

Details of Course

Course Title	Course Structure			Pre-Requisite
Thermal Physics -B.Tech. EP III Semester Lesson Plan	L	T	P	None
	3	1	0	

Course Objectives

This course aims to familiarize the students with laws of thermodynamics and its applications and apply them to various engineering problems. The student will learn the fundamental principles of thermodynamics and its properties by demonstrating the ability to simplify and model real systems and to explain, analyse, and predict a variety of natural phenomena.

Course Outcomes (CO)

By the end of this program, students should have the following knowledge, skills and values:

1. Would be able to explain basic principle and laws of thermodynamics, thermodynamic description of systems and thermodynamic potentials
2. Derive thermodynamic parameters and apply fundamental laws to solve thermodynamic problems
3. Understanding the fundamental concept of heat, temperature, entropy and free energies
4. Devise and implement a systematic strategy for solving a complex problem in thermodynamics by breaking it down into its constituent parts and apply a wide range of mathematical techniques to build up its solution.

Unit	Content	Contact Hours
1	Microscopic and macroscopic points of view: thermodynamic variables of a system. Thermodynamic limit, State function, exact and inexact differentials, Thermal equilibrium, zeroth law and the concept of temperature, Thermodynamic equilibrium, Internal energy, External work, Quasistatic process, state and path functions, Work done in an internally reversible non-flow process, T-V, P-V, and P-T diagrams of a pure substance. First law of thermodynamics and	9 Hours

	applications including magnetic systems, Specific heats and their ratio, Isothermal and adiabatic changes in perfect and real gases.	
2	Reversible and irreversible processes, Carnot's cycles - efficiency, Carnot's theorem. Kelvin's scale of temperature, Relation to perfect gas scale, Various thermodynamic cycles; Free energies, Path and State Functions, Second law of thermodynamics - different formulations and their equivalence, Clausius inequality, Concept of Entropy, Change of entropy in various thermodynamic processes, Entropy and disorder, Equilibrium and principle of maximum entropy.	7 Hours
3	Enthalpy, Helmholtz and Gibbs' free energies, Legendre transformations, General equation for molar heat capacities, Gibb's-Duhem relations, Thermodynamic Relations for dU, dH, dA, and dG. Maxwell relations simple deductions using these relations, General equation for dU, dH, dS. Volume expansivity and isothermal compressibility. Thermodynamic equilibrium and free energies.	8 Hours
4	Equilibrium between phases, Triple point: Gibbs' phase rule and simple applications, First and second order phase transitions, Ehrenfest criterion, Clausius- Clapeyron's equation, Joule-Thomson effect. Antoine equation. Residual property. dU, dH, and dS for ideal gases and real gases. Calculations of Joule-Thompson coefficient and residual properties of gases and liquids and molar heat capacity at constant pressure using van der Waals equation of state. $dG=RT \ln f$, and the importance of fugacity in relation to equilibrium.	8 Hours
5	Chemical Potential, Chemical Equilibrium, Phase Diagram, Gibb's Phase Rule, Phase Transitions, Stable and Metastable States, Phase Co-existence, Saha-Ionization; Speed of Sound in Fluids and Shock Waves. Rankine cycle. Comparison of Carnot and Rankine cycles. Reheat cycle. Regenerative cycle. Air standard power cycles. Otto cycle. Diesel cycle. Brayton cycle. Coefficient of Performance. Reversed Carnot Cycle. Vapour-compression refrigeration cycle. Ammonia absorption refrigeration cycle.	9 Hours

Books:

S. No.	Name of Books/Authors/Publisher
1.	Stephen J. Blundell and Katherine M. Blundell, Concepts in Thermal Physics, 3rd Ed, Oxford University Press, 2014.
2.	R. H. Dittman and M. W. Zemansky, Heat and Thermodynamics, McGraw-Hill College; Subsequent Ed, 1996.
3.	Nag, P.K., Engineering Thermodynamics, Third Edition, Tata McGraw-Hill, New Delhi, 2005.
4.	Moran, M.J. and Shapiro, H.N., Fundamentals of Engineering Thermodynamics, Fourth Edition, John Wiley, 2000
5.	M. N. Saha and B. N. Srivastava, Treatise on Heat, 3rd Edition, The Indian Press, Allahabad, 1950.
6.	R.Baierlein, Thermal Physics, Cambridge University Press, 2005.
7.	Ahuja, P., Chemical Engineering Thermodynamics, PHI Learning, 2009