

OCT-R-296**B. Tech. EXAMINATION, 2020**

Semester III (CBS)

ENGINEERING THERMODYNAMICS (ME, AE)

ME-303

Time : 3 Hours

Maximum 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 : Attempt Five questions in all, selecting one question from each Sections A, B, C and D. Q. No. 9 is compulsory. Use of scientific calculator is permitted.

Section A

1. (a) A pump forces $1 \text{ m}^3/\text{min}$ of water horizontally from an open well to a closed tank where the pressure is 0.9 MPa . Compute the work the pump must do upon the water in an hour just

to force the water into the tank against the pressure. Sketch the system upon which the work is done before and after the process. 5

- (b) Derive an expression for the work done (closed system) during an adiabatic process, $PV^\gamma = C$. 5

2. Air flows steadily at the rate of 0.9 kg/s through an air compressor, entering at 6 m/s velocity, 150 kPa pressure, and $0.98 \text{ m}^3/\text{kg}$ volume, and leaving at 3 m/s , 800 kPa , and $0.29 \text{ m}^3/\text{kg}$. The internal energy of the air leaving is 80 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 68 kW :

- (a) Compute the rate of shaft work input to the air in kW.
(b) Find the ratio of the inlet pipe diameter to outlet pipe diameter. 10

Section B

3. (a) Derive an expression for the thermal efficiency of reversible heat engine. 5

- (b) A domestic food freezer maintains a temperature of -15°C . The ambient air temperature is 30° . If heat leaks into the freezer at the continuous rate of 1.75 kJ/s , what is the least power necessary to pump this heat out continuously ?

5

4. (a) Water flows through a turbine in which friction causes the water temperature to rise from 35°C to 37°C . If there is no heat transfer, how much does the entropy of the water change in passing through the turbine ? (Water is incompressible and the process can be taken to be a constant volume).

5

- (b) Explain that the adiabatic mixing of two fluids is irreversible.

5

Section C

5. (a) Draw and explain $h-s$ (Mollier diagram) for a pure substance.

5

- (b) Steam flows in a pipeline at 1.5 MPa . After expanding to 0.1 MPa in a throttling calorimeter, the temperature is found to be 120°C . Find the quality of steam in the pipeline. What is the maximum moisture at 1.5 MPa that can be determined with this set-up if at least 5°C of superheat is required after throttling for accurate readings ?

5

6. 0.5 kg of air is compressed reversibly and adiabatically from 80 kPa , 60°C to 0.4 MPa and is then expanded at constant pressure to the original volume. Sketch these processes on the $P-V$ and $T-S$ planes. Compute the heat transfer and work transfer for the whole path.

10

Section D

7. Derive an expression for the thermal efficiency of dual cycle.
8. Derive an expression for the heat capacity of reacting gases in equilibrium.

10

10

Section E

(Compulsory Question)

9. (i) Write the examples of extensive properties.
(ii) What are the properties of pure system ?
(iii) What is a reversible process ?
(iv) Write the expression for Carnot efficiency.
(v) What is the significance of Maxwell relations ?
(vi) Define isothermal compressibility.
(vii) What is the significance of Mollier chart ?
(viii) Write the thermal efficiency expression for Otto cycle.
(ix) Draw the TS diagram of Rankine cycle.
(x) Define enthalpy of formation of combustion.

10×2=20

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