MODEL ANSWER

SUMMER– 18 EXAMINATION

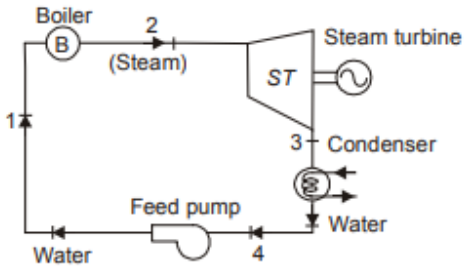
Subject Title: **BME** Subject Code: 22214

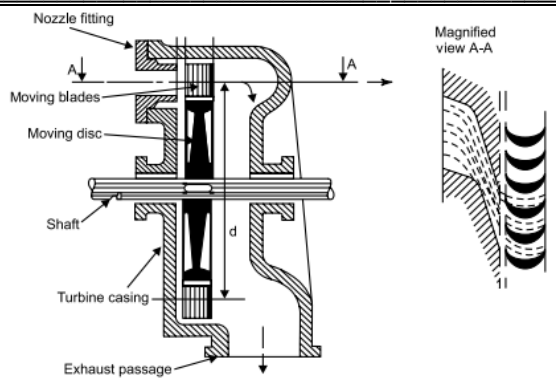
Important Instructions to examiners:

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
Q. 1	a)	**Dryness fraction**: It is the mass fraction of vapour in a mixture of liquid and vapour at any point in liquid-vapour mixture region. It is generally denoted by 'x'. It is also called quality of steam. Dryness fraction; $x = \frac{\text{Mass of vapour}}{\text{Mass of liquid} + \text{Mass of vapour}}$ **Degree of superheat** is given by difference between temperature of steam and saturation temperature at given pressure. Degree of superheat = Temperature of steam – Saturation temperature at given pressure.	**01 M EACH** **2 Marks**
	b)	**Compounding of steam turbine** is required as in case of simple impulse turbine, the single stage may offer speed of the order of 30,000 rpm which cannot be directly used for any engineering application and needs to be reduced. Also such a high speed shall induce large stresses in the blades. Compounding is a thermodynamic means for reducing the speed of turbine where speed reduction is realized without employing a gear box.	
	c)	**Important components of I.C. engine**: i) Cylinder block, ii) cylinder head, iii) crankshaft, iv) Piston, v) connecting rod, etc….	**01 M each**

	d)	**Mach number** is defined as the square root of the ratio of the inertia force of a fluid to the elastic force. $\therefore$ Mach number, $M = \sqrt{\frac{\text{Inertia force}}{\text{Elastic force}}} = \sqrt{\frac{\rho A V^2}{KA}}$ $= \sqrt{\frac{V^2}{K/\rho}} = \frac{V}{\sqrt{K/\rho}} = \frac{V}{C}$ $[\because \sqrt{K/\rho} = C$. $M = \frac{V}{C}$ Thus, $M = \frac{\text{Velocity at a point in a fluid}}{\text{Velocity of sound at that point at a given instant of time}}$	**02 Marks**
	e)	**Effects of knocking** (1) **Noise** – As intensity of detonation increases, the sound intensity increases & it is harmful. (2) **Mechanical damage** – shock waves are so violent that it may cause mechanical damage like breaking of piston. It increases the rate of wear erosion of piston. (3) **Power output & efficiency decreases** - Power output & thermal efficiency decreases due to abnormal combustion. (5) **Increase in heat transfer** – Temperature of cylinder in detonating engine is higher than in non – detonating engine, hence increases the heat transfer. (6) **Carbon deposits**- Detonation results in increased carbon deposits.	**Any two** **01 m each**
	f)	**ton of refrigeration''** is defined as the refrigerating effect produced by the melting of 1 tonne of ice from and at 0°C in 24 hours. Since the latent heat of fusion of ice is 336 kJ/kg, the refrigerating effect of 336 × 1000 kJ in 24 hours is rated as one tonne, i.e., 1 tonne of refrigeration (TR) = 336 1000 24 × = 14000 kJ/h.	**2 marks**
	g)	**Effects of frosting:** 1. It will maintain operating efficiency 2. Increasing the space available for food storage 3. Frozen food will not stick together 4. Smells are limited 5. Better temperature management	**01 mark each**

Q. 2			
	a)	**Clausius Statement -**"It is impossible for a self acting machine working in a cyclic process unaided by any external agency, to convey heat from a body at a lower temperature to a body at a higher temperature". In other words, heat of, itself, cannot flow from a colder to a hotter body. Example : Heat pump **Kelvin-Planck Statement** -"It is impossible to construct an engine, which while operating in a cycle produces no other effect except to extract heat from a single reservoir and do equivalent amount of work".	**02 M each**
	b)	Example : Heat Engine **Super heater**: Its purpose is to super heat steam and is a type of heat exchanger in which steam flows inside tubes and hot gases surround it	**2 Marks each**
	c)	**Fusible plug:** It is a safety device used for preventing the level of water from going down below a critical point and thus avoids overheating. Fusible plug is mounted at crown plate of combustion chamber.	
	d)	**Layout of steam power plant**  *Simple steam power plant layout* **IMPULSE TURBINE**: Schematic of impulse steam turbine is shown in Fig. It has single-stage having a nozzle fitted in the casing followed by ring of moving blades mounted on the shaft. Variation of velocity and pressure along the axis of turbine is also shown here. Here pressure drop occurs only in the nozzle and ideally no pressure drop occurs in blades. High pressure steam from boiler enters the nozzle through piping and leaves nozzle at predefined angle so as to smoothly flow over the moving blades. Steam velocity gets increased during its flow through nozzle due to its expansion occurring in it. During the passage of steam over the moving blades steam undergoes change in its' direction while losing the velocity and thus causing rotation of moving blade ring mounted on shaft	**2 M for sketch & 2 M for labeling** **02 M for explain & 02 M for Sketch**



Schematic of simple impulse steam turbine stage

Q. 3 a) i

Engine does not start: Causes and Remedies

1. No fuel in tank. Fill tank with clean, fresh fuel.
2. Shut-off valve closed. Open valve.
3. Obstructed fuel line. Clean fuel screen and line. If necessary, remove and clean carburetor.
4. Tank cap vent obstructed. Open vent in fuel tank cap.
5. Water in fuel. Drain tank. Clean carburetor and fuel lines. Dry spark plug and points. Fill tank with clean, fresh fuel.
6. Engine over choked. Close fuel shut-off and pull starter until engine starts. Reopen fuel shut-off for normal fuel flow.
7. Improper carburetor adjustment. Adjust carburetor.
8. Loose or defective magneto wiring. Check magneto wiring for shorts or grounds; repair if necessary.
9. Faulty magneto. Check timing, point gap; if necessary, overhaul magneto.
10. Spark plug fouled. Clean and re-gap spark plug.
11. Spark plug porcelain cracked. Replace spark plug.
12. Poor compression. Overhaul engine.
13. No spark at plug. Disconnect ignition cut-off wire at the engine.
14. Crank engine. If spark at spark plug, ignition switch, or safety switch interlock switch is inoperative. If no spark, check magneto.

Any 4 ½ Mark each

ii

Smoky exhaust of diesel engine: Causes and Remedies

Problem	Solution
➢ engine is burning oil	➢ Change the oil grade
➢ worn or broken piston rings	➢ Change piston ring
➢ worn valve guide or valve guide seals	➢ Change valve guide or seals
➢ leaking head gasket	➢ Change head gasket
➢ broken or cracked engine head	➢ Change or servicing engine head
➢ Air/fuel mixture is too rich	➢ Change injector
➢ leaky fuel injector	
➢	

Any 4 ½ Mark each

b) **Difference between open and closed cycle gas turbine**

S.no	Closed Cycle Gas Turbine	Open Cycle Gas Turbine
1	It works on closed cycle. The working fluid is recirculates again and again. It is a clean cycle.	It works on open cycle. The fresh charge is supplied to each cycle and after combustion and expansion. It is discharge to atmosphere.
2	The gases other than the air like Helium or Helium-Carbon dioxide mixture can be used, which has more favorable properties.	Air-fuel mixture is used which leads to lower thermal efficiency.
3	Since heat is transferred externally, so any type of fuel; solid, liquid or gaseous or combination of these can be used for generation of heat.	Since combustion is an integral part of the system thus it requires high quantity liquid or gaseous fuel for burning in a combustio chamber.
4	The heat is transferred indirectly through a heat exchanger.	Direct heat supply. It is generated in the combustion chamber itself
6	High thermal efficiency for given lower and upper temperature liquids.	Low thermal efficiency for same temperature limits.
7	Part load efficiency is better.	Part load efficiency is less compared to Closed cycle gas turbine.
8	Reduced size per MWh of power output.	Comparatively large size for same power output.
9	Since combustion products do not come in direct contact of turbine blade, thus there is no blade fouling and longer blade life.	Direct contact with combustion products, the blades are subjected to higher therma stresses and fouling and hence shorter blade life.
10	Better control on power production.	Poor control on power production.

Any 4 01 Mark each

11	Closed cycle gas turbine plant is complex and costly.	Open cycle gas turbine plant is simple and less costly.	

c) **Various measures to control the pollution due to petrol and diesel engine**

TECHNICAL MEASURES

VEHICLE TECHNOLOGY
FUEL QUALITY
AFTER COMBUSTION TECHNOLOGY
ALTERNATIVE FUEL ZERO EMISSION VEHICLES (ZEVS)
MASS TRANSIT SYSTEM
URBAN ROAD & FLYOVER PROJECTS
I&M / PUC PROGRAMME T

Any 4 ½ Mark each

NON-TECHNICAL MEASURES

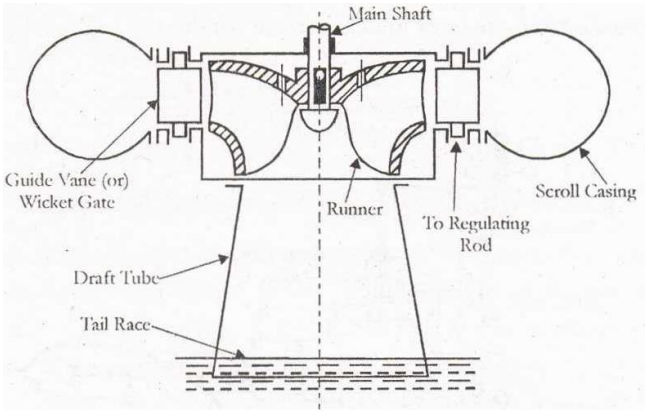
EMISSION WARRANTY
SCRAPING OLD POLLUTING VEHICLES
TOLL TAX FOR COMMERCIAL VEHICLES
SUBSIDIES FOR CLEAN VEHICLES
PARKING CHARGES & FINE ENCOURAGING CAR POOL
AWARENESS CAMPAIGNS N

Any 4 ½ Mark each

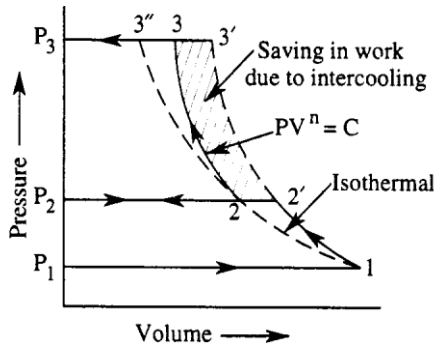
d) **A dam having 50m head of water**

For suggested 50 m head of water Kaplan turbine is suggested because this type of turbine is suitable for low head high discharge provided ample quantity of water. e.g. Range starts from 5 m to 80 m head of water.

2 Marks

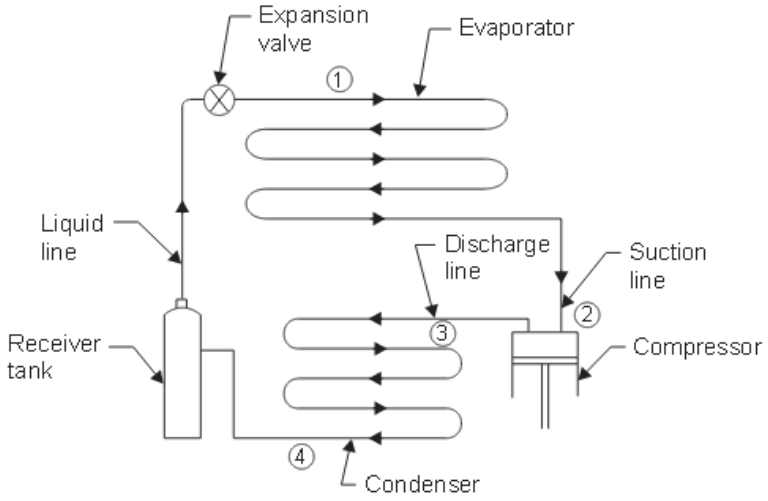


2 M for sketch

Q.4	a)	**Two stage reciprocating air compressor with P – V diagram**	
			**P – V diagram** **02 M**
		Two stage reciprocating air compressors consist of two cylinders. One is called low-pressure cylinder and another is called high-pressure cylinder. When piston in a low-pressure cylinder is at its outer dead centre (ODC) the weight of air inside a cylinder is zero (neglecting clearance volume), as piston moves towards inner dead centre (IDC) pressure falls below atmospheric pressure & suction valves open due to a pressure difference. The fresh air is drawn into the low-pressure cylinder through air suction filter. This air is further compressed by piston and pressure inside & outside the cylinder is equal, at this point suction valves closed. As the piston moves towards ODC compression of air took place, then delivery valves open & this compressed air is then entered into a high-pressure cylinder through the intercooler. This called low-pressure compression. Suction valves of a high-pressure cylinder open when the air pressure in a high-pressure side is below to the receiver pressure & air from low-pressure cylinder drawn into the high-pressure cylinder. As piston moves towards the ODC, first stage air is further compressed. When air pressure from the low-pressure cylinder and inside the high-pressure cylinder is equal, suction valves closed. Now the air is further compressed by piston until the pressure in the High-Pressure Cylinder exceeds that of the receiver & discharge valves open. This desired high-pressure air is then delivered to a receiver.	**02 Marks**
	b)	i) Refrigerator : Hermatically sealed compressor ii) Central air conditioner : Open type reciprocating compressor iii) Air filling station : Reciprocating compressor iv) Domestic air cooler : Blower	**1 M each**
	c)	**Methods to reduce power consumption of air compressor** 1. Cooling cylinder by spraying water during compression stroke. 2. Circulation of water surrounding to cylinder by providing jackets 3. Installing inter cooler between two cylinders	**1 M for each**

		4. Providing greater fins on cylinder 5. By selecting suitable material for cylinder 6. By providing suitable choice of cylinder proportions i.e. short stroke and large bore in construction with sleeve valve	**method**
	d)	**Brake thermal efficiency** = Brake power/ Heat supplied = 4.2/16.8 = 0.25 = (25 %)	**4 Marks**
	e)	**Power developed by the turbine** = ρ . g . Q . H = 1000x9.81x3.5x120 = 4120200 Watt = 4120.2 kW = 4.1202 MW	**4 Marks**
Q. 5	a)	Figure shows line diagram of domestic Refrigerator. It consists of following parts performing important functions like in basic vapour compression refrigeration system. **Compressor** A compressor is introduced for this purpose. The compressor will raise the pressure back to its initial level. But since it is compressing gas, along with pressure, temperature will also be increased. This is unavoidable. **Condenser (For Heat Rejection Process)** This heat exchanger is fitted outside the refrigerator, and the refrigerant temperature is higher than atmospheric temperature. So heat will dissipate to the surroundings. The vapor will be condensed to liquid, and the temperature will return to a normal level. It has 4 main components: compressor, condenser, evaporator, and throttling device. Of these components, the throttling device is the one that is responsible for the production of the cold liquid. So we will first analyze the throttling device in a detailed way and move on to the other components. **Throttling Device** The throttling device obstructs the flow of liquid; cold liquid is produced with the help of this device. In this case, the throttling device is a capillary tube. The capillary tube has an approximate length of 2 m and an inside diameter of around 0.6 mm, so it offers considerable resistance to the flow. **Evaporator – (For Heat Absorption Process)** The next phase is simple: this cold liquid is passed over the body that has to be cooled. As a	**Explain** **4 marks**

result, the refrigerant absorbs the heat. During the heat absorption process, the refrigerant further evaporates and transforms into pure vapor. A proper heat exchanger is required to carry the cold refrigerant over the body. This heat exchanger is known as an evaporator.



2 Marks for sketch

b)

Suggested remedial Actions

i) Desired cooling effect is not getting: Charging of gas is required

ii) A/c making noise: Due to overloading, due to low voltage, Fault / Problem in Compressor fan, compressor is running out of use, cooling blower damaged, etc.

iii) Unit is not running: Fuse not ok, Short circuit, Thermostat not set to cool position, Compressor failed, Solenoid not working, etc.

iv) Air throw with bad odour & dust: Filters are choked or rusted or not cleaned, Fresh air induction necessary, contamination of smell in room itself, gas leaking, etc.

1.5 Marks each

c) **Suitable type of A/c for:**

i) Computer Lab with 60 PCs: Split A/c in Multiple numbers (may be 6 to 8 A/c of 1Ton capacity required)

ii) Auditorium: Central Air conditioning system

iii) ATM: Split A/c

02 Marks each

Q. 6	a)	i) **Defrost Heaters:** The defrost heater is mounted onto or woven right into the evaporator coil in the freezer. The defrost termination limit switch is usually mounted on the side of the evaporator coil or on one of the connecting tubing. It is used for defrosting purpose. ii) **Thermostat:** A thermostat is a component which senses the temperature of a refrigeration system so that the system's temperature is maintained near a desired set point. Usually it is fitted in evaporator for setting cooling temperature. iii) **Low Pressure or LP cut out**: This is a compressor safety which cut off the compressor in the event of pressure drop in the suction line. The pressure of the suction line is continuously sensed by the control unit and when it goes below the set value, which means the room is properly cooled, the LP cut out will auto trip the compressor. When the pressure rises, indicating there is flow of refrigerant in the line due to increase in room temperature, the LP switch will start the compressor. **High pressure or HP cut out:** As the name suggests, the high pressure cut out activates and trips the compressor when the discharge side pressure increases above the limit value. The HP cut out is not auto reset and has to be done manually. The reason behind it is to manually attend the fault which is leading to rise in pressure; else this situation can lead to overloading of compressor parts and may damage the same.	**02 Marks each**
	b)	**Classify Nozzles:** **According to the shape or geometrical profile** i) Convergent Nozzles ii) Divergent Nozzles iii)Convergent – Divergent Nozzles **According to the velocity at exit of nozzle** i) Sub-sonic Nozzles ii) Sonic Nozzles iii) Super-sonic Nozzles **According to the use of working fluid** i) Liquid Nozzles and ii) Gas Nozzles	**03 M for classify**

		Applications: They are used in i) Spray Pumps ii) Engines iii)Steam turbines iv) Also used in Hose pipes, garden hose, garden sprinkler, kitchen faucet, water fountains, dancing fountains, firefighter hose, fire detectors	**03 for applications**
	c)	**Applications of Pumps** i) **Centrifugal Pumps**: Centrifugal pumps are used in buildings for pumping the general water supply, as a booster and for domestic water supplies. The design of a centrifugal pump makes them useful for pumping sewage and slurries. They are also used in fire protection systems and for heating and cooling applications. **Reason**: It is a low head high discharge pump **ii) Jet pumps** can be used for either oil wells, bore wells (lesser depth), deep or shallow well applications. Mini. jet pumps are used for smaller applications, such as aquariums. **Reason**: It is a medium head and high pressure pump iii)**Submersible Pumps**: Multiple stage submersible pumps are typically lowered down a borehole and most typically used for residential, commercial, municipal and industrial water extraction (abstraction), water wells and in oil wells. Other uses for submersible pumps include sewage treatment plants, seawater handling, fire fighting (since it is flame retardant cable), water well and deep well drilling, offshore drilling rigs, artificial lifts, mine dewatering, and irrigation systems. **Reason**: It is a high head and high pressure pump & there are no cavitations. It has high efficiency at high heads.	**02 Marks each**