

2043: Thermodynamics		
Teaching Scheme:	Credits	Examination Scheme:
TH: 04 Hr/week	Th:04	TH In-Sem: 50
		End-Sem: 50
PR: 02 Hrs/week	PR/OR/TW:01	PR: --
		OR: 50
		TW: --
Prerequisites: - 1. Engg. Mathematics 2. Engg. Physics/Chemistry 3. Fundamental Concepts and laws of Thermodynamics.		
Course Objectives: • Identify and use units and notations in Thermodynamics. • State and illustrate first and second laws of Thermodynamics. • Explain the concepts of entropy, enthalpy, reversibility and irreversibility. • Apply the first and second laws of Thermodynamics to various gas processes and cycles. • To get conversant with properties of steam, dryness fraction measurement, vapor processes and Thermodynamic vapor cycles, performance estimation. • To get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.		
Course Outcomes: • On completion of the course, learner will be able to– • Apply various laws of thermodynamics to various processes and real systems. • Apply the concept of Entropy, Calculate heat, work and other important thermodynamic properties for various ideal gas processes. • Estimate performance of various Thermodynamic gas power cycles and gas refrigeration cycle and availability in each case. • Estimate the condition of steam and performance of vapour power cycle and vapour compression cycle. • Estimate Stoichiometric air required for combustion, performance of steam generators and natural draught requirements in boiler plants. • Use Psychrometric charts and estimate various essential properties related to Psychrometry and processes		
Course Contents		

Unit I Laws of thermodynamics Introduction of thermodynamics, Review of basic definitions, Zeroth law of thermodynamics, Macro and Microscopic Approach, State Postulate, State, Process and Thermodynamic Cycles, First law of thermodynamics, Joules experiment, Applications of first law to flow and non flow processes and cycles. Steady flow energy equation and its application to different devices. Equivalence of Clausius and Kelvin Planck Statement, PMM I and II, Concept of Reversibility and Irreversibility.	(6 Hrs)
Unit II Entropy Entropy as a property, Clausius inequality, Principle of increase of Entropy, Change of entropy for an ideal gas and pure substance.	(4 Hrs)
Ideal Gas Ideal Gas definition Gas Laws: Boyle's law, Charle's law, Avagadro's Law, Equation of State, Ideal Gas constant and Universal Gas constant, Ideal gas processes- on P-V and T-S diagrams Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytropic, Throttling Processes, Calculations of heat transfer, work done, internal energy. Change in entropy, enthalpy.	(6 Hrs)
Unit III Thermodynamic cycles Gas Power Cycles: Air Standard Cycle, Efficiency and Mean Effective Pressure, Carnot Cycle, Otto Cycle, Diesel cycle, Dual cycle, Comparison of cycles, Brayton cycle, Gas Refrigeration Cycle: Reversed Carnot, Bell Coleman Cycle.	(6 Hrs)
Availability Available and unavailable energy, concept of availability, availability of heat source at constant temperature and variable temperature, Availability of non flow and steady flow systems, Helmholtz and Gibbs function, irreversibility and second law efficiency.	(4 Hrs)
Unit IV Properties of Pure substances Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and Mollier diagram for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined) Non-flow and Steady flow vapour processes, Change of properties, Work and heat transfer.	(5 Hrs)
Thermodynamic Vapour Cycle Vapour Power Cycles: Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle, Vapour Refrigeration Cycles: Reversed Carnot Vapor Cycle, Vapor Compression Cycle and representation of cycle on P-h and T-s diagram, Refrigerating effect, Compressor power and COP estimation (Numerical treatment using R134a only and enthalpy Cp, Cv data should be provided in tabulated form).	(5 Hrs)

Unit V Steam Generators	(6 Hrs)
Introduction to fuels, Theoretical amount of Oxygen / Air required for combustion. Stoichiometric Air: Fuel ratio, Excess air, lean and rich mixtures, Stoichiometric A: F ratio for petrol (No Numerical Treatment on fuels and combustion, only basic definitions and terminologies to be covered) . Classification, Constructional details of low pressure boilers, Features of high pressure (power) boilers, Introduction to IBR, Boiler performance calculations-Equivalent evaporation, Boiler efficiency Energy balance, Boiler draught (natural draught numerical only).	
Unit VI Psychrometry	(6 Hrs)
Psychrometry and Psychrometric Properties, Basic Terminologies, Psychrometric Relations, Psychrometric Chart, Psychrometric Processes, Thermodynamics of Human Body, Comfort Conditions (Numerical treatment using Psychrometric chart only) .	
Books:	
Text: 1. R. K. Rajput, Engineering Thermodynamics, EVSS Thermo Laxmi Publications 2. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications 3.	
Reference: 1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach, 2. P. L Ballany: Thermal Engineering, Khanna Publishers 3. C.P. Arora: Engineering Thermodynamics, Tata McGraw Hill. 4. S. Domkundwar, C. P. Kothandaraman, Anand Domkundwar, Thermal Engineering, Dhanpat Rai Publishers.	

List of Practical's:

1. Joule's experiment to validate first law of thermodynamics.
2. Determination of C_p and C_v for Ideal gas.
3. Performance estimation of Air standard cycle using standard simulation software's (MATLAB, VC++ etc.).
4. Determination of dryness fraction of steam (At least two Calorimeters).
5. Experiment to Calculate COP of Simple Vapor Compression Cycle (VCC).
6. Performance estimation of VCC using any professional software (CoolPack etc.)
7. Study of Boiler Mountings.
8. Study of Boiler Accessories.
9. Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
10. Industrial visit to any process industry which uses boiler and submission of detailed report.
11. Demonstration of Psychrometric processes (At least four).

Notes:

1. Minimum 8 experiments should be performed.
2. Experiment No. 9 and 10 are compulsory.