



Subject Code: **17413**

**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. Attempt any SEVEN of the following:**

**(7 x 2=14)**

**(a) How boiler efficiency is differing from seasonal 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.

The Seasonal Boiler Efficiency is a 'weighted' average of the efficiencies of the boiler at 15%, 30% and 100% of the boiler output (the efficiency at 15% is taken to be the same as that at 30%).

OR

In addition to stack losses & jacket losses, seasonal efficiency accounts for heat loss during periods that the boiler is idling to maintain its internal temperature irrespective of external heat.

**... 1Mark for each**

**(b) State different power losses in steam turbine.**

**Ans:** Following are the different power losses in steam turbine. **(Any four , 2 marks)**

- 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 friction
- 6) Loss due to wetness of steam
- 7) Radiation loss
- 8) Losses in exhaust piping

**(c) What is the purpose of Morse Test? Name other methods. ... 1Mark for each**

**Ans:** The Morse Test provides a simple, rapid & fairly accurate method for determining the Indicated Power of multi cylinder engine.

The other test for measurement of Brake power, Frictional power & Indicated Power are as Motoring Test, Willan's Line Method, and Rope brake dynamometer.



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**(d) State different industrial use of air compressor.**

**Ans:** Practical applications of compressed air : **(any four, 2 mark)**

1. To start I.C. Engines
2. To operate pneumatic tools such as rock drills, pneumatic hammer, pneumatic grinder etc.
3. To operate various pneumatic controls on machine tools and instruments.
4. To inject the fuels in diesel engines
5. To clean workshops and automobiles
6. To supercharge I.C .Engines
7. To spray paints
8. Filling air in automobile tyres.

**(e) Define FAD (free air delivered) of air compressor. (2 marks)**

**Ans:** Free air delivered: It is the volume of air delivered under the condition of temperature & pressure existing at the compressor intake. Generally the condition is 1.01325 bar and 15<sup>0</sup>C.

**(f) Write different uses of rotodynamic pump. (2 marks)**

**Ans:** Roto dynamic pumps are used where continuous supply of liquid with low or moderate pressure is required. These pumps are used in irrigation of agriculture fields and also in process industries.

**(g) Classify turbine according to direction of steam flow. (2 marks)**

**Ans:** turbine according to direction of steam flow areas follow:

- (i) Axial flow (ii) Radial flow (iii) Tangential flow

**(h) Write function of foot valve. (2 marks)**

**Ans:** Foot valve is one type of non-return valve or one way valve which is used for restricting the fluid in centrifugal pump back to sump again.

**(i) Write the equation of power required to drive the reciprocating pump.**

**Ans:** **(01 mark for equation, 01 mark for meaning of terms)**

Power required by reciprocating pump :

$$P = (\text{Work done per second})/1000$$

$$= 2 \cdot \rho \cdot g \cdot A \cdot L \cdot N \cdot (h_s + h_d) / 60 \cdot 1000$$

Where  $\rho$  = density of fluid

$g$  = gravitational constant

$A$  = cross sectional area of piston or cylinder

$L$  = Length of stroke (2r)

$N$  = rpm of crank

$h_s$  = height of axis of cylinder from water surface in sump( suction head)

$h_d$  = height of delivery outlet above the cylinder axis ( delivery head)

**(j) What is the principle of operation of steam turbine? (2 marks)**

**Ans:** 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.

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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.

**(k) Enlist the sources of heat losses in boiler. ( any four 2 marks)**

- Heat Loss Due To Unburned Carbon,
- Heat Loss due to Dry Flue Gas,
- Unburned carbon loss or loss on Ignition,
- Heat Loss Due To Moisture in Fuel,
- Loss Due To sensible Heat in Bottom Ash

**Q. 2. Attempt any FOUR of the following:**

**(4 x 3=12)**

**(a) Sketch and explain Benson critical boiler. (Working-2 Marks, Sketch- 1 Mark)**

**Ans:** It is a water tube boiler capable of generating steam at supercritical pressure. Figure shows the schematic of Benson boiler. 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%.

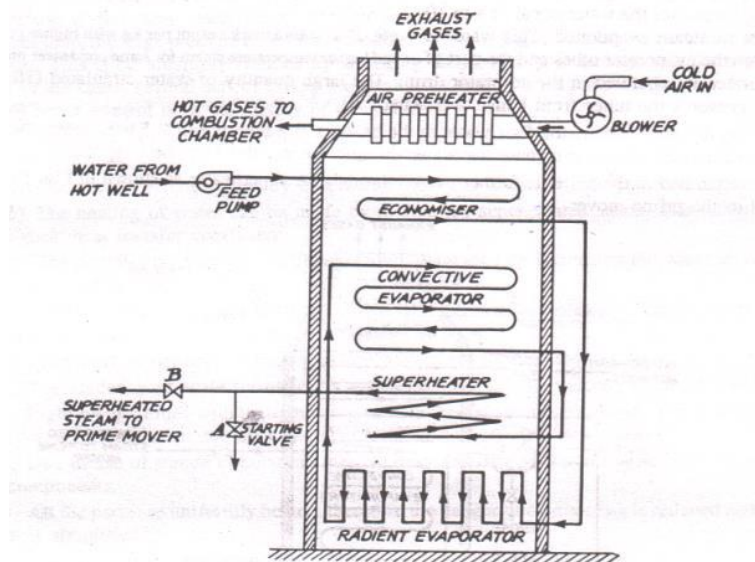


Fig. Benson Boiler

**(b) Define cylinder bore and piston displacement of IC engine.**

**(1.5 Marks to each)**

**Ans: (i) Cylinder bore (d):** The internal diameter of the cylinder of an IC engine. It is denoted by (d).

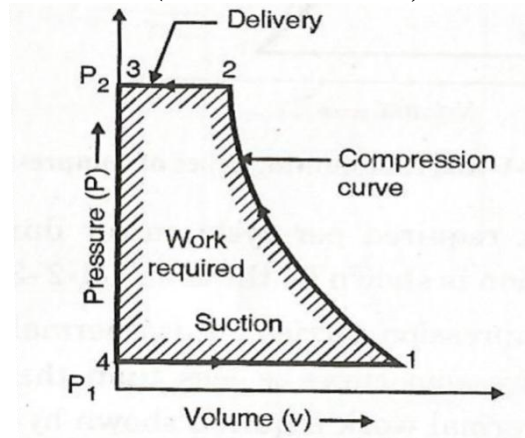
**(ii) Piston Displacement:** The displacement of the piston from TDC to BDC in one revolution of crankshaft. It is denoted by  $V_s$

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(c) Explain working of single stage air compressor with P-V diagram.

**Ans:** (1 Mark for sketch; 2 Marks for working)

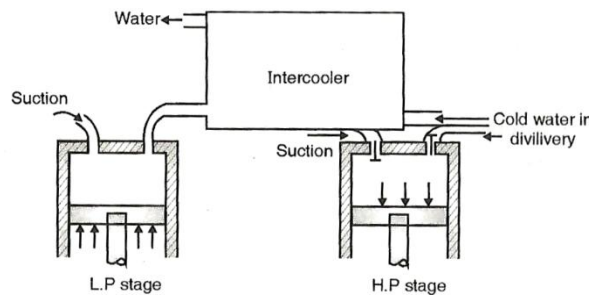


**Fig: P-V diagram for single stage air compressor**

The above figure shows the P-V diagram for single stage reciprocating air compressor without clearance. During the suction stroke the air is drawn into the cylinder along line 4-1 at constant pressure  $P_1$  which is slightly below than atmosphere. At point 1, the piston completes the suction stroke and starts its compression stroke. At this time, all the valves are closed; the air inside the cylinder is compressed along the curve 1-2. At point 2, the pressure  $P_2$  is reached which is slightly higher than the receiver pressure. At this point discharge valve opens delivery of compressed air takes place along line 2-3 at constant pressure  $P_2$ . The piston has now reached at top of cylinder and again starts its suction stroke & the pressure in the cylinder will be lowered again  $P_1$  & the cycle of operations will be repeated. The net work done required is represented by area 1-2-3-4.

(d) What does staging mean? What are the advantages of multistage compression?

**Ans:** (01 Mark for advantage; 01 Mark for staging; 01 Mark for sketch)



**Fig: Two stage air compressor with intercooler**

**Staging:** The air is compressed in more than single piston cylinder arrangement for reducing its volume by decreasing air outlet temperature after first stage by using intercooler in between two stages.

**Advantages of multistage compression: ( any two)**

1. Less power required
2. Leakage loss is less
3. Torque is uniform
4. Small size of flywheel required
5. More volumetric efficiency

(e) Write advantages and disadvantages of double acting pump.



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(any 3 point ½ M to each)

**Ans:**

Advantages

- Doubled discharge
- Less vibrations
- High efficiency

Disadvantages

- High maintenance
- Low speed
- Bulky

**(f) How you can select proper piping system of centrifugal pump? (03 Marks)**

**Ans:** Piping systems must meet the performance criteria required of the system i.e. pressure head and discharge, do so economically. The first step in designing a piping system is determining what is required of the system. Although systems vary, these factors should always be considered.

Environmental conditions, required flow rates, Operating schedules and control systems, Fabrication, Lift, and Velocity head decides selection of material.

**Q.3. Attempt any FOUR of the following:**

**4 x 3=12**

**(a) Differentiate between subcritical and supercritical boiler.**

**Ans:** ( any six points 3 marks)

Sr. No.	Parameter	Subcritical Boiler	Supercritical Boiler
1	Latent Heat Addition	Nil	Heat addition more
2	Sp. Enthalpy	Low	More
3	Sp. Coal consumption	Low	High
4	Air flow, Dry flu gas loss	Low	High
5	Coal & Ash handling	Low	High
6	Pollution	Low	High
7	Aux. Power Consumption	Low	More
8	Overall Efficiency	High (40-42%)	Low (36-37%)
9	Total heating surface area Reqd	Low $(84439m^2)$	High $(71582m^2)$
10	Tube diameter	Low	High
11	Material / Infrastructure (Tonnage)	Low 7502 MT	High 9200 MT
12	Startup Time	Less	More
13	Blow down loss	Nil	More

**(b) How combustion takes place in C.I. engine? Also write its application. (2 +1 marks)**

**Ans:** In diesel engines only air is send into the combustion chamber during induction. This air is compressed during the compression stroke and towards the end of compression stroke;

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fuel is injected by the fuel-injection system into the cylinder - just before the desired start of combustion. Liquid fuel is injected at high velocities as one or more jets through small orifices or nozzles in the injector tip. The fuel atomizes into small droplets and penetrates into the combustion chamber - the droplets vaporize and mix with high-temperature and high-pressure cylinder air.

**Applications: (any two)**

Power source for land and water vehicles, including automobiles, motorcycles, ships and to a lesser extent, locomotives, Powered aircraft, jet engines and helicopters, unmanned aerial vehicles, Diesel generators

**(c) Name three types of reciprocating air compressor that are commonly used in industry with its one application.**

**Ans: (3 marks)**

- i) Inline Air Compressors: Oil refinery, Chemical Plant
- ii) V type Air compressors: Pneumatic applications like drilling
- iii) Multistage air compressors: Air filling in Tubes of vehicle

**(d) What is the purpose of hydraulic pump in fluid power system? (3 M for proper ans)**

**Ans:** Purpose of hydraulic pump is to generate flow so that energy conversion from mechanical to Fluid energy is possible. Pressure energy developed by pump is utilized to do work in actuators. Mechanical energy is provided to pump by electric motor.

**(e) Explain the power torque characteristics with graph of a spark ignition engine.**

**Ans: (Graph 01M and Explanation 02M)**

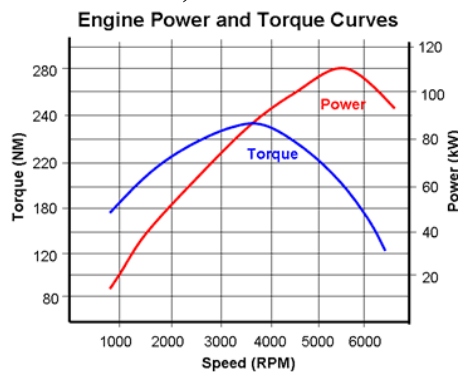


Fig: Engine power & torque curves

There is certain speed within the speed range of a particular engine at which the charge (Air+ Fuel) induced per cylinder per cycle will be maximum. At this point the maximum force can therefore be exerted on the piston. For all Practical purpose, the torque or engine capacity to do work will also be maximum. As the speed of the engine increase above this speed the quantity of charge will decrease however the power output of the engine increase with speed due to more number of cycle are executed per unit time.

**(f) Write the possible causes and remedies for following in case of IC engine:**

**Ans: (any three points 03 Marks)**

Faults	Cause	Remedies
(i) Excessive Vibration	Inlet of suction pipe	Insure adequate supply of



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	insufficiently submerged	liquid
(ii) Suction Problem	Impeller rotating in wrong direction	Reverse the direction of rotation
(iii) Bearing wear	Dirt in bearing	Dismantle and drain out bearing, flush through bearing & refill correct grade of oil
(iv) Irregular discharge	Air or vapor lock in suction	Stop pump & reprime

**Q.4. Attempt any FOUR of the following:****(4 x 3=12)****(a) Explain superheater and preheater in supercritical boilers.(1½M to each point)**

**Ans: Superheater:** The superheater is a heat exchanger in which heat is transfer to saturated steam to increase its temperature. It increases overall efficiency and reduces the moisture contains in the last stage of turbine. The superheaters are of two types: Convective superheater and Radiant superheater.

**Preheater:** The preheater is the heat exchanger which is used for heating purpose of air and water before supplying to boiler drum and furnace.

**(b) Explain clearly why priming is essential before starting of centrifugal pump.**

(justified ans 03 M)

**Ans:** To start delivery of the fluid the casing and impeller should be filled with the fluid without any air pockets.

This is called priming.

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.

**(c) Define the term specific speed of centrifugal pump and state the expression for it in terms of head, discharge and speed in rpm. (1+2 marks)**

**Ans:** Pump specific speed is the speed of an ideal pump geometrically similar to an actual pump, which when running at this speed would raise a unit of volume, in a unit of time, through a unit of head.

$$N_s = \frac{n\sqrt{Q}}{(H)^{3/4}}$$

$N_s$  is specific speed (unit less)

$N_s$   $n$  is pump rotational speed (rpm)

$Q$  is flowrate (l/s) at the point of best efficiency

$H$  is total head (m) per stage at the point of best efficiency

$g$  is acceleration due to gravity (m/s<sup>2</sup>)

**(d) Explain working of Impulse turbine with neat sketch.**

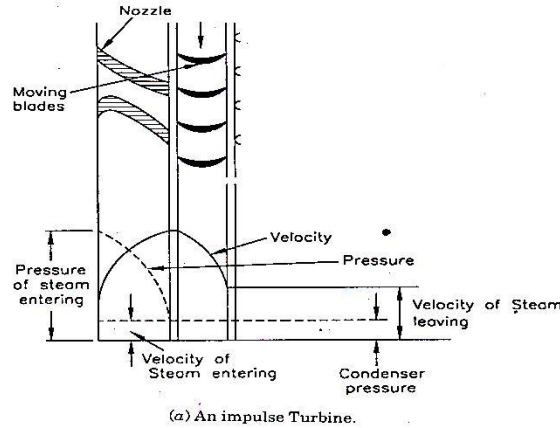
**Ans:** (1 Mark for sketch; 2 Marks for working)

**Principle of impulse turbine:** If a jet of steam is discharged from a fixed nozzle at a high speed over a flat stationary plate, a steady force will be exerted over this plate. This force is nothing but an impulse. No work is done as the plate is fixed. But, if a number of such plates are fixed on the rim of a wheel, the wheel may be rotated due to the impulse of steam. Curved

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plates are used instead of flat plates to utilize greater amount of energy. In the impulse turbine, steam is expanded in the fixed nozzle only. In the nozzle the velocity of steam increases with decrease of pressure. As the steam passes over the blades, the pressure remains constant with a decrease of velocity.



**(e) List the Four stages of compressed air preparation. (03 Marks)**

**Ans:** The Four stages of compressed air preparation are as follows:

- (i) Inlet filtering
- (ii) Compression
- (iii) Primary air treatment (cooler, dryer)
- (iv) Secondary air treatment (filter, dryer, lubricator)

**(f) State the faults and remedies for following causes in IC engine.**

**(03 Marks)**

**Ans:**

Faults	Cause	Remedies
(i) Incorrect gap between radiator and fan	Engine overheating	Correct the gap
(ii) Piston seizure	Insufficient oil	Add oil
(iii) No spark at spark plug	Spark plug faulty, fouled or worn out	Check spark plug condition
(iv) Engine turns over	Low battery voltage	Recharge or replace battery