

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17



**MAULANA ABUL KALAM AZAD UNIVERSITY OF
TECHNOLOGY, WEST BENGAL**

Paper Code : ME-701

POWER PLANT ENGINEERING

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$$10 \times 1 = 10$$

i) India's first nuclear power plant was installed at

- a) Tarapur b) Kalpakkam
c) Kota d) None of these.

ii) De-Laval turbine is a

- a) impulse reaction turbine
b) single rotor impulse turbine
c) multi-rotor impulse turbine
d) none of these.

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17

iii) The device used to put off fire in the furnace is called

- a) blow-off cock b) superheater
c) economiser d) fusible plug.

iv) The principal constituents of fuel are

- a) carbon and hydrogen
b) oxygen and hydrogen
c) sulphur and oxygen
d) sulphur and hydrogen.

v) Most widely used material of solar cell is

- a) arsenic b) cadmium
c) silicon d) steel.

vi) Specific speed (N) of a turbine is

- a) $\frac{N\sqrt{P}}{H^{5/4}}$ b) $\frac{N\sqrt{P}}{H^{3/4}}$
c) $\frac{N\sqrt{P}}{H^{3/2}}$ d) $\frac{N\sqrt{P}}{H^{2/3}}$

vii) The effect of considering friction losses in steam nozzle for the same pressure ratio leads to

- a) increase in exit velocity from the nozzle
b) decrease in exit velocity from the nozzle
c) no change in exit velocity from the nozzle
d) increase in or decrease depending upon the exit quality of steam.

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17

viii) For maximum blade efficiency for single stage impulse turbine

a) $\frac{V_b}{V_i} = \cos \alpha$ b) $\frac{V_b}{V_i} = \cos \alpha/2$
 c) $\frac{V_b}{V_i} = \cos^2 \alpha$ d) $\frac{V_b}{V_i} = \cos^2 \alpha/2$

ix) When $M = 1$ occurs at the throat, the flow is called

- a) choked flow b) steady flow
 c) stagnation flow d) none of these.

x) Compounding in impulse steam turbine is done for

- a) controlling turbine speed
 b) better working fluid utilization
 c) controlling steam temperature
 d) none of these.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Differentiate between boiler accessories and boiler mountings with example.
3. What are the needs of compounding in case of impulse turbine ? With neat sketch show the variation of steam pressure and velocity across the velocity compounded impulse stages. 2 + 3

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17

4. What is the function of FD fan ? Where is it located ?

5. Derive an expression for maximum discharge rate of gases through the given height of chimney.

6. a) Why are control rods used in the nuclear power plant ?

b) State the advantages of wind energy. 3 + 2

7. A thermal power plant works as natural draft. The height of the chimney is restricted to 40m. The ambient temperature is 20°C and the temperature of the flue gas passing through the chimney at its base is 300°C. The air-fuel ratio is 17 : 1. Calculate the diameter of the chimney at the base, if head loss due to friction is 25% of ideal draft.

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Why Rankine cycle is used instead of Carnot cycle in steam power plants ?
- b) Steam at 40 bar, 500°C flowing at the rate of 5500 kg/hr expands in a h.p. turbine to 2 bar with an isentropic efficiency of 83%. A continuous supply of steam at 2 bar, 0.87 quality and a flow rate of 2700 kg/hr is available from a geothermal

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17

energy source. This steam is mixed with h.p. turbine exhaust steam adiabatically and the mixture then expands in a l.p. turbine to 0.1 bar with an isentropic efficiency of 78%. Determine the power output and the thermal efficiency of the plant. Assume that 5500 kg/hr of steam is generated in the boiler at 40 bar, 500°C from the saturated feed water at 0.1 bar. 5 + 10

9. a) What are the different methods of firing coal? Discuss the advantages of mechanical methods of firing coal.
- b) Make neat sketch and explain the working of 'Chain grate stoker'.
- c) What is Fluidised Bed Combustion system? Sketch and describe a 'Fluidised Bed Combustion system'. State the advantages of FBC system. 5 + 5 + 5
10. a) What are the comparative advantages & disadvantages of fire-tube and water-tube boilers?
- b) What is the function of chimney? Why preheated air is supplied to the boiler?
- c) Determine the height of the chimney to produce a static draught of 20 mm of water. The mean flue gas temperature in the chimney is 270°C and the

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17

atmospheric air temperature is 20°C. Barometer reads 760 mm of Hg. The characteristic gas constant R for air is 287 Nm/kgK and for chimney gas it is 255 Nm/kgK.

11. a) Sketch the layout of hydroelectric power plant and explain the functions of each component in it. Discuss the advantages and limitations of this plant. 7
- b) A turbine generator unit has output of 150 mW and efficiency of 0.80. Calculate energy supplied per hour by steam generator. 6
- c) What do you mean by Renewable power plant? 2
12. a) Define the Nozzle efficiency. 3
- b) Derive the condition for maximum efficiency of an impulse turbine. 5
- c) The percentage composition of a sample of coal is C = 90, H₂ = 3.5, O₂ = 3.0, N₂ = 1.0, S = 0.5, the remainder being ash. Estimate the minimum weight of air required for the combustion of 1 kg of this fuel and the composition of the dry product, 50% excess air is supplied. 7

CS/B.TECH/ME/ODD SEM/SEM-7/ME-701/2016-17

13. a) The nozzle angle for a simple impulse turbine is 20° and the steam leaves the nozzle at 400 m/s. The blade velocity is 180 m/s. What should be the inlet and outlet angles for the blades so that the blade experiences no axial thrust ? Due to friction the velocity of steam as it passes over the blades is reduced by 15%. 7
- b) In a reaction turbine, the blade tips are inclined at 35° and 20° in the direction of motion. The guide blades are of the same shape as the moving blades, but reversed in direction. At a certain place in the turbine, the drum diameter is 1 m and the blades are 10 cm high. At this place the steam has a pressure of 1.75 bar and dryness 0.935. If the speed of the turbine is 250 rpm and the steam passes through the blades without shock, find the mass of the steam flow and power developed in the ring of moving blade. 8
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