

[Total No. of Questions - 9] [Total No. of Printed Pages - 3]

Dec.-23-0371

ME-303 (Engineering Thermodynamics) [ME, AE]

B.Tech. 3rd (CBCS)

Time : 3 Hours

Max. Marks : 60

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : There are five sections A, B, C, D and E. Candidate have to attempt one question selecting from each section A, B, C and D and each question is of 10 Marks. All subparts of the question in section E is compulsory.

SECTION - A

1. Derive the energy equations for the flow process and compare this with Bernoulli's equation. (10)
2. One kg of air is compressed isochorically till its pressure gets doubled. Then it is allowed to expand reversibly and isothermally to regain its original pressure. Thereafter, it is subjected to isobaric cooling whereupon its volume decreases to restore its initial state. Find the net-work done if the initial temperature of the air is 30°C. Assume air behaves as an ideal gas. Take the value of gas constant is 0.2871 kJ/kgK. (10)

SECTION - B

3. Establish the equivalence of Kelvin-Planck and Clausius statements. (10)
4. Which is the more effective way to increase the efficiency of a Carnot engine to increase T_1 , keeping T_2 constant or to decrease T_2 , keeping T_1 constant? (10)

2

ME-303

SECTION - C

5. Write down the first and second TdS equations and derive the expression for the difference in heat capacities, C_p and C_v . (10)
6. Steam at 0.8 MPa, 250°C and flowing at the rate of 1 kg/s passes into a pipe carrying wet steam at 0.8 MPa, 0.95 dry. After adiabatic mixing the flow rate is 2.3 kg/s. Determine the condition of steam after mixing. The mixture is now expanded in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of the steam leaving the nozzle. Neglect the velocity of steam in the pipeline. (10)

SECTION - D

7. What is the effect of reheat on specific output, cycle efficiency, specific steam consumption of the steam power plant explains with the T-S diagram. (10)
8. Biogas, which contains 40% by volume of CO_2 and rest methane, is being burnt in a laboratory setup. The volumetric composition of products of combustion, excluding water vapour, is found to be:
 CO_2 : 7.11%, O_2 : 12.78%, N_2 : 80.11%.

Determine the air-fuel ratio in the burner. If the products of combustion are cooled to 30°C (p_{sat} of water at 30°C is 4.246 kPa), determine the amount of water vapour that condenses per kg of biogas. (10)

SECTION - E (Compulsory)

9. (i) What is the relevance of Zeroth law of thermodynamics?
(ii) Prove that enthalpy becomes constant in the throttling process.

[P.T.O.]

- (iii) Prove that $COP_{\text{Heat pump}} = 1 + COP_{\text{Refrigerator}}$
- (iv) What do you mean by second law efficiency?
- (v) Why does hydrogen gas need to be cooled before being throttled to get the cooling effect?
- (vi) Why is Carnot cycle not practicable for steam power plant?
- (vii) Compare the Otto, Diesel and Dual cycle for same maximum pressure and work output.
- (viii) Define adiabatic flame temperature.
- (ix) Define volume expansivity and isothermal compressibility.
- (x) What do you understand by the entropy principle?
- (10×2=20)

SECTION - A

SECTION - C