Course Code	21ASC205T	Course Name	AERO ENGINEERING THERMODYNAMICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the engineering and practical applications of Heat, Energy and Work*
CLR-2:	*identify the applications of Thermodynamics on Engineering systems*
CLR-3:	*identify the significance of Thermodynamic Laws*
CLR-4:	*utilize the Thermodynamic concepts in physics for the broad understanding of Engineering and Technology*
CLR-5:	*analyze the working principle of Heat Energy driven systems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**Program Outcomes (PO)**												**Program Specific Outcomes**		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand laws of Thermodynamics and its applications to Aerospace Engineering*	*2*	*2*	-	-	-	-	-	-	-	-	-	*1*	*1*	-	-
CO-2:	*comprehend the concept and applications of energy, entropy and exergy*	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	*2*	-	-
CO-3:	*understand various gas and vapor power cycles with applications*	*3*	*2*	*2*	-	-	-	-	-	-	-	-	*1*	*2*	-	-
CO-4:	*apply the Thermodynamic Principles to Aerospace Engineering Applications*	*2*	*2*	-	-	-	-	-	-	-	-	-	*1*	*1*	-	-
CO-5:	*understand the gas mixture behavior and chemical reactions*	*2*	*2*	-	-	-	-	-	-	-	-	-	*1*	*2*	-	-

Unit-1 - First Law of Thermodynamics	***9 Hour***
Basic Concepts: Microscopic & macroscopic point of view, Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Zeroth law of thermodynamics, Thermodynamic equilibrium. First law of Thermodynamics: First law for a closed system undergoing a cycle, concept of Internal energy, change of state. Energy and Work Transfer in closed systems, P-V diagram, PMM1. First law for an Open system: Conservation of mass, energy, steady flow energy equation. Applications of SFEE to Nozzles, Diffusers. Types of turbines, compressor, boiler, pump. Heat exchanger and Throttling process	
Unit-2 - Second Law of Thermodynamics	***9 Hour***
Limitations of the first law of Thermodynamics - Introduction to heat reservoirs, sources and sinks. Heat Engine, Refrigerator and Heat pump. Thermal efficiency of heat engines, COP - Second law of Thermodynamics - Kelvin-Planck statement, Clausius statement and their equivalence. Reversible and irreversible processes- causes of irreversibility. Carnot Theorem and corollary. Absolute Thermodynamic Temperature scale. Carnot cycle and its performance	
Unit-3 - Third Law of Thermodynamics and Entropy	***9 Hour***
Limitations of Second Law of Thermodynamics. Explanation of the Concept of Entropy. Clausius inequality, T-s diagram. Entropy changes for different processes. Principle of increase of Entropy, p-v-t behavior and properties of ideal gas mixtures. Dalton's law of partial pressures, Avogadro's law. Gibbs-Dalton law, enthalpy and specific heat of a gas mixture. Maxwell relations, T-ds Equations, Difference and ratio of heat capacities. Energy equation, Joule Thomson Coefficient, Clausius-Clapeyron equation. Entropy changes of Ideal and Real gases. Isentropic efficiencies of steady flow devices. Exergy- High and low-grade energy. Available and unavailable energy of a source and finite body.	
Unit-4 - Air Standard Cycles	***9 Hour***
Otto cycle, Diesel cycle, Dual cycle. Indicator diagram, Air standard efficiency, Mean effective pressure. Brayton cycle - Effect of Reheat, Regeneration and Intercooling. Isentropic efficiency of Turbine and Compressor. Equivalent Carnot cycles- Stirling and Ericsson cycle, Humphrey cycle.	

Unit-5 - Basic Concepts, Heat Transfer and Combustion	***9 Hour***
Modes of heat transfer- conduction, convection and radiation. Governing equations for conduction. Newton's law of cooling, free and forced convective heat transfer, ablative heat transfer. Heat exchange due to radiation, Fundamentals of mass transfer, Fick's law of diffusion, Fundamentals of combustion and dissociation, Simulation of heat transfer and combustion processes	

Learning Resources	1. *Nag, P. K, "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill, New Delhi, 2017.* 2. *Yunus A. Cengel and Michael A. Boles, "Thermodynamics: an engineering approach", seventh edition, McGraw Hill Higher education, 2011.* 3. *Rayner Joel, "Basic Engineering Thermodynamics", 5th Edition, Addison Wesley, New York, 2016.*	4. *Michael Moran, J., and Howard Shapiro, N., "Fundamentals of Engineering Thermodynamics", 4th Edition, John Wiley & Sons, New York, 2010.* 5. *Holman, J. P., "Thermodynamics", 4th Edition Tata McGraw Hill, New Delhi, 2015.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
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