Code No: RR220802 **RR** **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 reversible heat engine, employing an ideal gas with constant specific heats, follows the following cycle: constant-volume heating from state 1 to state 2, adiabatic expansion from state 2 to state 3, and a constant-pressure process from state 3 to state 1. Show that for this cycle the ratio of net work produced to heat absorbed is given by
$\frac{W}{Q} = (1-\gamma)\frac{V_3/V_1-1}{P_2/P_1-1}$ [16]

2. (a) Show that heat is a path function and energy of an isolated system is conserved.
   (b) Discuss control-mass and control volume methods of energy analysis in brief. [8+8]

3. (a) Discuss the limitations of first law of thermodynamics.
   (b) Liquid water at 180^0C and 1,002.7 kPa has an internal energy (on an arbitrary scale) of 762.0 kJ/kg and a specific volume of 1.128 cm^3/g.
      i. What is its enthalpy?
      ii. The water is brought to the vapor state at 300^oC and 1,500 kPa, where its internal energy is 2,784.4 kJ/kg and its specific volume is 169.7 cm^3/g. Calculate ΔU and Δ H for the process.

   [6+10]

4. A cylinder closed at both ends contains a free piston, on one side of which is nitrogen and other side air. The initial pressure and volume of each being 1.03 bar and 0.5 m^3 respectively. Both the piston and cylinder are perfectly insulated. In the cylinder on the air side of the piston there is an electric heater which is used to heat the air. Heat is added to the air in this manner until the volume occupied by the nitrogen is 0.3 m^3. The initial temperature of each gas is 50^0C. Determine
   (a) the final temperature of air and
   (b) the heat supplied to air.
   Assume Cp for air as 1.005 and R for air as 0.287 kj / kg K and $\gamma = 1.4$ for nitrogen. Also draw the PV diagram. [16]

5. One mole of an ideal gas is compressed isothermally but irreversibly at $127(^0C)$ from $1\times10^5 N/m^2$ to $10\times10^5 N/m^2$ by a piston in a cylinder. The heat removed from the gas during compression flows to a heat reservoir at $27(^0C)$. The actual work required is 20 percent greater than the reversible work for the same compression. Calculate the entropy change of the gas, the entropy change of the heat reservoir, and ΔS_{total}. [16]

6. (a) What is the physical significance of two constants that appear in the Vander Waals equation of state? Explain.
   (b) A 1.2 m^3 vessel contains 3.1 kg of steam at a pressure of 450 kPa. Find the temperature of steam using
      i. the steam tables
      ii. the Vander Waals equation.

[8+8]

7. (a) Define and explain the term temperature. Further, compare the various temperature scales.
   (b) Define work and heat in thermodynamic sense and bring out the comparison between them. [8+8]

8. (a) By means of a schematic diagram, explain the Linde liquefaction process
   (b) Explain the operation of the Claude liquefaction cycle by means of a neat sketch [8+8]

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Code No: RR220802 **RR** **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) Define and explain the term temperature. Further, compare the various temperature scales.
   (b) Define work and heat in thermodynamic sense and bring out the comparison between them. [8+8]

2. A cylinder closed at both ends contains a free piston, on one side of which is nitrogen and other side air. The initial pressure and volume of each being 1.03 bar and 0.5 m^3 respectively. Both the piston and cylinder are perfectly insulated. In the cylinder on the air side of the piston there is an electric heater which is used to heat the air. Heat is added to the air in this manner until the volume occupied by the nitrogen is 0.3 m^3. The initial temperature of each gas is 50^0C. Determine
   (a) the final temperature of air and
   (b) the heat supplied to air.
   Assume Cp for air as 1.005 and R for air as 0.287 kj / kg K and $\gamma = 1.4$ for nitrogen. Also draw the PV diagram. [16]

3. One mole of an ideal gas is compressed isothermally but irreversibly at $127(^0C)$ from $1\times10^5 N/m^2$ to $10\times10^5 N/m^2$ by a piston in a cylinder. The heat removed from the gas during compression flows to a heat reservoir at $27(^0C)$. The actual work required is 20 percent greater than the reversible work for the same compression. Calculate the entropy change of the gas, the entropy change of the heat reservoir, and ΔS_{total}. [16]

4. (a) Show that heat is a path function and energy of an isolated system is conserved.
   (b) Discuss control-mass and control volume methods of energy analysis in brief. [8+8]

5. (a) Discuss the limitations of first law of thermodynamics.
   (b) Liquid water at 180^0C and 1,002.7 kPa has an internal energy (on an arbitrary scale) of 762.0 kJ/kg and a specific volume of 1.128 cm^3/g.
      i. What is its enthalpy?
      ii. The water is brought to the vapor state at 300^oC and 1,500 kPa, where its internal energy is 2,784.4 kJ/kg and its specific volume is 169.7 cm^3/g. Calculate ΔU and Δ H for the process.

   [6+10]

6. A reversible heat engine, employing an ideal gas with constant specific heats, follows the following cycle: constant-volume heating from state 1 to state 2, adiabatic expansion from state 2 to state 3, and a constant-pressure process from state 3 to state 1. Show that for this cycle the ratio of net work produced to heat absorbed is given by
$\frac{W}{Q} = (1-\gamma)\frac{V_3/V_1-1}{P_2/P_1-1}$ [16]

7. (a) By means of a schematic diagram, explain the Linde liquefaction process
   (b) Explain the operation of the Claude liquefaction cycle by means of a neat sketch [8+8]

8. (a) What is the physical significance of two constants that appear in the Vander Waals equation of state? Explain.
   (b) A 1.2 m^3 vessel contains 3.1 kg of steam at a pressure of 450 kPa. Find the temperature of steam using
      i. the steam tables
      ii. the Vander Waals equation.

[8+8]

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Code No: RR220802 **RR** **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 the physical significance of two constants that appear in the Vander Waals equation of state? Explain.

   (b) A 1.2 m^3 vessel contains 3.1 kg of steam at a pressure of 450 kPa. Find the temperature of steam using

      i. the steam tables
      ii. the Vander Waals equation.

   [8+8]

2. (a) By means of a schematic diagram, explain the Linde liquefaction process

   (b) Explain the operation of the Claude liquefaction cycle by means of a neat sketch [8+8]

3. (a) Define and explain the term temperature. Further, compare the various temperature scales.

   (b) Define work and heat in thermodynamic sense and bring out the comparison between them. [8+8]

4. (a) Discuss the limitations of first law of thermodynamics.

   (b) Liquid water at 180^0C and 1,002.7 kPa has an internal energy (on an arbitrary scale) of 762.0 kJ/kg and a specific volume of 1.128 cm^3/g.

      i. What is its enthalpy?
      ii. The water is brought to the vapor state at 300^oC and 1,500 kPa, where its internal energy is 2,784.4 kJ/kg and its specific volume is 169.7 cm^3/g. Calculate ΔU and Δ H for the process.

   [6+10]

5. A cylinder closed at both ends contains a free piston, on one side of which is nitrogen and other side air. The initial pressure and volume of each being 1.03 bar and 0.5 m^3 respectively. Both the piston and cylinder are perfectly insulated. In the cylinder on the air side of the piston there is an electric heater which is used to heat the air. Heat is added to the air in this manner until the volume occupied by the nitrogen is 0.3 m^3. The initial temperature of each gas is 50^0C. Determine

   (a) the final temperature of air and

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   Assume Cp for air as 1.005 and R for air as 0.287 kj / kg K and $\gamma = 1.4$ for nitrogen. Also draw the PV diagram. [16]

6. One mole of an ideal gas is compressed isothermally but irreversibly at $127(^0C)$ from $1\times10^5 N/m^2$ to $10\times10^5 N/m^2$ by a piston in a cylinder. The heat removed from the gas during compression flows to a heat reservoir at $27(^0C)$. The actual work required is 20 percent greater than the reversible work for the same compression. Calculate the entropy change of the gas, the entropy change of the heat reservoir, and ΔS_{total}. [16]

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   $\frac{W}{Q} = (1-\gamma)\frac{V_3/V_1-1}{P_2/P_1-1}$ [16]

8. (a) Show that heat is a path function and energy of an isolated system is conserved.
   (b) Discuss control-mass and control volume methods of energy analysis in brief. [8+8]

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Code No: RR220802 **RR** **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) Show that heat is a path function and energy of an isolated system is conserved.
   (b) Discuss control-mass and control volume methods of energy analysis in brief. [8+8]

2. (a) Define and explain the term temperature. Further, compare the various temperature scales.
   (b) Define work and heat in thermodynamic sense and bring out the comparison between them. [8+8]

3. (a) By means of a schematic diagram, explain the Linde liquefaction process
   (b) Explain the operation of the Claude liquefaction cycle by means of a neat sketch [8+8]

4. (a) Discuss the limitations of first law of thermodynamics.
   (b) Liquid water at 180^0C and 1,002.7 kPa has an internal energy (on an arbitrary scale) of 762.0 kJ/kg and a specific volume of 1.128 cm^3/g.
      i. What is its enthalpy?
      ii. The water is brought to the vapor state at 300^oC and 1,500 kPa, where its internal energy is 2,784.4 kJ/kg and its specific volume is 169.7 cm^3/g. Calculate ΔU and Δ H for the process.

   [6+10]

5. A reversible heat engine, employing an ideal gas with constant specific heats, follows the following cycle: constant-volume heating from state 1 to state 2, adiabatic expansion from state 2 to state 3, and a constant-pressure process from state 3 to state 1. Show that for this cycle the ratio of net work produced to heat absorbed is given by
   $\frac{W}{Q} = (1-\gamma)\frac{V_3/V_1-1}{P_2/P_1-1}$ [16]

6. One mole of an ideal gas is compressed isothermally but irreversibly at $127(^0C)$ from $1\times10^5 N/m^2$ to $10\times10^5 N/m^2$ by a piston in a cylinder. The heat removed from the gas during compression flows to a heat reservoir at $27(^0C)$. The actual work required is 20 percent greater than the reversible work for the same compression. Calculate the entropy change of the gas, the entropy change of the heat reservoir, and ΔS_{total}. [16]

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   Assume Cp for air as 1.005 and R for air as 0.287 kj / kg K and $\gamma = 1.4$ for nitrogen. Also draw the PV diagram. [16]

8. (a) What is the physical significance of two constants that appear in the Vander Waals equation of state? Explain.

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      i. the steam tables

      ii. the Vander Waals equation.

   [8+8]

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