MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

WINTER– 14 EXAMINATION

Subject Code: **17413(EME)** **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) Steam turbine based on direction of steam flow classified as **(2 Marks)**

1) Axial flow turbine
2) Radial flow turbine
3) Tangential flow turbine

Q.1 (b) Following are the two provisions under Boiler Act for remedial measure (Any Two) **(2 Marks)**

1) Prohibitions of use of unregistered or Uncertified Boiler
2) Renewal of Certificate
3) Alteration and renewal to boilers
4) Alterations and renewals to steam - pipes

Q.1 (c) Following tests are conducted for performance of I.C. engine (any four , ½ mark each)

1) Measurement of speed
2) Measurement of air consumption
3) Measurement of exhaust smoke
4) Measurement of Brake power

5) Measurement of Friction power
6) Measurement of Indicated power

Q.1 (d) **(Each definition – 1 Mark)**

Compressor capacity – It is defined as the volume delivered by the compressor in cubic metre per minute.

Swept Volume – It is the volume swept through by the first stage piston in cubic metre per minute.

Q.1 (e) **Centrifugal pumps may be classified in the following ways. (Any two- 01 mark each)**

(i)On the basis of speed
low speed, medium speed and high speed pumps.

(ii)On the basis of direction of flow of fluid,
radial flow, mixed flow and radial flow.

(iii) On the basis of head
low head (10 m and below), medium head (10-50 m) and high head pumps.

Single entry type and double entry type is another classification.

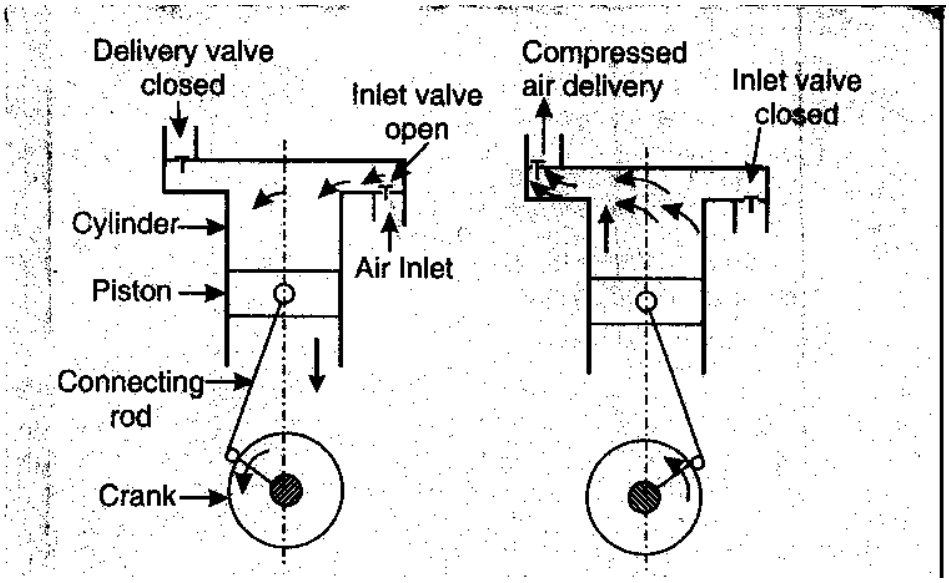
Q.1 (f) **In impulse turbine**, steam coming out at a very high velocity through the fixed nozzle strikes the blades fixed on the periphery of a rotor. The blades change direction of the steam flow without changing its pressure. The **force due to change of momentum** causes the rotation of the turbine shaft.

In reaction turbine, steam pressure decreases gradually while expanding through the moving blades as well as the fixed blades. The steam expands while flowing over the moving blades and thus **gives reaction to the** moving blades.

Q.1 (g) **Following are the different power losses in steam turbine. (Any four , each for ½ 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

Q.1 (h) **Sketch of single stage reciprocating compressor** **(sketch-02 marks)**



Q.1 (i)

Power required to drive the centrifugal pump:

Power = W. D. by impellor per sec / 1000 …kW

=(W/g) x Vw2 x u2 / 1000 (01 mark)

where w = weigh of water = ρ g Q

u2 – tangential velocity of impellor at outlet

Vw2 – Velocity of whirl at outlet (01 mark)

Q.1 (j) 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.

Q.1 (k) **(02 marks)**

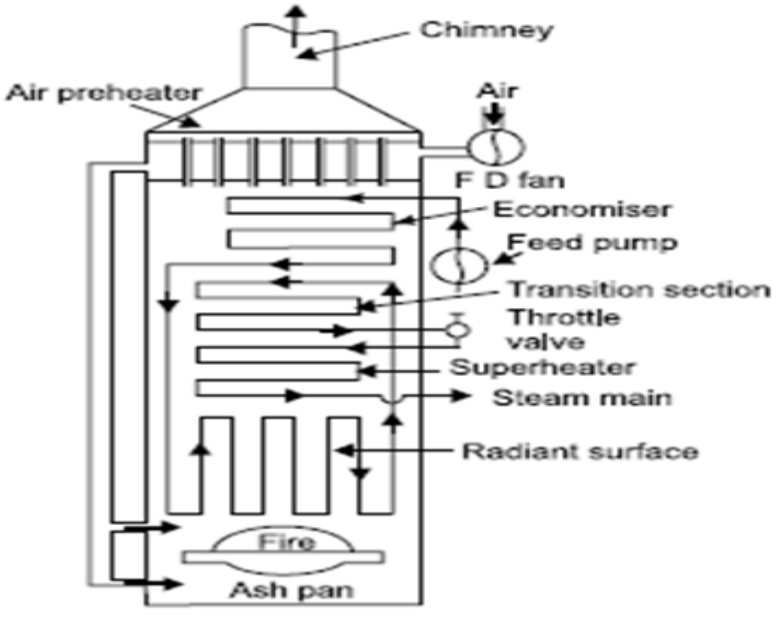
1) A simple disc with blades mounted perpendicularly on it is called **open impeller**.

2) If another disc is used to cover the blades, this type is called **shrouded impeller**.

3) The third type is just the **blades spreading out from the shaft.**

Q.2 (a) **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%.

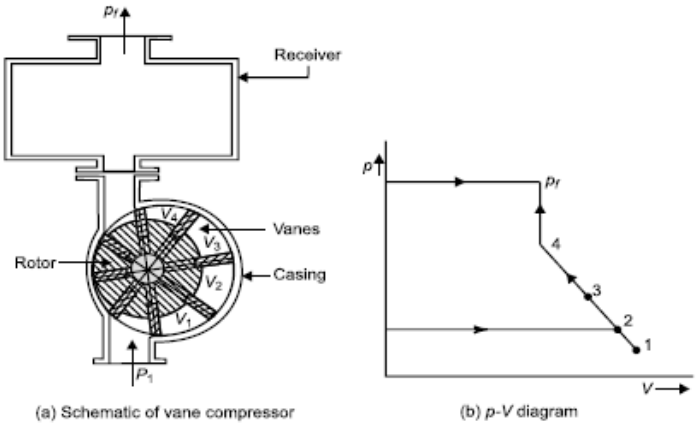


Benson boiler

Q.2 (b) Comparison between two –stroke & four stroke engines. (Any four points – 4 marks)

Four stroke engines	Two stroke engines
1) Cycle is completed in two revolutions of crank shaft.	1) Cycle is completed in one revolutions of crank shaft.
2) One power stroke is obtained in every two revolution of crank shaft.	2) One power stroke is obtained in every revolution of crank shaft.
3) Because of one power stroke for two revolutions, power produced for same size engine is small or for same power engine is bulky.	3) Because of one power stroke for one revolution, power produced for same size engine is more. Theoretically twice but in actual practice 1.7 to 1.8 times or for same power, engine is light and compact.
4) Engine contains valves & valve mechanism.	4) Do not contain valves but only ports are present.
5)Heavier flywheel required	5) Lighter flywheel required.
6) Initial cost is high because of heavy weight and complicated valve mechanism.	6) Initial cost is low because of light weight and no valve mechanism.
7) Thermal efficiency is more.	7) Thermal efficiency is less.
8) Used where efficiency is important. e.g. bus , truck, tractor	8) Used where light and compact engine is required. e.g. scooters, lawn movers.

Q.2 (c)*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 $V1$ initially to $V2$, $V3$ and $V4$. 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)**



Vane type compressor **(02 marks)**

Q.2 (d)

To start delivery of the fluid the casing and impeller should be filled with the fluid without any air pockets. This is called priming. **(02 marks)**

If air is present there will be only compression and no delivery of fluid. In order to release any air entrained an air valve is generally provided. The one way foot valve keeps the suction line and the pump casing filled with water. **(02 marks)**

Q.2 (e)

At 6 bar pressure

enthalpy is 2600 kJ/kg

Enthalpy < $h_f + h_{fg}$

So steam is wet —— (1) mark

$h_{wet} = h_f + x \cdot h_{fg}$ —— (1) mark

$2600 = 670.56 + x \cdot (2086.3)$

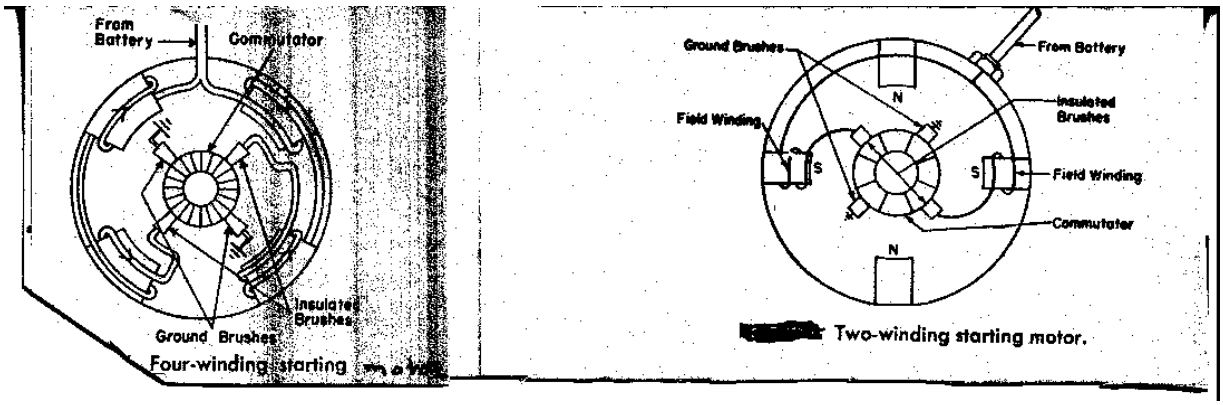
$x \cdot (2086.3) = 1929.44$

$x = 0.925$

Dryness fraction (x) = 0.925 —— (2) marks

Q.2 (f) Starting motors are direct – current motors designed to operate on large currents at low voltages. The armatures and fields are built with thick wire to keep the resistance low and to enable them to carry large currents without overheating. The faster they turn, the less current they draw, the slower they turn, the more torque they develop.

To increase the torque, the motors are designed with four poles in the field and four poles in the armature. The current from the battery divides when it enters the motor, each branch leading to separate field winding. From the fields the current is led to the commutator of the armature through the two insulated brushes. The current in the armature creates simultaneously four poles that are adjacent to the four poles to produce the attractive and repulsive forces that run the armature. The armature current returns to the battery through the two grounded brushes.



Q.3 (a) Differentiate between fire tube boilers and water tube boilers (Any four points , 1 mark each)

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.3 (b)

Q3 (b) mean height of indicator diagram $= \frac{420}{60} = 7\text{mm}$

mep = mean height × spring scale

$= 7 \times 1.1 = 7.7$ bar —— (1 Mark)

Indicated Power $= P_m(LA)N$

$= 7.7 \times 10^2 \left[0.15 \times \frac{\pi}{4}(0.1)^2\right] \times \frac{450}{60 \times 2}$

$= 3.403$ kW —— (1 mark)

Brake Power $= 2\pi N \cdot T$

$= 2\pi \cdot N \cdot (W \cdot S) \cdot D/2$

$= 2 \times \pi \times \frac{450}{60} \times (200 - 30) \times \frac{0.625}{2}$

$= 2504.46$ W

$= 2.504$ kW —— (2 mark)

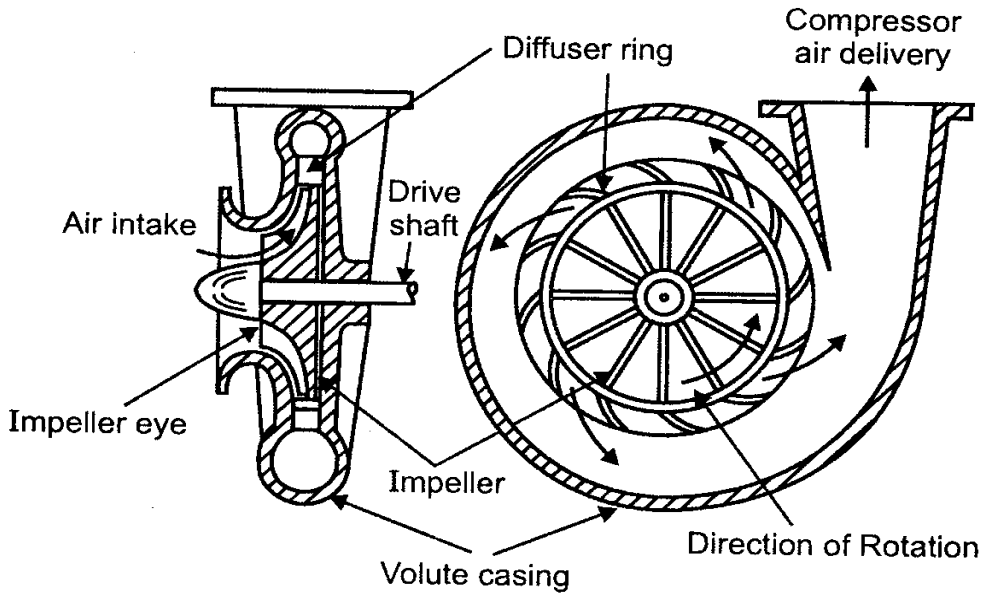
Q.3 (c) Following are the methods of energy saving in air compressor.

(Methods – 2 Marks explanation – 2 Marks)

1) Inter – stage cooling
2) Water jacketing
3) Multi stage compression
4) By using regenerative air dryer, this uses the heat of compressed air to remove moisture.

Explain any one method in detail.

Q.3 (d)



(a) Centrifugal compressor consists of a rotating member known as 'impeller wheels' mounted on steel shaft and enclosed in cast iron casing.

(b) The impeller wheel consists of two discs, a hub disc and cover disc with number of blades mounted radially between them. Impeller blades are constructed in stainless steel to avoid corrosion and erosion.

(c) An impeller has rotary vanes, which provides closed radial passage for flow of air. Atmospheric air is sucked in at the center of the impeller called the eye. A diffuser ring, around the impeller, is provided with diffuser vanes. In diffuser vanes the kinetic energy of air changes into pressure energy. The volute casing also provides diffuser passage for further build-up of air pressure.

(d) As the impeller rotates at high speed air undergoes centrifugal action and is accelerated to a high velocity. The air is decelerated in the diffuser and volute casing, to build its pressure. Finally the compressed air leaves through the outlet.

(e) Uses of centrifugal compressor: Such type of compressors is used in turbo jet engines, even furnaces and for pipeline flow and for supercharging I. C. engines.

Q.3 (e) Comparison of reciprocating compressor with centrifugal compressor (Any 4 points)

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.

Q.3 (f) Volute casing, vortex casing and diffuser type