

Total No. of Questions : 09]

[Total No. of Pages : 02

B.Tech. (Sem. - 3rd)
APPLIED THERMODYNAMICS - I
SUBJECT CODE : ME - 209
Paper ID : [A0805]

[Note : Please fill subject code and paper ID on OMR]

Time : 03 Hours

Maximum Marks : 60

Instruction to Candidates:

- 1) Section - A is **Compulsory**.
- 2) Attempt any **Four** questions from Section - B.
- 3) Attempt any **Two** questions from Section - C.

Section - A

Q1)

(10 × 2 = 20)

- a) What do you mean by stoichiometric air-fuel (A/F) ratio?
- b) Give the graphical representation of the process of formation of steam.
- c) What is the function of a boiler chimney?
- d) Describe the various operations of a Rankine Cycle.
- e) State the relation between the velocity of steam and the heat during any part of a steam nozzle.
- f) What do you mean by compounding of steam turbines?
- g) State the advantages of reheating steam.
- h) Define the term "degree of reaction" used in reaction turbine also write an analytical expression for the same.
- i) In what respects a jet condenser differs from a surface condenser?
- j) State the conditions which lower the volumetric efficiency of a reciprocating air compressor.

Section - B

(4 × 5 = 20)

Q2) Explain with a neat sketch the construction and working of stirling boiler.

with steam at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle.

If the steam is reheated at 5.5 bar to a temperature of 395°C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle?

- Q4)** Define critical pressure ratio of a nozzle and discuss why attainment of sonic velocity determines the maximum mass rate of flow through steam nozzle.
- Q5)** Derive the expression for maximum blade efficiency in a single-stage impulse turbine.
- Q6)** Steam is expanded in a set of nozzles from 10 bar and 200°C to 5 bar. What type of nozzle is it? Neglecting the initial velocity find minimum area of the nozzle required to allow a flow of 3kg/s under the given conditions. Assume that expansion of steam to be isentropic.

Section - C

(2 × 10 = 20)

- Q7)** The following is the analysis (by weight) of a chemical fuel :
Carbon=60 percent : Hydrogen = 20 percent, Oxygen = 5%, Sulphur = 5 percent and Nitrogen = 10 percent. Find the stoichiometric amount of air required for complete combustion of this fuel.
- Q8)** 300 kg/min of steam (2 bar, 0.98 dry) flows through a given stage of a reaction turbine. The exit angle of the fixed blades as well as moving blades is 20° and 3.68 kW of power is developed. If the rotor speed is 360 r.p.m and the tip leakage is 5 percent, calculate the mean drum diameter and the blade height. The axial flow velocity is 0.8 times the blade velocity.
- Q9)** Prove that the volumetric efficiency of a single stage compressor is given by

$$\eta_{\text{vol}} = 1 + k - k \left(\frac{P_2}{P_1} \right)^{\frac{1}{n}}, \text{ where } k = \frac{V_c}{V_s}$$