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

SUMMER – 15 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 judgment 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. Attempt any NINE of the following.

a) Define the term boiler efficiency.

Ans. ***Boiler efficiency*** is the fraction of energy input that actually goes into raising steam. Thus it could be given by the ratio of heat actually used for steam generation and total heat available due to combustion of fuel in boiler.

$$\text{Boiler efficiency} = \frac{\text{Heat used in steam generation}}{\text{Total heat available due to fuel burning}}$$

$$= \frac{m(h - h_w)}{m_f \times \text{C.V.}}$$

Where m_f is the mass of fuel burnt per hour, C.V. is calorific value of fuel used (kJ/kg), m is mass

of steam generated per hour and enthalpies h and h_w are that of final steam and feed water, kJ/kg.

Generally high heating value of fuel is used as calorific value of fuel.

b) State the functions of nozzles used with steam turbine. (1 mark each)

Ans. 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.

c) Define brake power & indicated power. (1 mark each)

Ans. The power developed by an engine and measured at the output shaft is called the brake power (bp) and is given by,

$$bp = \frac{2\pi N \tau}{60}$$

where:

τ is the torque, in Newton meter (N.m),

N is the rotational speed, in minutes,

bp is the brake power, in watt.

Indicated Power (ip) is defined as the power developed by combustion of fuel in the cylinder of engine. It is always more than brake power.

d) Classification of air compressor:- (Any four)

a) According to number of stages:-

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

b) According to number of cylinder:- i) Single cylinder ii) Multi cylinder.

c) According to method of cooling:- i) Air cooled ii) Water cooled.

d) According to action of air:- i) Single acting ii)Double acting.

e) According to capacity:- i) Low capacity ii) Medium capacity iii) High capacity.

f) According to drive:- i) Steam engine drive ii) Steam turbine drive iii) Electric motor drive iv) Internal combustion drive.

e) List the types of pumps.

Ans. A) **Centrifugal pumps**

1- Axial flow pump 2- Radial flow pump

B) Positive displacement pumps

- Rotary gear pump 2- Rotary vane pump 3- Rotary lobe pump 4- Rotary screw pump 5- Reciprocating pump

f) Define the term degree of reaction as applied to reaction turbine.

Ans. **Degree of reaction**: The ratio of pressure energy change inside a runner to the total energy change inside the runner or it is defined as the fraction of energy transfer by change in static head to the total energy transfer in the rotor. It is represented by 'R'.

$$R = \frac{\text{Static pressure rise in rotor}}{\text{Total pressure rise in stage}}$$

g) State the classification of steam turbine. (any four, ½ mark each)

Ans.**1) According to flow direction**

a) Axial flow b) Radial flow

2) According to way of energy conversion

a) Impulse b) Reaction

3) According to type of compounding

a) Pressure compounding b) Velocity compounding c) Pressure-Velocity compounding

4) According to exhausting conditions

a) Condensing b) Extraction c) Back pressure d) Reheat

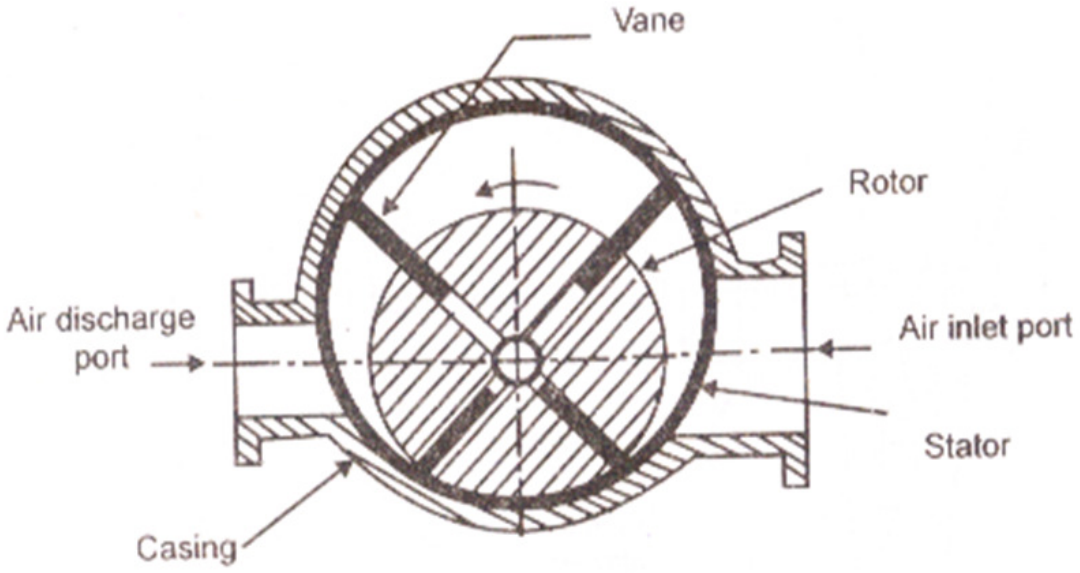
5) According to inlet pressure

a) Low b) Medium c) High

6) According to no. of stages

a) Single stage b) Multi stage

h) Draw a labeled sketch of vane type rotary compressor.



i) Define suction head & delivery head of centrifugal pump. (1 mark each)

Ans. **Suction Head** – It is the vertical height of the centre line of the centrifugal pump above the water surface in the tank or pump from which water is to be lifted. It is denoted by 'h_s'.

Delivery head – The vertical distance between the centre line of the pump and the water surface in the tank to which water is delivered is known as delivery head. It is denoted by ' h_d'.

j) What is the purpose of I.C. engine testing? (1 mark each)

Ans. i) To reduce the cost and to improve the power output and reliability of an engine.

ii) To know & improve the performance of an engine.

Q.1 (k) 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) For spray painting in paint industry.
8) In automobile & railway braking systems.
9) To operate air tools like air guns.
10) To hold & index cutting tools on machines like milling.

Q.2 (a) Differentiate between fire tube boilers and water tube boilers (Any four points , 1 mark each)

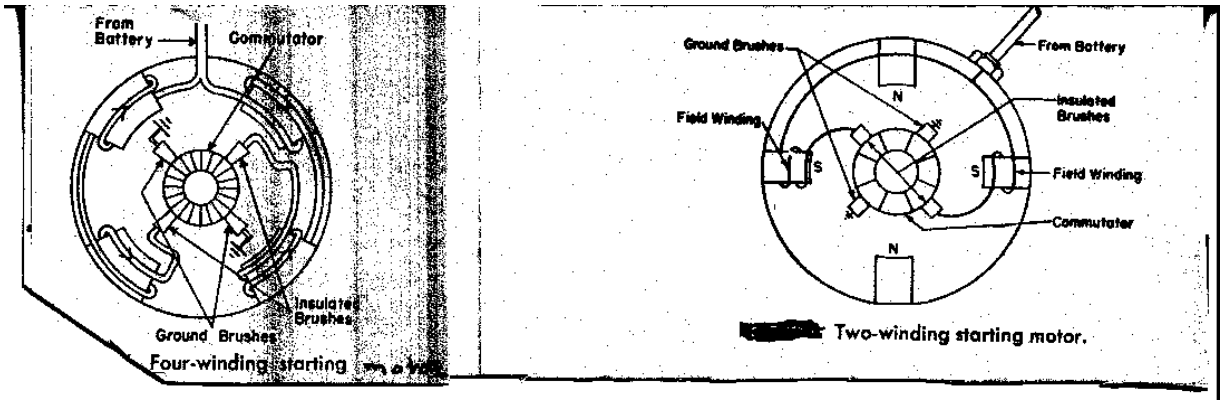
Sr. No	Fire tube boilers	Water tube boilers
01	Hot flue gases flow in the tubes surrounded outside by the water	Water flows in the tubes surrounded outside hot gases
02	Slower in operation and have low evaporation rates	faster in operation and have low evaporation rates
03	Failure due to Temperature 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.2 (b) Following are the different types of impellers (Types – 1 mark, application 1 mark each)

1. **Fully closed type –** It is suitable for handling clear and thin liquids.
2. **Semi – closed type –** It is suitable even if the liquids are charged with some debris.
3. **Open type –** Such impellers are useful in the pumping of liquids containing suspended solid matter, such as paper pulp, sewage and water containing sand or grit.

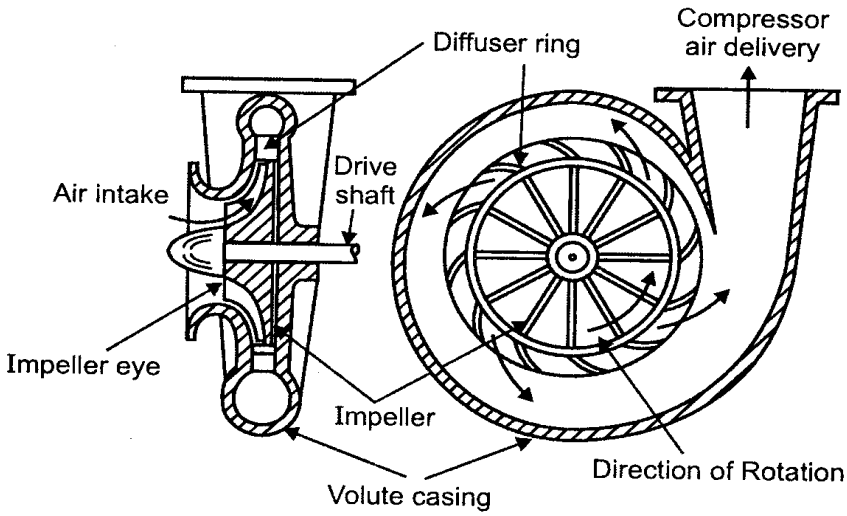
Q.2 (c) Starting motors are direct – current motors designed to operate on large currents at low voltages. The armatures and fields are built with thick wire to keep the resistance low and to enable them to carry large currents without overheating. The faster they turn, the less current they draw, the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



(4 Marks)

Q.2 (d) Working of Centrifugal Compressor (Working – 2 Marks Sketch – 2 Marks)



(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. 2 (e) Priming in centrifugal pump : (4 Marks)

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.

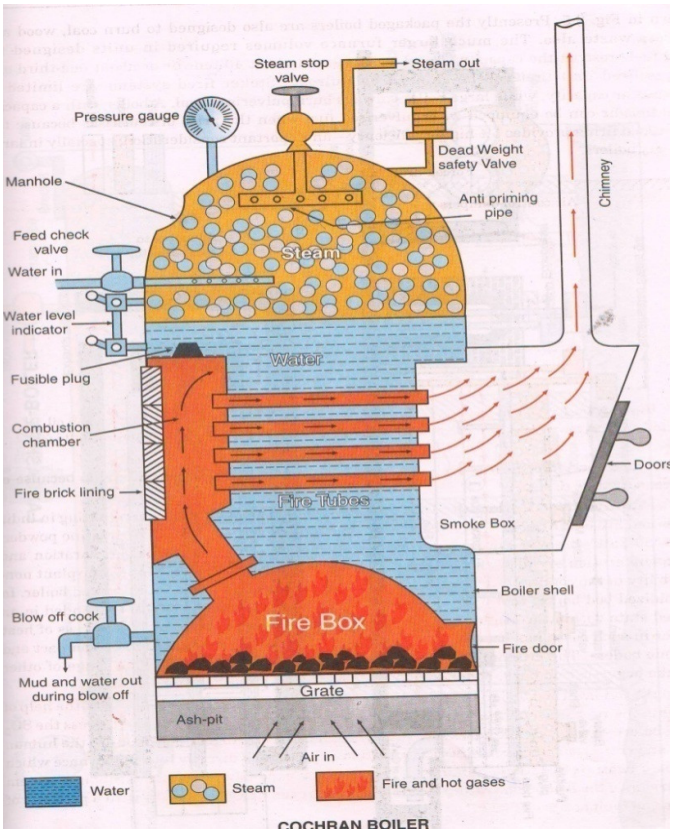
This means that when there is no water in the pump, it is running in air. The pressure head developed is in terms of meters of air. Whereas when there is water, pressure head developed is in terms of meters of water. But as the density of air is very low, the generated head of air in terms of equivalent meter of water head is negligible and hence water may not be sucked from the sump. To avoid this difficulty, priming is necessary.

Q. 2 (f) 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.

Q. 3 (a) Sketch of Cochran Boiler (4 marks)



3 (b) Applications of Reciprocating Compressor (Any Four, each for ½ mark)

1. Fertilizer production
2. Food and beverage industry
3. Gas cylinder filling
4. Polyethylene production, low density
5. Polymer productions
6. Underground gas storage
7. Underground natural gas storage

Applications of Centrifugal Compressor (Any Four, each for ½ mark)

1. In gas turbines and auxiliary power units.
2. In automotive engine and diesel engine turbochargers and superchargers.
3. In pipeline compressors of natural gas to move the gas from the production site to the consumer.
4. In oil refineries, natural gas processing, petrochemical and chemical plants.
5. Air-conditioning and refrigeration and HVAC: Centrifugal compressors quite often supply the compression in water chillers cycles.
6. In air separation plants to manufacture purified end product gases.
7. In oil field re-injection of high pressure natural gas to improve oil recovery.

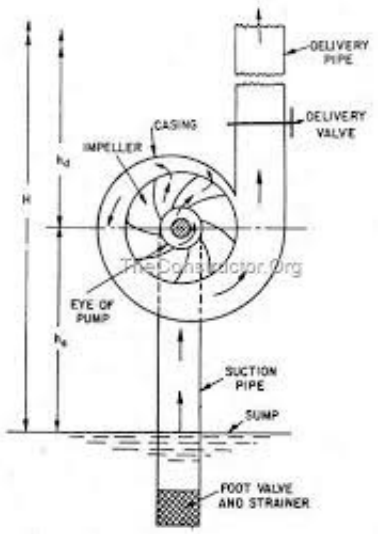
3 (c) Following are the methods of energy saving in air compressor.

(each method – 1 Mark)

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 each method in short.

Q.3 (d) Centrifugal pump- Working – 2 marks, Sketch – 2 marks



A centrifugal pump is a pump in which an impeller rotating inside a close fitting casing draws in liquid at the centre and by virtue of centrifugal force, throws out through an opening or openings at the side of casing.

In operation, the pump is filled with water and the impeller is rotated. The blades cause the liquid to rotate with the impeller and in turn, impact a high velocity to the water particles. The centrifugal force causes the water particles to be thrown from the impeller into casing. The forward flow through the impeller reduces pressure at the inlet, allowing more water to be drawn in through the suction pipe by atmospheric pressure or an external pressure. The liquid passes into the casing, where its high velocity is reduced and converted into pressure and the water is pumped out through the discharge pipe.

Q.3 (e) 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. **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.

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

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.

Q.3 (f)

Q3 (f) Given,

$W = 200\ N \qquad S = 30\ N$

effective brake wheel dia. = 630 mm

$b.p. = 2\pi NT$

$= 2\pi N \cdot (W-S) \cdot R$

$= 2\pi \times \frac{430}{60} \times (200-30) \times \frac{0.630}{2}$

$= \underline{2.4123\ kw}$ — (2 marks)

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

$= \frac{420}{60} \times 1.1 = \underline{7.7\ bar}$

— (1 mark)

$I.P. = P_m \cdot L \cdot A \cdot \frac{N}{n}$ $\quad n = 2$ for four stroke cycle

$= 7.7 \times 10^5 \times 0.15 \times \frac{\pi}{4} \times (0.1)^2 \times \frac{430}{2 \times 60}$

$= \underline{3.251\ kw}$ — (1 mark)