

PARUL UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY
M.Tech. Summer 2017 - 18 Examination

Semester: 1
Subject Code: 03210103
Subject Name: Advanced Thermodynamics

Date: 26/05/2018
Time: 02:00PM TO 04:30PM
Total Marks: 60

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

- Q.1A) Derive the differential form of the S.F.E.E. (05)**
 B) What do you understand by the entropy principle? (05)

- C) Two identical bodies of constant heat capacity are at the same temperature T_1 . A refrigerator (05)
 operates between these two bodies until one body is cooled to temperature T_2 . If the bodies remain
 at constant pressure and undergo no change of phase, show that the minimum amount of work

needed to do this is
$$W_{\min} = C_p \left(\frac{T_1^2}{T_2} + T_2 - 2T_1 \right)$$

- Q.2 Answer the following questions. (Attempt any three) (Each five mark) (15)**

- A) Deduce the expression for available energy from a finite energy source at temperature T when the environmental temperature is T_0 .
- B) Define the second law efficiency. How is it different from the first law efficiency in the case of simple power plant?
- C) A room is maintained at 27°C while the surrounding are at 20°C . The temperature of the inner and outer surfaces of the wall ($k=0.71 \text{ W/m K}$) are measured to be 21°C and 60°C , respectively. Heat flows steadily through the wall in cross-section and 0.32 m in thickness. Determine (a) the rate of heat transfer through the wall, (b) the rate of entropy generation in the wall, and (c) the rate of total entropy generation with this heat transfer process.
- D) Why are $dU = C_v dT$ and $dH = C_p dT$ true for an ideal gas in any process, whereas these are true for any other substance only at constant volume and at constant pressure respectively?

- Q.3A) Determine the maximum work obtainable by using one finite body at temperature T and a thermal energy reservoir at temperature T_0 , $T_1 > T_2$. (07)**

- B) Write down the first and second law equations, and derive the expression for the difference in heat capacities. What does the expression signify? (08)

OR

- B) **I.** What is the condition for exact differential? Derive Maxwell's equations. (08)
II. Explain Joule-Kelvin effect. What is inversion Temperature?

- Q.4A) A domestic food freezer maintains a temperature of -15°C . The ambient air temperature is 30°C . (07)
 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?**

OR

- B) Show that the Maxwell-Boltzmann distribution function of particles among cells in phase space at (07)

equilibrium is given by:
$$\frac{N_i}{g_i} = \frac{1}{(B.e^{\beta \epsilon_i})}$$
 where β is a constant.

- B) Write short note on: (any four) (08)

- I. Quasi-Static process
- II. Continuum concept
- III. Zeroth Law of thermodynamic and triple point of water
- IV. State the properties introduced by the first law.
- V. How entropy is related to molecular disorder in the system?