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12MTP14/13MTH14

First Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
Thermodynamics & Combustion Engineering

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Distinguish between heat and work interactions. **(04 Marks)**
b. List the different causes of irreversibility. Explain any one of them in detail. **(08 Marks)**
c. The capacity of a system at constant volume is $C_V = AT^2$ where $A = 0.042\ J/K^3$. The system is originally at 200 K and the thermal resevoir is at 100 K. What is the maximum amount of work that can be recovered as the system is cooled down to the temperature of the reservoir? **(08 Marks)**

2 a. Are available energy and availability same? Explain. **(04 Marks)**
b. Explain : i) Law of degredation of energy ii) Useful work iii) 2^{nd} law efficiency and iv) Dead state. **(08 Marks)**
c. Calculate the decrease in available energy when 25 kg of water at 97°C mixes with 45 kg of water at 40°C at constant pressure and a surrounding temperature of 15°C. Take C_p of water as 4.2 KJ/kgK. **(08 Marks)**

3 a. What is a pure substance? With a relevant sketch explain critical point. **(04 Marks)**
b. With neat sketch explain how dryness fraction is measured using combined seperating and throttling calorimeter. **(07 Marks)**
c. Steam at 0.8 MPa and 250°C flowing with a rate of 1 kg/s passes into a pipe carrying wet steam at 0.8 MPa and 0.95 dry. After adiabatic mixing the flow rate is 2.3 kg/s. Determine the condition of steam after mixing. The mixture is then expanded in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of the steam leaving the nozzle. Neglect the velocity of steam in pipeline. Show the processes on both T-S and h-S diagrams with relevant values. **(09 Marks)**

4 a. Write a brief note on reduced properties of gases. **(05 Marks)**
b. For the chemical reaction $CO_2 + H_2 \Leftrightarrow CO + H_2O$, the equilibrium value of the degree of reaction at 1200 K is 0.56. Determine the equilibrium constant and the Gibbs function change. **(06 Marks)**
c. 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 the processes on P-V and T – S planes. Compute the heat transfer and work transfer for the whole path. **(09 Marks)**

5 a. What are transport properties of substances? Give a brief account of all of them. **(10 Marks)**
b. What is an equation of state? Give examples. **(02 Marks)**
c. Oxygen gas is contained in a one litre flask at atmospheric pressure and 300 K. Calculate
i) How many collisions per second are made by one molecule with other molecules?
ii) How many molecules strike one sq.cm of the flask per second?
iii) How many molecules are there in the flask? Take radius of oxygen molecule as 1.8×10^{-10} m. ***(08 Marks)***

6 a. Explain : i) Law of mass action ii) Heat of reaction and iii) Enthalpy of formation. **(10 Marks)**

b. A gasoline engine delivers 150 kW. The fuel used is C_8H_{18} (l) and it enters the engine at 25°C, 150% theoritical air is used and it enters at 45°C. The products of combustion leave the engine at 750 K and the heat transfer from the engine is 205 kW. Determine the fuel consumption per hour if complete combustion is achieved. **(10 Marks)**

7 a. List the different factors that affect laminar burning velocity. Explain any three of them. **(10 Marks)**

b. Explain the differences between premixed and diffusion flames. **(05 Marks)**

c. Explain why single burning velocity cannot be determined for a diffusion flame. **(05 Marks)**

8 a. Write a note on:
i) Flammability limits.
ii) Theories of flame propogation. **(10 Marks)**

b. Clearly explain combustion in closed and open systems with examples. Discuss the case of a gas turbine combustion. **(10 Marks)**

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