

## SCHEME OF COURSE WORK

### Course Details:

<b>Course Title</b>	: Advanced Thermodynamics		
<b>Course Code</b>	: 15ME2302	<b>L T P C</b>	: 3 0 0 3
<b>Program:</b>	: M.Tech.		
<b>Specialization:</b>	: Thermal Engineering		
<b>Semester</b>	: I		
<b>Prerequisites</b>	: Thermodynamics		

### Course Outcomes (COs):

At the end of the course, student will be able to
1. Apply the concept of entropy and irreversibility to solve practical problems.
2. Explain P-V, T-S, P-T and h-s diagram of pure substance and its significance.
3. Distinguish the equation of state for ideal and real gases and gas mixtures.
4. Develop TdS, Maxwell's equations and power cycles.
5. Explain thermodynamic distribution function and partition function in statistical thermodynamics

### Program Outcomes (POs):

A postgraduate of Thermal Engineering will able to

PO 1	exhibit in-depth knowledge in thermal engineering specialization
PO 2	think critically and analyze complex engineering problems to make creative advances in theory and practice
PO 3	solve problem, think originally and arrive at feasible and optimal solutions with due consideration to public health and safety of environment
PO 4	use research methodologies, techniques and tools, and will contribute to the development of technological knowledge
PO 5	apply appropriate techniques, modern engineering tools to perform modeling of complex engineering problems with knowing the limitations
PO 6	understand group dynamics, contribute to collaborative multidisciplinary scientific research
PO 7	demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors
PO 8	communicate complex engineering problems with the engineering community and society, write and present technical reports effectively
PO 9	engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously
PO10	exhibit professional and intellectual integrity, ethics of research and scholarship and will realize the responsibility towards the community
PO11	examine critically the outcomes of actions and make corrective measures

### Course Outcome versus Program Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	M	M		M				M		
CO2	S	M				M			M		
CO3	S	M				M		M	M		
CO4	S	M	M	M	M			M	M	M	
CO5	S	S		M	M	M		M	M	M	

*S* - Strongly correlated, *M* - Moderately correlated, *Blank* - No correlation

<b>Assessment Methods:</b>	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam
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### Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	Introduction, clausius theorem and inequality of entropy	CO1	Establish clausius inequality	□ Lecture □ Demo class	
2	Principle of entropy and its applications	CO1	Derive change in entropy of mixing of two fluids	□ Lecture □ Discussion	<b>Assignment- 1 (Week 2- 6)</b>
3	Entropy generation in open and closed systems	CO1	Show that entropy generation is not a property	□ Lecture □ Discussion	
4	Introduction on availability and maximum work in a reversible process	CO2	Write a shot note on dead state	□ Lecture □ Discussion	
5	Availability in steady, non flow process and chemical reactions	CO2	Any problem on availability and irreversibility	□ Lecture □ Problem solving	
6	P-v, T-s, P-T and h-s diagram for pure substance and measurement method for dryness fraction	CO2	Explain h-s diagram? Why the constant pressure lines are diverges one another	□ Lecture □ Problem solving	
7	Equation of state, vander waals equation and law of corresponding states	CO3	Explain law of corresponding states	□ Lecture □ Discussion	
8	Beattie-Bridgeman equation and Redlich-Kwong equation	CO3	Problem on any equation by using generalized compressibility chart	□ Lecture □ Discussion	
9	<b>Mid-Test 1</b>				<b>Mid-Test 1 (Week 9)</b>
10	Dalton's law of partial pressures, enthalpy and entropy of gas mixture	CO3	Problem on mixing of gases	□ Lecture □ Discussion □ Problem solving	
11	Degree of reaction, reaction equilibrium, law of mass action and heat of reaction	CO3	What is law of mass action and heat of reaction	□ Lecture □ Discussion	<b>Assignment- 2 (Week 11- 16)</b>
12	Temperature dependence of the heat reaction, equilibrium constants, change in Gibbs function, fugacity and activity	CO3	Explain fugacity and activity	□ Lecture □ Discussion	
13	Thermodynamic relations	CO4	Derive Maxwell relations	□ Lecture □ Discussion	
14	Brayton cycle, comparison between Brayton and Rankine cycle	CO4	Compare Brayton and Rankine cycles	□ Lecture □ Discussion	
15	Thermodynamic distribution function, ensemble, micro canonical ensemble, canonical ensemble and grand canonical ensemble.	CO4	Explain the terms ensemble and canonical ensemble	□ Lecture □ Discussion	

16	Maxwell – Boltzmann, Fermi-Dirac and Bose-Einstein statistics and distribution	CO5	What is Fermi-Dirac statistics and distribution	▫ Lecture ▫ Discussion	
17	Liouville equation, equilibrium constant by statistical thermodynamic approach	CO5	describe Liouville equation for statistical thermodynamic approach	▫ Lecture ▫ Discussion	
18	Partition function for ideal monoatomic gas, decomposition, translational, electronic, rotational and vibrational	CO5	Write down the partition function for ideal monoatomic gas	▫ Lecture ▫ Discussion	
19	<b>Mid-Test 2</b>				<b>Mid-Test 2 (Week 19)</b>
20/21	<b>END EXAM</b>				<b>END EXAM</b>