R09

Code No: C2102

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech I - Semester Examinations, April/May-2012
ADVANCED THERMODYNAMICS
(THERMAL ENGINEERING)

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

Answer any five questions
All questions carry equal marks
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1.a) Considering the steady and adiabatic flow of an ideal gas through a pipe, show that the rate of decrease in availability or lost work is proportional to the pressure drop and the mass flow rate.

b) Exhaust gases leave an internal combustion engine at $800^0 C$ and l bar 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 $30^0 C$.

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?

2.a) Show that in a diffusion process at constant temperature the entropy increases and the Gibbs function decreases.

b) A certain mass of air is contained in a vessel of $0.142 m^3$ capacity at pressure and temperature of 23.1 bar and $18^0 C$ respectively. A valve is opened momentarily and the pressure falls immediately to 6.9 bar. Sometime later the temperature is again $18^0 C$ and the pressure is observed to be 9.1 bar. Estimate the value of specific heat ratio.

3. n_1 moles of an ideal gas at pressure P_1 and temperature T are in one compartment of an insulated container. In an adjoining compartment, separated by a partition, are n_2 moles of an ideal gas at pressure P_2 and temperature T. When the partition is removed, Calculate

i) The Final pressure of the mixture.

ii) The entropy change when the gases are identical.

iii) The entropy change when the gases are different.

Prove that the entropy change when the gases are different is the same as that produced by two independent free expansions.

4. An auditorium has to be air conditioned (first by cooling and dehumidifying and then heating) for summer when the outdoor conditions are: dbt $35^0 C$, RH 70%, Indoor conditions: dbt 20^0C, RH 60%, cooling coil dew point temperature 10^0C. Amount of free air to be circulated is $300 m^3$/min. Estimate

i) The capacity of the cooling coil and its by pass factor,

ii) Capacity of the heating coil and its surface temperature when the by pass factor is 0.25 and

iii) The mass of water vapor removed.

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5. An internal combustion engine burns liquid octane and uses 150% theoretical air. The air and fuel enter at 25^0C, and the products leave the engine exhaust ports at 900 K. In the engine 80% of the carbon burns to $C0_2$ and the remainder burns to C0. The heat transfer from this engine is just equal to the work done by the engine. Determine
   i) The power output of the engine if the engine burns 0.006 kg/sec of fuel and
   ii) The composition and the dew point of the products of combustion.

6.a) Define chemical potential of a component in terms of U, H and G.

b) Gaseous butane at 25^0C is mixed with air at 400K and burned with 400% theoretical air. Determine the adiabatic flame temperature.

7.a) What is a Cogeneration plant? What are the thermodynamic advantages of such a plant?

b) In a Cogeneration plant, the power load is 5.6 MW and the heating load is 1.163 MW. Steam is generated at 40 bar and 500^0C and is expanded isentropically through a turbine to a condenser at 0.06bar. The heating load is supplied by extracting steam from the turbine at 2 bar which condensed in the process heater to saturated liquid at 2 bar and then pumped back to the boiler. Compute
   i) The steam generation capacity of the boiler in tonnes/hr.
   ii) The heat input to the boiler in MW.

8.a) What is thermionic emission effect? How space charge effect is minimized?

b) Derive the expression for power and efficiency for a thermionic generator.

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