

# 16BT308 THERMODYNAMICS FOR BIOTECHNOLOGISTS

Hours Per Week :

L	T	P	C
3	-	-	3

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[www.upsbatterycenter.com](http://www.upsbatterycenter.com)

## Course Description and Objectives:

This course deals with the laws of thermodynamics and their applications to estimate thermodynamic properties of substances. In addition, a clear-cut idea about estimation of property changes of the process and determining equilibrium states of the system also is dealt with. The objective of the course is to familiarize the students about the three laws of thermodynamics, PVT behavior of pure components, equations of state, phase equilibrium and chemical reaction equilibrium.

## Course Outcomes:

Upon completion of the course, the student will be able to

- CO1: Understand thermodynamic systems and laws of thermodynamics.
- CO2: Estimate the system property changes by using laws of thermodynamics.
- CO3: Determine the entropy changes for ideal gases.
- CO4: Evaluate phase equilibrium and determine equilibrium properties.
- CO5: Investigate chemical reaction equilibrium to estimate equilibrium composition of a reaction mixture.

## SKILLS:

- ✓ Calculate heat and work interactions for industrial processes.
- ✓ Estimate thermodynamic properties of substances.
- ✓ Expertise on phase equilibrium calculations.
- ✓ Capability of estimation of chemical reaction equilibrium.

UNIT - 1

L-9

THE FIRST LAW AND OTHER BASIC CONCEPTS: The scope of thermodynamics; The first law of thermodynamics, thermodynamic state and state functions, enthalpy, steady-state steady flow process, equilibrium, phase rule, reversible process, constant - V processes, constant - P processes and heat capacity; Calculation of work, energy and property changes in reversible processes.

UNIT - 2

L-9

SECOND LAW OF THERMODYNAMICS: Statements of the second law, heat engines, thermodynamic temperature scales; Entropy, entropy changes of an ideal gas; Third law of thermodynamics and entropy from the microscopic viewpoint.

UNIT - 3

L-9

THERMODYNAMIC PROPERTIES OF FLUIDS AND SOLUTION THERMODYNAMICS: Fundamental property relations, Maxwell relationships and their applications; Partial molar properties, concepts of chemical potential and fugacity, activity coefficient; Gibbs Duhem equation.

UNIT - 4

L-9

PHASE EQUILIBRIA: Criteria for phase equilibrium; Duhem's theorem, vapor-liquid equilibrium calculations, phase diagrams for binary solutions, ideal and non ideal solutions; Liquid-liquid equilibrium.

UNIT - 5

L-9

CHEMICAL REACTION EQUILIBRIA: Equilibrium criteria for homogeneous chemical reactions; Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions.

TEXT BOOKS:

1. J.M.Smith, H.C.Van Ness and M.M.Abbott, "Introduction to Chemical Engineering Thermodynamics", 5<sup>th</sup> edition, McGraw Hill, 2005.
2. Y.V. C. Rao, "Chemical Engineering Thermodynamics", 1<sup>st</sup> edition, University Press, 2004

REFERENCE BOOKS:

1. K. V. Narayanan, "A Text Book of Chemical Engineering Thermodynamics", 1<sup>st</sup> edition, Prentice Hall of India Publications, 2001.
2. Y.V.C. Rao, "Engineering Thermodynamics", 1<sup>st</sup> edition, Universities Publications, 2004.
3. M.D. Koretsky, "Engineering and Chemical Thermodynamics", 1<sup>st</sup> edition, John Wiley and Sons, 2004.

ACTIVITIES:

- *Estimation of efficiency of heat engine and refrigerator.*
- *Calculation of heat changes in fermentation process.*
- *Determine equilibrium constant for a chemical reaction.*
- *Draw phase equilibrium diagrams.*