.

Dr.APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY A

First Semester M.Tech Degree Examination

Mechanical Engineering

Specialization: **Thermal Engineering**

03ME6001 Advanced Thermodynamics

Max.Time:3 hours **Max.Marks:60**

PART A

(Answer ***ALL*** questions) **4x5 = 20**

I. Derive the general expression for irreversibility in steady flow and non flow process

II. Develop entropy balance relation at pressure other than $P_0 = 1$ at any temperature

III. Explain the statement All microstates are equally probable

IV. Develop the speed distribution function for each of the three velocity components and explain its significance.

PART B **4x10 = 40**

V. A a) In a steam generator, water is evaporated at 260°C, while the combustion gas (*Cp* = 1.08 kJ/kg K) is cooled from 1300°C to 320°C. The surroundings are at 30°C. Determine the loss in available energy due to the above heat transfer per kg of water evaporated (Latent heat of vaporization of water at 260°C = 1662.5 kJ/kg). **6**

b) Exhaust gases leave an internal combustion engine at 800°C and 1 atm, after having done 1050 kJ of work per kg of gas in the engine (*Cp* of gas = 1.1 kJ/kg K). The temperature of the surroundings is 30°C. **4**

i) How much available energy per kg of gas is lost by throwing away the exhaust gases?

(ii) What is the ratio of the lost available energy to the engine work?

Or

B Air enters an adiabatic compressor at atmospheric conditions of 1 bar, 15°C and leaves at 5.5 bar. The mass flow rate is 0.01 kg/s and the efficiency of the compressor is 75%. After leaving the compressor, the air is cooled to 40°C in an after-cooler. Calculate **10**

(a) The power required to drive the compressor

(b) The rate of irreversibility for the overall process (compressor and cooler).

VI. A Liquid Octane enters the combustion chamber of a gas turbine steadily at one atm and 25^0C, and it is burned with air that enters the combustion chamber at the same state. **10**

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Determine the adiabatic flame temperature for

a) Complete combustion with 100 percent theoretical air

b) Complete combustion with 400 percent theoretical air

c) Incomplete combustion(some CO in the product) with 90 percent theoretical air

Or

B Methane gas enters a steady flow adiabatic combustion chamber at 25^0C and 1 atm. It is burned with 50 percent excess air that also enters at 25^0C and 1atm. Assuming complete combustion determine, **10**

a) The temperature of the products

b) The entropy generation

c) The reversible work and exergy destruction

Assume that T_0 = 298K and the product leaves the combustion chamber at 1 atm pressure

VII. A

a) Derive Maxwell Boltzmann distribution function of particles among cells in phase space at equilibrium **6**

b) Show that $S = K[\ln Z + T\{\frac{\partial \ln Z}{\partial T}\}_v]$ **4**

Or

B

a) Explain the physical model of Bose Einstein **3**

b) Show that the number of microstate for a given macro state of distinguishable particle base on Bose Einstein model. **3**

c) Show that $U = NKT^2 \frac{d}{dt}(\ln Z)$ **4**

VIII. A

a) Show that the average pressure of a gas excreted by the molecule, $p = \frac{1}{3} mn\bar{v}^2$ **6**

b) Show that the absolute temperature of a gas is measure of kinetic energy of its molecules **4**

Or

B

a) Show that root mean square velocity of gas molecule is given by $v_{rms} = \left[\frac{3KT}{m}\right]^{1/2}$ **6**

b) Give proof of the Clausius equation of state **4**