation of working 3 marks.

The conditioner works on vapour compression refrigeration system. The air from the room is drawn through the air filter at lower part of indoor portion with the help of fan. The air is then forced over the evaporator coil by the same fan and is cooled and circulated back into the conditioned room. The moisture removed from the air is collected into the pan at bottom of the evaporator coil. The moisture then flows to the tray of outdoor portion.

The compressor and condenser are mounted in such a way that the fan in the same compartment draws outside air from lower portion of the unit circulates it over the condenser coil and discharge it outside from the upper portion of the unit.

When required temperature is reached in the room, the unit automatically stops.



6 Attempt any TWO of the following: 12 Marks

6 a) Add a short note on methods of energy saving in refrigeration and air conditioning systems.

Ans:

In most of the refrigeration and air conditioning devices the electrical energy is supplied to the compressor to get the desired refrigerating effect. Following are some of the methods/tips which can reduce the energy consumption in refrigeration and air conditioning units. 6 marks for correct explanation.

1) Do not use unnecessary lower evaporator temperature. For less evaporating temperatures the compressor runs for longer time, which increases the energy consumption.
2) The condenser should be of proper capacity and of proper type. The condenser pressure directly affects the compressor discharge pressure. If discharge pressure increases, energy consumption increases.
3) Maintain the evaporator and condenser coils surface clean. This increases heat transfer rate.
4) Use of multistage compression systems reduces energy consumption.
5) Operate the systems at full load capacity as per the designed capacity. Do not operate at part load.
6) Use proper type of insulating material with proper thickness. Which reduces heat losses.
7) Minimize the heat loads.
8) Ensure the air conditioner does not get overloaded.
9) Replace or clean the air filters regularly.
10) Avoid frequent opening and closing of doors.
11) Routinely inspect for refrigerant leakage.

6 b) Explain the working principle and state any two applications of the following:
i)Reciprocating pump
ii)Rotary pump

Ans:

i) Reciprocating pump: The reciprocating pump is a positive displacement pump as it sucks and raises the liquid by actual displacing it with a piston/plunger that executes a reciprocating motion in a closely fitting cylinder. The amount of fluid pumped is equal to volume displaced by the piston. 2 marks for working principle

Applications: The reciprocating pump is suitable for relatively less discharge and high pressure. Some common applications are i) Light oil pumping, ii) Pneumatic pressure system. iii) Bore well pump iv) Boiler feed pump v) cycle pump vi) Football pump etc. 1 mark for any two applications

ii)Rotary pump: The rotary pump is a rotodynamic pump in which increase in energy of fluid is due to combination of centrifugal energy, pressure energy and kinetic energy. The pumps work on the principle of forced vortex flow which means that when a certain mass of liquid is rotated by external torque, the rises in pressure of the rotating liquid takes place. 2 marks for working principle

Applications: The rotary pump is suitable for relatively less pressure and high discharge. Some common applications are i) Lifting of highly viscous liquid like paper pulp, muddy water, sewage water, oil etc. ii) These can also be used lift water from well or river for farm irrigation. 1 mark for any two applications

6 c) Differentiate between impulse turbine and reaction turbine.

Ans:

Sr. No.	Impulse turbine	Reaction turbine
1	Available fluid energy is converted	Available fluid energy is partly converted

	into kinetic energy by nozzle.	into kinetic energy by nozzle before entering the runner.	
2	Pressure remains the same throughout the action of fluid on the runner.	After entering the runner with an excess pressure, fluid undergoes changes both in velocity and pressure while passing through the runner.	1 Mark for each of any six points of differences = 6 Marks
3	Relative velocity remains constant throughout the action of fluid on the runner.	Relative velocity does remains constant (continuously increases) throughout the action of fluid on the runner.	
	Speed of turbine is high	Speed of turbine is relatively low.	
4	Air tight casing is not required.	Air tight casing is required.	
5	Always installed above the tail race.	May be installed above or below the tail race.	
6	No draft tube is used.	Draft tube is used.	
7	Space required is less.	Space required is more.	
8	Flow regulation is by means of needle valve fitted into the nozzle.	Flow regulation is by means of guide vanes assembly.	
9	Guide vanes are absent	Guide vanes are present.	
10	Loss of energy is more as compare with reaction turbine.	Loss of energy is less as compare with impulse turbine.	
11	Suitable for small power generation	Suitable for medium to high power generation.	
12	It has low efficiency.	It has more efficiency as compare with impulse turbine.	