Course Code – 214301
Applied Thermodynamics - I

Credit Points	Teaching Hrs/Week	Practical Hrs/Week
5	3	2

Objective	Students can estimate the potentials and limitations for thermal-mechanical energy conversion in engineering cycles and devices
Prerequisites	None

Unit	Topic Name	Details	Hrs
1	**Thermodynamic Relations**	Enthalpy, entropy, internal energy, and specific heat relations ; Tds equations for entropy change ; Difference in heat capacities, Ratio of specific heats, Evaluation of thermodynamic properties from an equation of state.[1] Helmoltz's and Gibb's functions; Some mathematical theorems; Maxwell's relations.[1] Applications of Maxwell's relations to ideal and real gases; Joule-Thomson effect and coefficient; Clausius-Clapeyron equation. [1] Real gas equation of state (Van-der Walls, Verial, Peng-Robinson, Redlich Kwong, etc); Compressibility factor; General compressibility charts and applications. [1]	4
2	**Property Relationships for pure substance and Mixtures**	Mixture of gases : Dalton's law of partial pressures and Amagot's law of partial volumes for ideal gas mixtures ; Volumetric and gravimetric analysis ; principle of corresponding states; Evaluation of ideal gas mixture properties and applications to various processes[1] Properties of real gas mixtures; Use of compressibility charts for real gas mixtures. [1] Pscychrometry **:** Atmospheric air and Psychometric properties ; Dry bulb temperature, wet bulb temperature, dew point temperature, partial pressures, specific and relative humidity and the relation between the two. [1] Enthalpy and adiabatic saturation temperature. Construction and use of psychrometric chart ; Analysis of various processes- heating, cooling, dehumidifying and humidifying.[1] Adiabatic mixing of stream; Summer and winter air-	5

		conditioning; Cooling load calculations. [1]	
3	**Combustion Thermodynamics**	Stoichiometric air for combustion of fuels; Excess air; Mass balance, A/F ratio and equivalence ratio; Exhaust gas analysis (Orsat apparatus). [1] Composition of various solid, liquid and gaseous fuels. ; Properties of fuels. [1] Energy balance for a chemical reactions (First law analysis); Enthalpy and internal energy of combustion; Enthalpy of formation and bond energy; Sensible energy. [1] Calculation of heat release for various combustion processes; Use of enthalpy tables; Calculation of adiabatic flame temperature. [1] Rate of chemical reactions; Law of mass action; Collision theory for reaction kinetics; Arehnius factor and activation energy; Multi-step reactions. [1] Dissociation and chemical equilibrium; Reversible reactions; Gibb's and Helmotz's free energy; Relation between equilibrium constants and free energy. [1] Calculation of equilibrium composition of reacting mixtures; Effect of pressure and temperature on equilibrium composition; Combustion efficiency and emissions. [1]	7
4	**Gas Power Cycles**	Air standard cycle approximations; Carnot, Otto, Diesel Cycles – p-v and T-s diagrams; Numerical Problems. [1] Description-efficiency, mep, etc.; Comparison of Otto, Diesel cycles for same compression ratio and heat input; Dual cycles- p-v and T-s diagrams. [1] Stirling cycles, Ericsson cycle, Atkinson cycle; Basic Gas turbine (Brayton) cycle (for open and closed systems). [1] Efficiency of gas turbine cycle; Regenerative gas turbine cycle; Inter-cooling and reheating in gas turbine cycles; Numerical problems. [1]	4
5	**Vapour Power Cycles**	Carnot vapour power cycle & its associated difficulties; Simple Rankine cycle – description, Ts diagram & analysis of performance; Application to thermal power plants. [1] Comparison of Carnot and Rankine cycle; Effect of pressure and temperature on Rankine cycle performance; Numerical problems. [1] Reheat Rankine cycle; HPT and LPT steam expansion; Efficiency of reheat cycles; Numerical problems. [1] Ideal and practical regenerative Rankine cycles; open and closed feed water heaters; Efficiency of regenerative cycles; Numerical problems. [1]	4

6	**Refrigeration Cycles**	Reversed Carnot cycle and its limitations; Basic vapour compression refrigeration system; Refrigeration effect; COP; Capacities; Unit of refrigeration; ph & Ts diagrams. [1] Practical vapour compression refrigeration system; Refrigerants and their desirable properties; Numerical problems. [1] Vapour absorption refrigeration system & COP; Comparison between VCRS and VARS and their applications. [1] Air cycle refrigeration; Reversed Brayton cycle; Steam jet refrigeration; Vortex tube; Introduction to cryogenics. [1]	4
7	**Reciprocating Compressors**	Single stage reciprocating compressor cycle without clearance; Work input and power through p-v diagrams; Steady state and steady flow analysis. [1] Effect of clearance and volumetric efficiency; Work input and power through p-v diagrams; Adiabatic, isothermal and mechanical efficiencies; Multi-stage compressors. [1] Effect of intercooling on work input in multi-stage compression; Saving in work. [1] Optimum intermediate pressure (general case) ; Numerical problems [1]	4
8	**Compressible Flows**	Propagation of infinite pulse in a fluid; Velocity of sound; Disturbance propagation in subsonic and supersonic flows; Mach cone; stagnation property. [1] 1D isentropic flow in a variable area duct; Critical properties; Choking in a isentropic flow; Shapes of supersonic/subsonic nozzles and diffusers. [1] Variation of pressure and Mach number with area ratio; C-D nozzle; Effect of back pressure; Flow with normal shocks; Numerical problems. [1] Adiabatic flow with friction (Fanno flow) ; Flow in constant area duct without friction and with heat transfer (Rayligh flow); Normal shocks. [1] Normal shock relations; Numerical problems; Introduction to oblique shocks and bow shocks. [1]	5

Lab/ Term Work
A Journal containing record of any eight of the following: 1. Determination of calorific value using gas calorimeter. 2. Determination of calorific value using Bomb calorimeter. 3. Flue gas analysis using gas analyzer. 4. Trial on reciprocating air compressor. 5. Determination of dryness fraction of steam using throttling calorimeter or throttling and separating calorimeter. 6. Demonstration and study of boiler mountings and accessories. 7. Study/Trial on boiler to determine boiler efficiency, equivalent evaporation and energy balance sheet. 8. Report on visit to any process industry which uses boiler. 9. Study of package boilers.

Text Books	1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publications 2. Rayner Joel, "Engineering Thermodynamics", ELBS Longman
Reference Books	**An Introduction to Thermodynamics**, Y.V.C. Rao, University Press (India) Private Limited. **Thermodynamics: an Engineering Approach**, Y.A.Cengal and M.A.Boles, McGraw Hill. **Fundamentals of Classical Thermodynamics**, G.VanWylen, R.Sonntag and C.Borgnakke, John Willey & Sons. **Thermal Engineering** ,P L Ballany, Khanna Publishers **Thermodynamics and Heat Engines**, Kothandaraman and Domkundwar.
Related Websites	

Examination Scheme	Internal Assessment – 40 marks	
	Term Work – 25 marks	
	Final Theory Paper – 60 marks	