Total Printed Pages : 4

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E-1139

B. E. IIIrd Semester (Main & Re) Examination - December, 2019

ENGINEERING THERMODYNAMICS

Branch : Mechanical Engineering

Code : BME-303

Time : Three Hours] *[Maximum Marks : 60*

Note : Attempt ***all*** questions from Section-**A** (objective types questions), ***four*** questions from Section-**B** (short answer type questions) and ***three*** questions from Section-**C** (long/essay type questions).

SECTION – A $10 \times 1 = 10$

(Objective Type Questions)

1. An ideal gas goes through a reversible isothermal process from state 1 to state 2. Work done during the process will be given by [m = Mass of the gas, R = Gas constant, T = Temperature of the gas, p = Pressure of the gas, V = Volume of the gas]

(a) Zero (b) $mRT_1 \ln \frac{p_1}{p_2}$ (c) $mRT_1 \ln(p_1 + p_2)$ (d) $2P(V_2 \times V_1)$

2. Which of the following is incorrect ?

(a) Heat is a path function

(b) Work is a path function

(c) Heat is transferred due to temperature difference only

(d) Work is transferred due to temperature difference only

3. Triple point of water is :

(a) 0°C (b) 100°C (c) 0 K (d) 0.01°C

4. Throttling calorimeter is used to measure :

(a) Temperature gas (b) Steam quality

(c) Mass flow rate of gas (d) Pressure of steam

P. T. O.

5. A series of state changes so that that the final state is identical with the initial state is known as :

   (a) thermodynamic cycle
   (b) path of the process
   (c) irreversible process
   (d) reversible process

6. For ideal gas, Joule-Kelvin coefficient is always :

   (a) one (b) zero (c) less than zero (d) 10

7. Irreversibility of a process is given by :

   (a) $T_0 S_{gen}$ (b) $2T_0 S_{gen}$ (c) $3T_0 S_{gen}$ (d) $4T_0 S_{gen}$

8. Temperature is a ..... (intensive/extensive) property.

9. PMM-I violates the :

   (a) first law of thermodynamics
   (b) second law of thermodynamics
   (c) third law of thermodynamics
   (d) none of these

10. Efficiency of Carnot cycle depends upon :

    (a) temperature limits of the cycle
    (b) pressure limits of the cycle
    (c) working fluid
    (d) material of construction

SECTION – B

$5 \times 4 = 20$

(Short Answer Type Questions)

1. Using first and second TdS equations, prove that :

$$C_P - C_V = -T\left(\frac{\partial V}{\partial T}\right)_T^2 \left(\frac{\partial V}{\partial T}\right)_T$$

2. A thermal reservoir at 1000K is separated from another thermal reservoir at 500K by a cylindrical rod insulated on its lateral surface At steady state, energy transfer by conduction takes place through the rod at a rate of 10kW. Evaluate the irreversibility rate for the rod. (T_0 = 300K).

3. Determine the maximum work obtainable by using one finite body at temperature T and a thermal energy reservoir at temperature T_0 ($T > T_0$).

4. Explain the following : Zeroth law of thermodynamics, flow work, Second law statements.

5. Derive SFEE. Also, reduce this equation for Nozzle, Throttling valve, and Compressor.

6. Describe : System, continuum, state, path, process, adiabatic flame temperature.

SECTION – C

$10 \times 3 = 30$

(Long Answer Type Questions)

1. An ideal gas cycle is represented by a rectangle on a p-V diagram. If p_1 and p_2 are the lower and higher pressure; and V_1 and V_2, the smaller and larger volumes respectively. Calculate : work done per cycle; heat absorbed by one mole of gas in one cycle. Also show that efficiency of the cycle is (Assuming heat capacities are constant) :

$$\eta = \frac{\gamma - 1}{\frac{\gamma p_2}{p_2 - p_1} + \frac{V_2}{V_2 - V_1}}$$

2. Three identical finite bodies of constant heat capacity are at temperature of 300, 300, and 1000K. If no work or heat is supplied from outside, what is the highest temperature to which any one of the bodies can be raised by the operation of heat engines or refrigerator.

3. 0.5 kg of air is compressed reversibly and adiabatically from 80kPa, 60°C,to 0.4MPa, and is then expanded at constant pressure to the original volume. Sketch these processes on the p-v and T-s plane. Determine the heat transfer and work transfer for the whole path.

4. The product of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus : CO_2 = 8.0%, CO = 0.9%, O_2 = 8.8% and N_2 = 82.3%. Determine : (i) the composition of the fuel, (ii) air-fuel ratio and (iii) the percentage excess air used

5. Air enters a compressor at 1bar, 30°C, which is also the state of the environment. It leaves at 3.5bar, 141°C and 90 m/s. Neglecting inlet velocity and PE effect, determine : (i) whether the compression is adiabatic or polytropic, (ii) if not adiabatic, the polytropic index, (iii) the isothermal efficiency, (iv) the minimum work input and irreversibility and (v) the second law efficiency. [c_p for air = 1.0035 KJ/kg-K].