# Introduction to the Course

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SSN

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# Questionnaire

1. What information could be obtained from thermodynamic analysis?

2. What are the limitations of thermodynamics?

3. What is *first law* of thermodynamics?

4. What are the ways by which the energy of a gaseous system can be increased ?

5. What do you mean by *isothermal* and *adiabatic* processes?

6. What is the value of universal gas constant **R** ?

7. Temperature of a gas -----------(decreases / increases) when its pressure is reduced.

8. Velocity of a gas can be increased by ------- (decreasing / increasing) the flow cross section.

9. What is *a heat engine?*

10. Efficiency of thermal power plants is approximately -------- %.

# About this Course

- Chemical Engineering Thermodynamics is primarily concerned with the application of thermodynamics to phase equilibria and reaction equilibria in multicomponent systems.

- Of secondary importance in this context is the application of Thermodynamics to heat-to-work and work-to-heat conversion devices (*this aspect will be covered in Thermo I*). These applications are studied in greater detail by **Mechanical Engineers.**

- Chemical engineers are concerned with the calculation of work in separation and in mixing processes.

- Phase and reaction equilibria involving two or more solid phases are of primary interest to **Metallurgists.**

# About this Course (contd.)

- Thermodynamics plays a supervisory and often intangible role in engineering.

    – Its applications are obvious in the design of Chemical engineering equipment in processes in which approach to equilibrium is nearly one hundred percent in practice.

    – Even in those cases where the processes are governed by rate considerations, thermodynamics sets the boundaries of design.

# Syllabus Topics

1.  Basic concepts                                    6 hrs

2.  Laws of Thermodynamics                            12

3.  Thermodynamic properties of real gases            9

4.  Thermodynamic formulations                        9

5.  Compression of fluids                             9

Total: 45 hrs

# Syllabus – CH 2303 (3 credit)

- *UNIT I BASIC CONCEPTS:* The terminologies of thermodynamics, the variables and quantities of thermodynamics, categorization of systems and processes. Energy classifications, point and path properties, energy in transition, heat and work, reversible and irreversible processes, phase rule.

- *UNIT II LAWS OF THERMODYNAMICS:* The first law and internal energy, statements of first law for the non flow and flow systems, enthalpy and heat capacity limitations of the first law. Statements of the second law of thermodynamics, available and unavailable energies, and the entropy function, applications of the second law.

- *UNIT III THERMODYNAMIC PROPERTIES OF REAL GASES:* The PVT behavior of fluids, laws of corresponding states and equation of states approaches to the PVT relationships of non ideal gas, problems; compressibility factors, generalized equations of state, property estimation via generalized equation of state; fugacity and fugacity coefficients of real gases.

- *UNIT IV THERMODYNAMIC FORMULATIONS:* Measurable quantities, basic energy relations, Maxwell relations, thermodynamic formulations to calculate enthalpy, internal energy and entropy as function of pressure and temperature, other formulations involving Cp and Cv, complex thermodynamic formulations, thermodynamic properties of an ideal gas, entropy change in reversible and irreversible process.

- *UNIT V COMPRESSION OF FLUIDS:* Thermodynamic aspects of compression process, classification of compression processes, basic equation for change of state of gases, the work expression for different situations, the effect of clearance volume, multistage compression, convergent divergent flow, Ejectors.

# Text Books

- Smith, J.M., Van Ness, H.C., & Abbot M.C, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, 7th Edition, 2004.

- Narayanan K.V "A Text Book of Chemical Engineering Thermodynamics" Prentice Hall of India Pvt. Ltd. 2001.

# Reference Books

- Hougen, O.A., Watson, K.M., and Ragatz, R.A., "Chemical Process Principles Part II, Thermodynamics", John Wiley 1970.

- Dodge, B.F., "Chemical Engineering Thermodynamics", McGraw-Hill, 1960.

- Sandler, S.I., "Chemical and Engineering Thermodynamics 2nd edn.", Wiley, 1989.

- Kyle, B.G., "Chemical and Process Thermodynamics 2nd edn.", Prentice Hall of India Pvt. Ltd., 1990.

# Instructor's Expertise

- Handling this subject for the fourth time:

  – Handled two times at SVCE: 2001-02 and 2003-04, and one time at SSN: 2011-12

# Learning Process

- ## Class Time Table:
  Mon: 3; Tue: 6; Thurs: 1; Fri: 2, 5

- ## Tutorials: (Tue 6$^{th}$ hr)
  10 sets;

  | | |
  |---|---|
  | Laws of Thermodynamics | 3 |
  | Thermodynamic properties of real gases | 3 |
  | Thermodynamic formulations | 2 |
  | Compression of fluids | 2 |