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10MTP14

First Semester M.Tech. Degree Examination, December 2011
Thermodynamics and Combustion Engineering

Time: 3 hrs. Max. Marks:100

Note: 1. *Answer any FIVE full questions.*
2. *Use of Thermodynamic datahand book is permitted.*

1 a. Compare heat and work and show that heat and work are path functions. **(06 Marks)**

b. State the first law of thermodynamics for a closed system undergoing a change of state and show that internal energy is a property of the system. **(08 Marks)**

c. An incompressible metal with density 9400kg/m^3 and specific heat 205 J/kg K extrudes slowly through a die under a pressure of 200MPa. Evaluate rise in temperature of the metal presuming that there is no cooling of the metal during the extruding process. **(06 Marks)**

2 a. Show the equivalence of Kelvin – Planck and Clausius statement of II – law of thermodynamics. **(08 Marks)**

b. State third law of thermodynamics. What is the importance of third law of thermodynamics? **(04 Marks)**

c. 1m^3 of air is heated reversibly at constant pressure from 290K to 580K and is then cooled reversibly at constant volume back to initial temperature. If the initial pressure is 1 bar, workout the net heat flow and overall change in entropy. Represent the processes on T – S and P – V plot. Take Cp = 1.005 kJ/kg and R = 287J/ kg K. **(08 Marks)**

3 a. Clearly define the following : i) High grade energy ii) Availability iii) Unavailable energy iv) Energy v) Dead state. **(10 Marks)**

b. Comment on the statement "Energy is always conserved, but its quality is always degraded". **(02 Marks)**

c. A single stage air turbine is to operate with an inlet pressure and temperature of 6 bar and 800K. The outlet pressure and temperature are 1.0bar and 500K. During expansion the turbine loses 25kJ/kg to the surroundings which are at 1 bar and 300K. For unit mass flow rate, determine the decrease in availability, the maximum work and the reversibility.
For air take Cp = 1.005 kJ/kg K and R = 0.287 kJ/kg K **(08 Marks)**

4 a. Define quality of steam. With a neat sketch, discuss any one method of measurement of quality of steam. **(08 Marks)**

b. Consider 0.1kg of steam at 1 bar and 150^{0}C contained in a Piston cylinder assembly. If 25 kJ of energy in the form of heat is removed from the steam while the pressure is held constant, use Mollier diagram to workout the final condition of steam. **(06 Marks)**

c. Explain in brief Dalton's law of partial pressures and Avogadro's law. **(06 Marks)**

5 a. What do you understand by phase and reaction equilibrium? Clearly discuss the criterion for both phase and reaction equilibrium. **(10 Marks)**

b. Develop expressions for enthalpy , internal energy and specific heats of an ideal gas. **(10 Marks)**

6 a. Explain the terms rate of reaction, order of reaction, molecularity, half life and zero order reaction. **(10 Marks)**

b. With suitable graphs, explain the structure of the laminar flame. **(10 Marks)**

7 a. Define turbulent burning velocity. Explain briefly the factors affecting turbulent burning velocity. **(10 Marks)**

b. Discuss the mechanism of flame stabilization. **(10 Marks)**

8 a. Explain the combustion of fuel droplet. **(10 Marks)**

b. Discuss the fields of application of oil burners. How are they classified? With a neat sketch, explain rotary cup oil burner. **(10 Marks)**

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