Course Code	18ME33	Course Title	Basic Thermodynamics	Semester	III
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

	Teaching Hr
Course Learning Objectives: This course will enable students to; • The course aims at to cover the basic principles of thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice. • To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments. • To learn the basics of heat engine, heat pump, refrigerator and Carnot principle and their Practical applications. • To describe the concept of entropy and its importance in practical applications. • To teach students about properties of pure substances and process related to vapor.	
Module-1 **Fundamental Concepts & Definitions:** Definition of Thermodynamics. Microscopic and Macroscopic approaches to the study of thermodynamics. System and types of system. Definition of thermodynamic property, Intensive and extensive properties, thermodynamic state, process, quasi-static process, thermodynamic cycle. Thermodynamic equilibrium; definitions of thermal, chemical and mechanical equilibrium. Zeroth law of thermodynamics, Concept of Temperature with simple numerical problems on measurement of temperature. **Work and Heat:** Thermodynamic definition of work, sign convention. Exact & Inexact differentials. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Definition of heat and its sign convention. Comparison of work and heat. Simple numerical problems on work and heat transfer only.	12
Module-2 **First Law of Thermodynamics**: Statement of the First law of thermodynamics for a closed system undergoing a cyclic process. First law of thermodynamics for a change of state of the system and concept of energy. Energy as a property of the system and its significance. Simple numerical problems on systems undergoing closed process. **Steady flow process**, First law applied to steady flow process, derivation of steady flow energy equation and its applications. Simple numerical problems on systems undergoing steady flow process.	12
Module-3 **Second Law of Thermodynamics:** Thermal reservoir. Source and sink. Heat engine, heat pump and refrigerator. Efficiency and coefficient of performance. Kelvin – Planck and Clausius statement of the Second law of thermodynamics and equivalence of the two Statements. Definition of perpetual motion machines of I & II kind with example. Reversible and Irreversible processes. Reversible heat engine - Carnot Cycle and expression for efficiency of Carnot cycle. Simple numerical problems on heat engines and heat pumps.	12

Module-4 **Pure substances:** Definition of pure substance, two-property rule applied to pure substance. P-T P-V & T-V diagrams, definitions of Sub-cooled liquid, saturated liquid, mixture, saturated vapour and superheated vapour. Definitions of triple point and critical point. Enthalpy of changes of a pure substance, temperature- Enthalpy diagram, Temperature Entropy diagram, definition of sensible heat, latent heat and super heat. Two phase mixture, quality of steam and definition of Dryness fraction. Measurement of dryness fraction using throttling calorimeter, separating calorimeter and throttling and separating calorimeter. Simple problems.	**10**
Module-5 **Entropy**: Claudius Inequality: Statement, and proof. Entropy: Definition, entropy as a property of the system. Principle of increase of entropy. Entropy as a quantitative test for irreversibility. Expression for entropy using T-dS relations, Calculation of entropy changes in different thermodynamic cyclic process. Equation of state, internal energy and enthalpy. Specific heats. Simple numerical problems based on heat, work, internal energy, enthalpy and entropy change in various processes. **Ideal gases:** Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases.	**10**
Course outcomes: By the end of the course, the student shall be able to CO1: Describe the fundamental concepts of thermodynamic systems and various processes of heat and work interactions CO2: Apply the First law of thermodynamics for flow and non-flow processes in different applications CO3: Explain the second law of thermodynamics, entropy and its applications CO4: Compute the properties of vapor, ideal and real gases.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Textbooks: 1. P .K. Nag, **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 3rd Edition, 2006. 2. B. K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics, PHI, New Delhi, 2010. 3. R K Rajput, "**Engineering Thermodynamics"** Laxmi Publications Pvt Ltd, 3rd Edition, 2011. 4. Mahesh M Rathore, "**Thermal Engineering**" McGraw Hill Pvt Ltd., 1st Edition, New Delhi, 2010. **Reference Books:** 1. Yunus A. Cenegal and Michael A. Boles "Thermodynamics, An Engineering Approach", Tata McGraw Hill publications, 2002. 2. J. B. Jones and G. A. Hawkins "Engineering Thermodynamics", John Wiley and Sons. 3. G. J. Van Wylen and R. E. Sonntag "Fundamentals of Classical Thermodynamics", Wiley Eastern. **4.** Y. V. C. Rao"An Introduction to Thermodynamics, Wiley Eastern, 1993.	