17413

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.	Answer	Marking Scheme
1	a)	**Advantages of Super Critical Boilers (Any four – each for ½ marks)** 1. Improvements in plant efficiency. 2. Decrease in Coal Consumption 3. Reduction in Green House gases. 4. Overall reduction in Auxiliary Power consumption. 5. Reduction in requirement of Ash dyke Land & Consumptive water. 6. Sliding pressure operation because of Once through system . 7. Even distribution of heat due to spiral wall arrangement leading to less Boiler tube failure, thereby improving system continuity and availability of the station. 8. Low thermal stress in Turbine. 9. The startup time is less for boiler.	
	b)	**Differentiate between fire tube boilers and water tube boilers** **(Any two points each for 1 mark)**	

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	Failure due to Temperature stress

		causing failure of feed water arrangement is minimum	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	

c)

i) Compression ratio – It is the ratio of total cylinder volume to the clearance volume.

ii) Expansion ratio - It is the ratio of volume after expansion to the volume before expansion

1M each

d)

(Any four – each for ½ mark)

Following are the applications of rotary compressor –

1) Oil refinery
2) Petrol chemical plant
3) Natural gas transmission
4) Refrigeration plant
5) Supercharging of I.C. engines

e)

It is defined as the operation in which the suction pipe, casing of the pump and the portion of the delivery pipe up to the delivery valve is completely filled up from outside source with the liquid to be raised by the pump before the starting the pump.

This means that when there is no water in the pump, it is running in air. The pressure head developed is in terms of meters of air. Whereas when there is water, pressure head developed is in terms of meters of water. But as the density of water is low, the pressure head developed by air is negligible than that developed by water. Due to this water will not be sucked by the pump. To avoid this, priming is necessary.

Def. 1 Mark

Purpose 1 Mark

f)

Functions of nozzles are:

1. To accelerate the steam passing through it.
2. To convert pressure energy into kinetic energy, thereby achieving a pressure drop across the section.

1M each

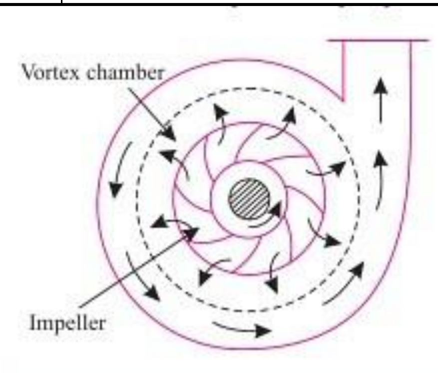
	g)	A steam turbine is a device that extracts thermal energy from pressurized steam and uses it to do mechanical work through the rotation of turbine blades and shaft. An ideal steam turbine is considered to be an isentropic process, or constant entropy process, in which the entropy of the steam entering the turbine is equal to the entropy of the steam leaving the turbine. No steam turbine is truly isentropic, however, with typical isentropic efficiencies ranging from 20–90% based on the application of the turbine.	**1M each**
	h)	FAD is the volume of air delivered by compressor under the intake conditions of temperature and pressure. Capacity of compressor is generally given in terms of free air delivery.	**2M**
	i)	**Following are the applications of compressed air in industry - *(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) For cleaning purposes. 5) To cool large buildings. 6) In the processing of food and farm maintenance. 7) In vehicle to operate air brake. 8) For spray painting in paint industry.	
	j)	**Comparison of reciprocating compressor with centrifugal compressor (Any 4 points)**	**½ Mark each**

Sr. No	Reciprocating Compressor	Centrifugal Compressor
01	Compression of air takes place due to reciprocating motion of piston.	Compression of air takes place due to
02	Deliver of air intermittent	Delivery of air continuous.
03	Delivery pressure is high.	Delivery pressure is low.
04	Flow rate of air is low.	Flow rate of air is high.
05	Speed of compressor is low because of unbalanced forces.	Speed of compressor is high because of perfect balancing.

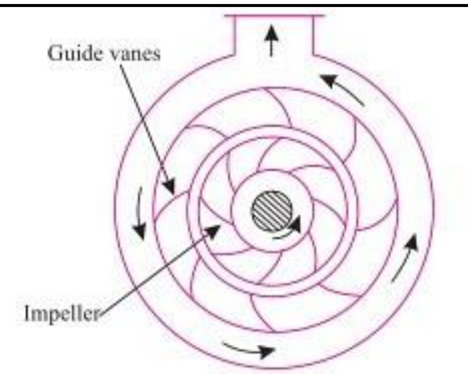
06	It has more number of moving parts, more wear and tear, more lubrication and maintenance required.	It has less number of moving parts, less wear and tear therefore less lubrication and maintenance required.	
07	Used when small quantity of air at high pressure required.	Used when large quantity of air at lower pressure required	
08	It has suction and discharge valves.	In rotary compressor, valves are replaced by ports in the housing.	

k)

1M each



Volute casing



Casing with guide blades

2 a)

Function of each part – 1 mark

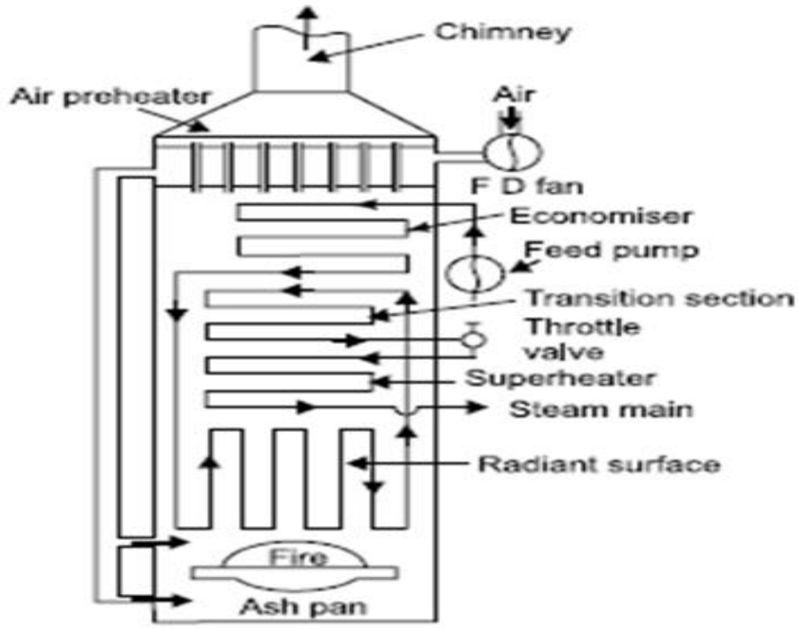
1. **Piston** – It is the heart of the engine. It's function is to compress the fresh charge during the compression stroke and to transmit the force produced due to combustion of the charge to the connecting rod and then to the crank during the power stroke

2. **Crank** - The function of the crankshaft is to translate the linear reciprocating motion of a pistons into the rotational motion required by the automobile.

3. **Piston ring** – The upper piston rings are called compression rings and their function is to provide gas tight seal and to prevent leakage of high pressure gas. The lower piston rings are called oil control rings whose function is to provide effective seal and to prevent the leakage of oil into the engine cylinder.

4. **Cylinder** – It is the main body of the engine in which piston reciprocates to develop power. Sleeves or liners are inserted into the cylinder when the engine block is heavy.

	b)	**Methods of Energy saving in 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 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	**1M each**
	c)	**BENSON BOILER (sketch 02 marks, Explain-02 marks)** It is a water tube boiler capable of generating steam at supercritical pressure. Figure shows the schematic of Benson boiler. Mark Benson, 1992 conceived the idea of generating steam at supercritical pressure in which water flashes into vapour without any latent heat requirement. Above critical point the water transforms into steam in the absence of boiling and without any change in volume i.e. same density. Contrary to the bubble formation on tube surface impairing heat transfer in the normal pressure boilers, the supercritical steam generation does not have bubble formation and pulsations etc. due to it. Steam generation also occurs very quickly in these boilers. As the pressure and temperatures have to be more than critical point, so material of construction should be strong enough to withstand thermal stresses. Feed pump has to be of large capacity as pressure inside is quite high, which also lowers the plant efficiency due to large negative work requirement. Benson boilers generally have steam generation pressure more than critical pressure and steaming rate of about 130–135 tons/hr. Thermal efficiency of these boilers is of the order of 90%.	



Benson boiler

	d)	A) Centrifugal pumps 1- Axial flow pump 2- Radial flow pump B) Positive displacement pumps 1- Rotary gear pump 2- Rotary vane pump 3- Rotary lobe pump 4- Rotary screw pump 5- Reciprocating pump	**1 m each**
	e)	**Following are the different power losses in steam turbine.** **(Any four points each for 1 mark)** 1) Residual velocity loss 2) Losses in regulating valves 3) Loss due to steam friction in nozzle. 4) Loss due to leakage 5) Loss due to mechanical frication 6) Loss due to wetness of steam 7) Radiation loss 8) Losses in exhaust piping	

f

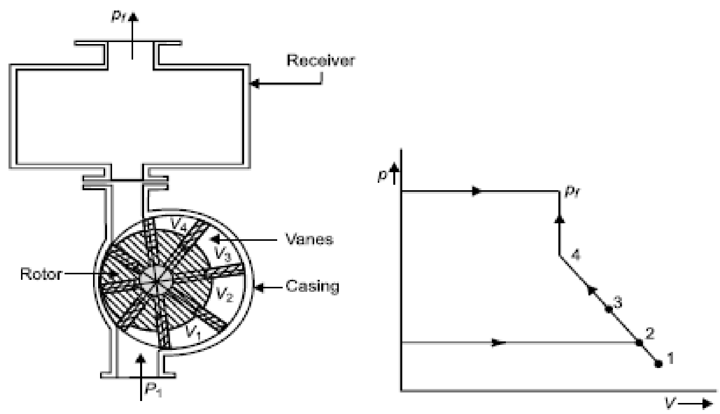
Problem	Cause	Solution	
i) Compressor will not operate.	1. No electrical power.	Turn on power. Push the reset button.	**Any Two causes For 2M**
	2. Low oil level.	Check oil level. Replace your oil if necessary	
	3. Pressure switch not making contact.	See pressure switch adjustment.	
	4. Pressure in the tank is below the cut-in pressure.	See pressure switch adjustment. Replace pressure switch to one that Has a lower cut-in PSI	
ii) Excessive noise in operation.	1. Loose pulley, flywheel, belt, belt guard, cooler, clamps or accessories.	Tighten any loose ends.	
	2. Lack of oil in crankcase.	Check for possible damage to bearings Replenish the oil level.	**Any Two causes For 2M**
	3. Piston hitting the valve plate.	Remove the compressor cylinder head and inspect for foreign matter on top of the piston. Add a new gasket and reassemble the head.	
	4. Compressor floor mounting loose.	Tighten the bolts on the air compressor. It may also be a good idea to replace Your vibration pads	
	5. Defective crankcase.	Repair or replace.	
	6. Excessive crank end play.	Adjust and shim properly.	

3	a	Q3 (a) For double acting pump, for one complete revolution of the crank there are two delivery strokes & water is delivered to the pipes by the pump during these two delivery strokes Let, D = Diameter of the piston, d = Diameter of the piston rod ∴ Area on one side of the piston $A = \frac{\pi}{4}D^2$ Area on the other side of the piston, where piston rod is connected to the piston $A_1 = \frac{\pi}{4}D^2 - \frac{\pi}{4}d^2$ If 'd' the diameter of the piston rod is very small as compared to the diameter of the piston, then it can be neglected. ∴ volume of water delivered in one revolution of crank = A × Length of stroke + A_1 × Length of stroke $= AL + A_1L$ $= (A + A_1)L$ $= \left[\frac{\pi}{4}D^2 + \frac{\pi}{4}D^2 - \frac{\pi}{4}d^2\right] \times L$ — (1m) $= 2\frac{\pi}{4}D^2 \times L$ ∴ Discharge of pump/sec. = Volume of water delivered in one revolution × No. of revolution/sec. $= 2\frac{\pi}{4}D^2 \times L \times \frac{N}{60} = \frac{2LAN}{60}$ — (1m)	

		Work done/sec. = Weight of water delivered × Total height $= \rho g \times \text{Discharge/sec.} \times \text{Total height}$ $= \rho g \times \frac{2ALN}{60} \times (h_s + h_d)$ $= 2\rho g \times \frac{ALN}{60} \times (h_s + h_d)$ — (1m) ∴ Power required to drive the double acting pump in KW $P = \frac{\text{work done/sec.}}{1000}$ $= \frac{2\rho g \times ALN \times (h_s + h_d)}{60,000}$ — (1m)	
	b	***Vane type rotary compressor:*** Schematic of vane type compressor is shown in Fig.(a) It has cylindrical casing having an eccentrically mounted rotor inside it. The rotor has number of slots in it with rectangular vanes of spring loaded type mounted in slots. These vanes are generally non-metallic and made of fibre or carbon composites or any other wear resistant material. These vanes remain in continuous contact with casing such that leakage across the vane-casing interface is minimum or absent. It has one end as inlet end and other as the delivery end connected to receiver. Upon rotation the eccentric rotor has the vanes having differential projection out of rotor depending upon their position. Air is trapped between each set of two consecutive blades in front of inlet passage and is positively displaced to the delivery end after compressing the volume *V*1 initially to *V*2, *V*3 and *V*4. When compressed volume comes in front of delivery passage and further rotation results in the situation when partly compressed air is forced to enter the receiver as their is no other way out. This	

cumulative transfer of partly compressed air in receiver causes irreversible compression resulting in gradual pressure rise.

(02 Marks)



(a) Schematic of vane compressor (b) p-V diagram

Vane type compressor

(02 marks)

c) **Provisions under boiler act for remedial measures are (4 provisions, each for 1 mark)**

No owner of a boiler shall use the boiler or permit it to be used

1. Unless it has been registered in accordance with the provision of this act
2. In the case of any boiler which has been transferred from one state to another, until the transfer has been reported in the prescribed manner
3. Unless certificate or provisional order authorizing the use of the boiler is for the time being in force under this act
4. At a pressure higher than the maximum pressure recorded in such certificate or provisional order
5. Where the State Government has made rules requiring that boilers shall be in charge of persons holding certificates of proficiency or competency unless the boiler is in charge of a person holding the certificate required by such rules.

	d)	**Indicated Power (ip)** – It is defined as the power developed by combustion of fuel in the cylinder of engine. It is always more than brake power. **Break Power (bp)** -The power available at the engine crankshaft is called the brake power (bp) **Friction Power (fp)** – It is the power required to overcome the friction in engine parts. It is the difference between indicated power and break power. **Mechanical Efficiency-** It is the ratio of the power available at the engine crankshaft (bp) to the power developed in the engine cylinder (ip).	**1 M each**
	e)	**i) Domestic water lifting** – Centrifugal Pump **ii) Bore wells** – Submersible pump **iii) Service station of automobile** – Reciprocating pump **iv) Irrigation** - Centrifugal Pump	**1M each**

f)

Q3. (f)

Given,

W = 202 N   S = 31 N   N = 455 r.p.m.

effective brake wheel dia. = 631 mm

$$b.p. = 2\pi N T$$

$$= 2\pi \times \frac{455}{60} \times (202-31) \times \frac{0.631}{2}$$

$$= \underline{\underline{2.572\ kW}}$$ — (2 Marks)

$$\text{Indicated mean effective Pressure } (P_m) = \frac{\text{Area of Indicator Dia.}}{\text{Length of indicator dia.}} \times \text{Spring Constant}$$

$$= \frac{422}{62} \times 1.2$$

$$= \underline{\underline{8.17\ bar}}$$ — (1 Mark)

$$I.P. = P_m \cdot L \cdot A \cdot \frac{N}{n}$$

n = 2 for four stroke cycle

$$= 8.17 \times 10^5 \times 0.151 \times \frac{\pi}{4} \times (0.1)^2 \times \frac{455}{2 \times 60}$$

$$= \underline{\underline{3.65\ kW}}$$ — (1 Mark)