MODEL QUESTION PAPER Prepared by ktubtechquestions.com

THIRD SEMESTER B.TECH DEGREE EXAMINATION JANUARY 2017

ME 205: THERMODYNAMICS

Time: 3 Hrs **Marks: 100**

PART A

(Answer any Three)

1 a) Derive the expression for work transfer and heat transfer in a polytropic process. **(8 marks)**

b) Classify the following properties of a system as extensive or intensive: volume, pressure, energy and density. **(2 marks)**

2. A gas expands in a piston–cylinder assembly from p1 = 8 bar, V1 = 0.02 m3 to p2 = 2 bar in a process during which the relation between pressure and volume is pV1.2 = constant. The mass of the gas is 0.25 kg. If the specific internal energy of the gas decreases by 55 kJ/kg during the process, determine the heat transfer, in kJ. Kinetic and potential energy effects are negligible.

3. Derive the steady flow energy equation, stating all the assumptions.

4. Air enters a compressor operating at steady state at a pressure of 1 bar, a temperature of 290 K, and a velocity of 6 m/s through an inlet with an area of 0.1 m2. At the exit, the pressure is 7 bar, the temperature is 450 K, and the velocity is 2 m/s. Heat transfer from the compressor to its surroundings occurs at a rate of 180 kJ/min. Employing the ideal gas model, calculate the power input to the compressor, in kW.

PART B

(Answer any Three)

5. State the Kelvin-Plank and Clausius statements of second law of thermodynamics and prove their equivalence.

6. 0.5 kg of air at 1 bar and 47 °C is compressed in a piston-cylinder assembly to 4 bar and 127°C by doing 5 kJ of work when the surrounding temperature is 27°C.
(Cp of air is 1.005 kJ/kgK, R =0.287 kJ/kgK)

Determine: i) the entropy change of air
ii) the entropy change of the surroundings, and
iii) the entropy change of the universe.

7. Sketch and explain the P-V diagram for a pure substance and show the isotherms and constant quality lines on it.

8. A mass of 8 kg of helium undergoes a process from an initial state of 3 m3/kg and 15°C to a final state of 0.5 m3/kg and 80°C. Assuming the surroundings to be at 25°C and 100 kPa, determine the increase in the useful work potential of the helium during this process. The gas constant of helium is R = 2.0769 kJ/kg.K, The constant volume specific heat of helium is cv = 3.1156 kJ/kg.K

PART C

((**Answer any Four**)

9. A 3.27m3 tank contains 100 kg of nitrogen at 175 K. Determine the pressure in the tank, using (a) the ideal-gas equation and (b) the van der Waals equation. Compare your results with the actual value of 1505 kPa.
(R = 0.2968 kPa·m3/kg·K, M = 28.013 kg/kmol, Tcr = 126.2 K, Pcr = 3.39 MPa).

10. Explain Joule Thomson effect. What do you mean by inversion temperature?

11.

From the first principles derive the Mayer relation, $c_p - c_v = \frac{vT\beta^2}{k}$

where $\beta = \frac{1}{v}\left(\frac{\partial v}{\partial T}\right)_p$ and $k = -\frac{1}{v}\left(\frac{\partial v}{\partial p}\right)_T$

12. Write notes on real gas mixtures.

13. Sketch and explain a psychrometric chart showing constant volume and constant enthalpy lines. Also explain the cooling, heating, humidifying and dehumidifying processes.

14. An insulated rigid tank of volume 1m3 is divided into two chambers by a partition. One chamber of volume 0.7 m3 contains helium at 20 bar and 400 K while the other chamber contains Nitrogen at 10 bar and 500 K. The partition is removed and the gases are allowed to mix.

Calculate i) the change in entropy of Helium and Nitrogen, and
ii) the total entropy change

for Nitrogen: Cp = 1.039 kJ/kg K, Cv = 0.742 kJ/ kg K
for Helium: Cp = 5.19 kJ/kg K, Cv = 3.12 kJ/ kg K

15. Explain Dalton's law of additive pressures. Does this law hold exactly for ideal-gas mixtures? How about non-ideal gas mixtures?