USN | | | | | | | | | | |

06ME33

Third Semester B.E. Degree Examination, December 2011
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO questions from each part.*
2. Use of thermodynamic data handbook is permitted.

PART – A

1 a. With the suitable sketches/examples, distinguish between:
i) Closed system and open system ii) Point function and path function
iii) Intensive and extensive properties iv) Thermal and mechanical equilibrium. **(08 Marks)**

b. State the zeroth law of thermodynamics. How does this forms the basis of temperature measurement? **(06 Marks)**

c. The emf in a thermocouple, with the test junction at t°C on gas thermometer scale and reference junction at ice point is given by $e = 0.20t - 5\times10^{4}t^{2}$ mV.
The millivoltmeter is calibrated at ice and steam points. What will this thermometer read in a place, where, the gas thermometer reads 50°C? **(06 Marks)**

2 a. Define work, from the thermodynamic point of view. Mention suitable examples. **(04 Marks)**

b. Compare heat and work. **(06 Marks)**

c. Show that work is a path function. **(03 Marks)**

d. A cylinder fitted with a piston on which a number of weights are placed. The initial pressure is 200 kPa and the initial volume is 0.04 m^3. Heat is transferred to the system and weights are removed from the piston in such a way that $PV^{1.3}$ = Constant describes the relation between the pressure and volume, during the process. Final volume is 0.1 m^3. Calculate the work done during the process. **(07 Marks)**

3 a. What is perpetual motion of I kind? Explain. **(03 Marks)**

b. Derive the steady flow energy equation for a single stream of fluid entering and a single stream of fluid leaving the control volume. **(08 Marks)**

c. A fluid system undergoes a non flow frictionless process following the pressure-volume relation $P = \left[\frac{5}{V} + 1.5\right]$, where P is in bar and V is in m^3. During the process, the volume changes from 0.15 m^3 to 0.05 m^3 and the system rejects 45 kJ of heat.
Determine: i) the change in internal energy and ii) the change in enthalpy. **(09 Marks)**

4 a. State the limitations of first law of thermodynamics. **(04 Marks)**

b. Define i) heat pump and ii) heat engine. Prove that, of all the heat engines operating between the two temperature limits, none has a higher efficiency than a reversible engine working between same temperature limits. **(08 Marks)**

c. A reversible heat engine operates between a source temperature of 800°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine? **(08 Marks)**

PART – B

5 a. State and prove the Clausius inequality. **(07 Marks)**

b. Explain the principle of measure of entropy. **(05 Marks)**

c. A fluid undergoes a reversible adiabatic compression from 0.5 MPa,0.2 m^3 to 0.5 m^3 according to the law $PV^{1.3}$ = Constant. Determine the change in enthalpy, internal energy and entropy and the heat transfer and work transfer during the process. **(08 Marks)**

6 a. Explain the concept of available and unavailable energy. When does the system become dead? **(06 Marks)**

b. Write a brief note on law of degradation of energy. **(04 Marks)**

c. Calculate the decrease in available energy when 25 kg of water at 95°C mixes with 35 kg of water at 35°C, the pressure being taken as constant and the temperature of the surroundings being 15°C. C_p of water = 4.2 kJ/kg.K. **(10 Marks)**

7 a. Define i) Isothermal compressibility, ii) Isentropic compressibility and iii) Coefficient of volume expansion. **(06 Marks)**

b. Explain the terms:
i) Pure substance ii) Degree of superheat iii) Sensible heat iv) Dryness fraction. **(04 Marks)**

c. With a neat sketch, explain the method of measurement of dryness fraction of steam, using a throttling calorimeter. **(06 Marks)**

d. Determine the amount of heat which should be supplied to 2 kg of water at 25°C to convert it into steam at 5 bar and 0.9 dry. **(04 Marks)**

8 a. Derive the expressions for gas constant and molecular weight of a mixture of the ideal gases A, B and C. **(06 Marks)**

b. Explain the following:
i) Compressibility factor
ii) Reduced properties
iii) Law of corresponding states
iv) Generalized compressibility chart **(08 Marks)**

c. The specific heats of a gas are given by $C_p = a + kT$ and $C_v = b + kT$, where a, b & k are constants and T is in K. 1.5 kg of this gas occupying a volume of 0.06 m^3 at 5.6 MPa, expands isentropically until the temperature is 240°C. If a = 0.946, b = 0.662 and $k = 10^{-4}$, calculate the work done in the expansion. **(06 Marks)**

* * * * *