Code No: NR220802 **NR** **Set No. 2**

II B.Tech II Semester Examinations,December 2010
CHEMICAL ENGINEERING THERMODYNAMICS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A vessel, insulated from its surroundings, is divided into two compartments, each with a volume of $0.03m^3$. Initially, one compartment contains saturated steam at $7\times10^5 N/m^2$ and the other compartment contains steam at $7\times10^5 N/m^2$ and 430^0C. The two compartments come to thermal equilibrium by heat transfer through the wall separating the two compartments. What is the change in entropy of the vessel? [16]

2. Hydrogen gas is contained in two constant volume vessels, each having a capacity of 500 liters. The pressure and temperature in vessel A are 5 bar and 300 K respectively, while in vessel B the values are 1.7 bar and 310 K. A valve connects the two vessels. The valve is now opened and the system is allowed to reach thermal equilibrium with the surroundings. If the surrounding temperature is 290 K, what is the final pressure in the vessel? [16]

3. An equimolar mixture of nitrogen and acetylene enters a steady flow reactor at 25^0C and atmospheric pressure. The only reaction occurring is:

   $N_{2(g)} + C_2H_2 \rightarrow 2HCN_{(g)}$

   The product gases leave the reactor at 600^0C and contain 24.2 mol% of HCN. How much heat is supplied to the reactor per mole of product gas? [16]

4. An inventor claims to have developed an engine that takes in 25,000(J)/(s) at a temperature of rejects 12,000 (J)/(s) at a temperature of 200(K), and delivers 15(kW) of mechanical power. Would you advice investing money to put this engine on the market? [16]

5. A reversible compressor of 1 mol of an ideal gas in a piston / cylinder device results in a pressure increase from 1 bar to P_2 and a temperature increase from 400 K to 950 K. The path followed by the gas during compression is given by;

   $$PV^{1.55} = \text{constant.}$$

   And the molar heat capacity of the gas is given by

   $$C_P \ / \ \text{R} = 3.85 + 0.57\times10^{-3}\text{T} \qquad [\ \text{T in Kelvin}\ ]$$

   Determine the heat transferred during the process and the final pressure. [16]

6. (a) Explain the concept of Continuum.
   (b) Explain the concept of pure substance. [8+8]

7. (a) What is equation of state? Discuss the ideal gas equation of state. [4]

(b) A room has a dimensions of $3m \times 4m \times 5m$. What is the mass of air in this room if the air pressure and temperature are 1 bar and 300K respectively? [2]

(c) An ideal gas undergoes a reversible adiabatic process. Derive an expression for the changes in internal energy and enthalpy in terms of the pressure ratio. [10]

8. Show that heat transfer during the polytropic process is $\{(\gamma - n) / (\gamma - 1)\}$X polytrophic work done. [16]

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Code No: NR220802 **NR** **Set No. 4**

II B.Tech II Semester Examinations,December 2010
CHEMICAL ENGINEERING THERMODYNAMICS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the concept of Continuum.
   (b) Explain the concept of pure substance. [8+8]

2. An equimolar mixture of nitrogen and acetylene enters a steady flow reactor at 25^0C and atmospheric pressure. The only reaction occurring is:

   $N_{2(g)} + C_2H_2 \rightarrow 2HCN_{(g)}$

   The product gases leave the reactor at 600^0C and contain 24.2 mol% of HCN. How much heat is supplied to the reactor per mole of product gas? [16]

3. Show that heat transfer during the polytropic process is $\{(\gamma - n) / (\gamma - 1)\}$X polytrophic work done. [16]

4. (a) What is equation of state? Discuss the ideal gas equation of state. [4]
   (b) A room has a dimensions of $3m \times 4m \times 5m$. What is the mass of air in this room if the air pressure and temperature are 1 bar and 300K respectively? [2]
   (c) An ideal gas undergoes a reversible adiabatic process. Derive an expression for the changes in internal energy and enthalpy in terms of the pressure ratio. [10]

5. Hydrogen gas is contained in two constant volume vessels, each having a capacity of 500 liters. The pressure and temperature in vessel A are 5 bar and 300 K respectively, while in vessel B the values are 1.7 bar and 310 K. A valve connects the two vessels. The valve is now opened and the system is allowed to reach thermal equilibrium with the surroundings. If the surrounding temperature is 290 K, what is the final pressure in the vessel? [16]

6. A reversible compressor of 1 mol of an ideal gas in a piston / cylinder device results in a pressure increase from 1 bar to P_2 and a temperature increase from 400 K to 950 K. The path followed by the gas during compression is given by;

   $$PV^{1.55} = \text{constant.}$$

   And the molar heat capacity of the gas is given by

   $$C_P \ / \ \text{R} = 3.85 + 0.57\times10^{-3}\text{T} \qquad [\ \text{T in Kelvin}\ ]$$

   Determine the heat transferred during the process and the final pressure. [16]

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8. A vessel, insulated from its surroundings, is divided into two compartments, each with a volume of $0.03m^3$. Initially, one compartment contains saturated steam at $7\times10^5 N/m^2$ and the other compartment contains steam at $7\times10^5 N/m^2$ and $430^0 C$. The two compartments come to thermal equilibrium by heat transfer through the wall separating the two compartments. What is the change in entropy of the vessel? [16]

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Code No: NR220802 **NR** **Set No. 1**

II B.Tech II Semester Examinations,December 2010
CHEMICAL ENGINEERING THERMODYNAMICS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What is equation of state? Discuss the ideal gas equation of state. [4]
   (b) A room has a dimensions of $3m \times 4m \times 5m$. What is the mass of air in this room if the air pressure and temperature are 1 bar and 300K respectively? [2]
   (c) An ideal gas undergoes a reversible adiabatic process. Derive an expression for the changes in internal energy and enthalpy in terms of the pressure ratio. [10]

2. An inventor claims to have developed an engine that takes in 25,000(J)/(s) at a temperature of rejects 12,000 (J)/(s) at a temperature of 200(K), and delivers 15(kW) of mechanical power. Would you advice investing money to put this engine on the market? [16]

3. (a) Explain the concept of Continuum.
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4. A vessel, insulated from its surroundings, is divided into two compartments, each with a volume of $0.03m^3$. Initially, one compartment contains saturated steam at $7\times10^5 N/m^2$ and the other compartment contains steam at $7\times10^5 N/m^2$ and 430^0C. The two compartments come to thermal equilibrium by heat transfer through the wall separating the two compartments. What is the change in entropy of the vessel? [16]

5. Show that heat transfer during the polytropic process is $\{(\gamma - n) / (\gamma - 1)\}$X polytrophic work done. [16]

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   $PV^{1.55}$ = constant.

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   C_P / R = 3.85 + 0.57×10^{-3}T [T in Kelvin]

   Determine the heat transferred during the process and the final pressure. [16]

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Code No: NR220802 **NR** **Set No. 3**

II B.Tech II Semester Examinations,December 2010
CHEMICAL ENGINEERING THERMODYNAMICS-I
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the concept of Continuum.
   (b) Explain the concept of pure substance. [8+8]

2. Hydrogen gas is contained in two constant volume vessels, each having a capacity of 500 liters. The pressure and temperature in vessel A are 5 bar and 300 K respectively, while in vessel B the values are 1.7 bar and 310 K. A valve connects the two vessels. The valve is now opened and the system is allowed to reach thermal equilibrium with the surroundings. If the surrounding temperature is 290 K, what is the final pressure in the vessel? [16]

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   $N_{2(g)} + C_2H_2 \rightarrow 2HCN_{(g)}$

   The product gases leave the reactor at 600^0C and contain 24.2 mol% of HCN. How much heat is supplied to the reactor per mole of product gas? [16]

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   (c) An ideal gas undergoes a reversible adiabatic process. Derive an expression for the changes in internal energy and enthalpy in terms of the pressure ratio. [10]

5. Show that heat transfer during the polytropic process is $\{(\gamma - n)/(\gamma - 1)\}$X polytrophic work done. [16]

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   And the molar heat capacity of the gas is given by

   $$C_P \ / \ \text{R} = 3.85 + 0.57\times10^{-3}\text{T} \qquad [\text{ T in Kelvin }]$$

   Determine the heat transferred during the process and the final pressure. [16]

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