

May 2024

B. Tech. (ME/ME(HINDI)) (Fourth Semester)
Applied Thermodynamics (PCC-ME-401-21)

Time : 3 Hours]

[Maximum Marks : 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other. Use of steam table and Mollier Chart is allowed.

Part A

1. (a) What are the advantages of gaseous fuels ?
1.5
- (b) Why are the accessories used in a boiler ?
1.5
- (c) Why is Carnot cycle not practical for a steam power plant ?
1.5
- (d) Brayton cycle and Rankine cycle are coupled in series with efficiency of brayton cycle as 15% and rankine cycle as 40 %, determine the overall efficiency of combined cycle.
1.5

- (e) Differentiate between jet and surface condensers. 1.5
- (f) What do you understand by the term vacuum efficiency of a condensing plant? 1.5
- (g) Dry saturated steam at 5 bar with negligible velocity expands isentropically in a convergent nozzle to 1 bar and dryness fraction 0.94. Determine the velocity of steam leaving the nozzle. 1.5
- (h) What is Reheat Factor? 1.5
- (i) Differentiate between Impulse and Reaction turbine. 1.5
- (j) Define the volumetric efficiency of compressor. On what factor does it depend? 1.5

Part B

2. (a) Calculate the quantity of air supplied per kg of fuel burnt in the combustion chamber of a boiler when the required draught of 1.85 cm of water is produced by a chimney of 32 m height. The temperature of the flue gases and ambient air recorded are 370°C and 30°C respectively. 5

- (b) Explain with a neat sketch the construction and working of Babcock and Wilcox boiler. 10

3. (a) What is the effect of regeneration on the (i) specific output, (ii) mean temperature of heat addition, (iii) cycle efficiency, (iv) steam rate and (v) heat rate of a steam power plant? 5

- (b) Explain Rankine cycle with a neat sketch and draw all its processes on $p-v$ and $T-s$ diagram. Also derive the expression to determine the efficiency of Rankine cycle. 10

4. (a) Explain different types of cooling tower? Mention advantages and disadvantages of each type. Also write the factors which affect the cooling of water in a cooling tower. 10
- (b) What are the various sources of air leakage into a steam condenser? How does it affect the performance of the condensing plant? 5

5. (a) Show that for maximum discharge through a nozzle, the ratio of throat pressure to inlet pressure is given by $\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$, where n is the index for isentropic expansion through the nozzle. 10

(b) Explain the supersaturated or metastable flow of steam through a nozzle. Also mention the effects of supersaturation on discharge and heat drop. 5

6. (a) In a two stage air compressor, in which intercooling is perfect, prove that the work done in compression is minimum when the pressure in the intercooler is the geometric mean between the initial and final pressures. Draw the indicator diagram for two stage compression. 10

(b) Explain the working of a single stage reciprocating air compressor with a neat sketch. 5

7. In an impulse turbine (with a single row wheel) the mean diameter of the blades is 1.05 m and the speed is 3000 r.p.m. The nozzle angle is 18° , the ratio of blade speed to steam speed is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3° less than the inlet angle. The steam flow is 10 kg/s. Draw the velocity diagram for the blades and determine : 15

- (i) Tangential thrust on the blades
- (ii) Axial thrust on the blades
- (iii) Resultant thrust on the blades
- (iv) Power developed in the blades
- (v) Blading efficiency.