INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE INFORMATION SHEET

Course Title	**THERMODYANMICS**			
Course Code	**AME003**			
Programme	B.Tech			
Semester	III			
Course Type	Core			
Regulation	IARE-R16			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	1	-	4
Course Coordinator	Mrs. N. SanthiSree, Assistant Professor. Department of ME.			
Course Faculty	Dr.CH. V K N S N Moorthy ,Professor , Department of ME. Mrs. N. SanthiSree, Assistant Professor,Department of ME.			

I. COURSE OVERVIEW:

Thermodynamics is the science that deals with the relationship between heat and work and those properties of systems that bear relation to heat and work. General laws of energy transformations concerning all types of systems, mechanical, electrical and chemical may fall within the purview of this science. It is a science based on a number of empirical laws formed by experimentation from which all predictions concerning the physical behavior of the system may be deduced by logical reasoning. The findings have been formalized into certain basic laws, which are known as Zeroth, First, Second and Third laws of thermodynamics. Power cycles and refrigeration cycle based on thermodynamic system is studied.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS008	II	Modern Physics	4
UG	AHS002	I	Linear Algebra and Ordinary Differential Equations	4
UG	AHS005	I	Engineering Chemistry	3

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Thermodynamics	70 Marks	30 Marks	100

Semester End Examination (SEE):
The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows: Two full questions with 'either''or' choice will be drawn from each unit. Each question carries 14 marks.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz / Alternative Assessment Tool (AAT).

Continuous Internal Examination (CIE):
The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 20 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, and open ended experiments, micro projects, five minutes video and MOOCs.

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

√	CHALK & TALK	√	QUIZ	√	ASSIGNMENTS	X	MOOCs
√	LCD / PPT	√	SEMINARS	X	MINI PROJECT	√	VIDEOS
X	OPEN ENDED EXPERIMENTS						

V. ASSESSMENT METHODOLOGIES–DIRECT

√	CIE EXAMS	√	SEE EXAMS	√	ASSIGNMENTS	√	SEMINARS
X	LABORATORY PRACTICES	X	STUDENT VIVA	X	MINI PROJECT	X	CERTIFICATION
√	TERM PAPER						

VI. ASSESSMENT METHODOLOGIES–INDIRECT

√	ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	√	STUDENT FEEDBACK ON FACULTY (TWICE)
√	ASSESSMENT OF MINI PROJECTS BY EXPERTS		

VII. COURSE OBJECTIVES

At the end of the course, the students will be able to:

I. Understand the laws of thermodynamics and determine thermodynamic properties, gas laws.
II. Develop the concept of properties during various phases of pure substances, mixtures, usage of steam tables and Mollier chart, psychometric charts.
III. Understand the direction law and concept of increase in entropy of universe.
IV. Knowledge of ideal air standard, vapor cycles and evaluate their performance in open systems. Like steam power plants engines, gas turbines etc.
V. Solve problems of different types of cycles and their performance which emphasizes knowledge in IC engines and refrigeration cycles.

VIII. COURSE LEARNING OUTCOMES

Students, who complete the course, will have demonstrated the ability to do the following:

S. No.	Description
CAME003.01	Understand the concepts of conservation of mass, conservation of energy.
CAME003.02	Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like system properties, amount of work transfer and heat during various processes,
CAME003.03	Explore knowledge & ability to design the thermal related components in various fields of energy transfer equipment.
CAME003.04	Derive the first law of Thermodynamics from the concept of conservation of energy
CAME003.05	Discuss the nature of steady and unsteady processes under the influence of time
CAME003.06	Develop the second law of thermodynamics from the limitations of first law.
CAME003.07	Determine entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations based on Carnot Cycle
CAME003.08	Understand the inter relationship between thermodynamic functions and an ability to use such relationships to solve practical problems
CAME003.09	Knowledge of the Gibbs and Helmholtz free energies as equilibrium criteria, and the statement of the equilibrium condition for closed and open systems
CAME003.10	Determine the equilibrium states of a wide range of systems, ranging from mixtures of gases, liquids, solids and pure condensed phases that can each include multiple components.
CAME003.11	Discuss pressure-temperature, volume-temperature, pressure-volume phase diagrams and the steam tables in the analysis of engineering devices and systems.
CAME003.12	Develop the Third Law of Thermodynamics from the concept of absolute thermodynamic scale and describe its significance.
CAME003.13	Understand the process of psychrometry that are used in the analysis of engineering devices like air conditioning systems
CAME003.14	Introduction to concepts of power and refrigeration cycles. Their efficiency and coefficients of performance.
CAME003.15	Ability to use modern engineering tools, software and equipment to analyze energy transfer in required air-condition application.
CAME003.16	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.

IX. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering Knowledge**:Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Term paper
PO2	**Problem Analysis:**An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	H	Term paper, Quiz
PO3	**Design/ development of solutions:**Competence to design a system, component or process to meet societal needs within realistic constraints.	S	Videos
PO4	**Conduct investigations of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	S	Assignments
PO5	**Modern tool usage:**An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	H	Mini Project, PPT, Videos

Program Outcomes		Level	Proficiency assessed by
PO6	**The engineer and society:**To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	S	Projects
PO7	**Environment and sustainability:** To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	N	--
PO8	**Ethics:** An understanding and implementation of professional and ethical responsibilities.	N	--
PO9	**Individual and team work:**To function as an effective individual and as a member or leader in multi-disciplinary environment and adopt in diverse teams.	H	Projects
PO10	**Communication:** An ability to assimilate, comprehend, communicate, give & receive instructions to present effectively with engineering community and society.	N	--
PO11	**Project management and finance**An ability to provide leadership in managing complex engineering projects at multidisciplinary environment and to become a Technocrat.	H	Assignments, Seminars
PO12	**Life-long learning:** Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	S	--

N= None **S= Supportive** **H = Highly Related**

X. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:**To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	H	Lecture, Assignments.
PSO2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	S	Projects
PSO3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	S	Projects

N-None **S-Supportive** **H-Highly Related**

XI. SYLLABUS:

UNIT I
INTRODUCTION: Basic Concepts*:* System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle, Reversibility, Quasi static Process, Irreversible Process, Causes of Irreversibility, Various flow and non-flow processes ,Energy in State and in Transition, Types-Work and Heat, Point and Path function., Zeroth Law of Thermodynamics, Concept of quality of Temperature, Principles of Thermometry, Reference Points, Constant Volume gas Thermometer, Ideal Gas Scale, PMMI - Joule's Experiments, First law of Thermodynamics, Corollaries First law applied to a Process, Applied to a flow system, Steady Flow Energy Equation.
UNIT II
LIMITATIONS OF THE FIRST LAW: Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase, Availability and Irreversibility, Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations, Elementary Treatment of the Third Law of Thermodynamics.

UNIT III
PURE SUBSTANCES: Phase Transformations, T-S and h-s diagrams, P-V-T- surfaces, Triple point at critical state properties during change of phase, Dryness Fraction, Mollier charts, Various Thermodynamic processes and energy Transfer, Steam Calorimeter. **PERFECT GAS LAWS:** Equation of State, Specific and Universal Gas constants, Throttling and Free Expansion Processes, Deviations from perfect Gas Model, Vander Waals Equation of State.
UNIT IV
MIXTURES OF PERFECT GASES: Mole Fraction, Mass friction, Gravimetric and volumetric Analysis, Volume fraction, Dalton's Law of partial pressure, Avogadro's Laws of additive volumes, and partial pressure, Equivalent Gas constant, Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases . Psychrometric properties-Dry bulb temperature, wet bulb temperature, specific humidity, Relative humidity, saturated air, Degree of saturation-adiabatic saturation, carrier equation, psychrometric chart
UNIT V
POWER CYCLES: Otto, Diesel, Dual Combustion cycles, Description and representation on P-V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis, comparison of Cycles, Introduction to Brayton cycle and Bell Coleman cycle.

TEXT BOOKS:

1 P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publishers, 5th Edition, 2013.
2 Yunus Cengel, Michael A. Boles, "Thermodynamics-An Engineering Approach", Tata McGraw Hill publishers, 8th Edition, 2014.

REFERENCES:

1 Y. V. C. Rao, "An Introduction to Thermodynamics", Universities Press,Revised Edition,2009.
2 K. Ramakrishna, "Engineering Thermodynamics", Anuradha Publishers, 2003.
3 J.P Holman, "Thermodynamics" Tata McGraw Hill Publishers, 2003.
4 Mahesh M Rathore, Thermal Engineering, McGraw Hill Publications - 2012.

XII. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1	Explain the basics of Thermodynamics	Surrounding, Boundaries, Universe, Types of Systems, properties	T1(1.7)
2-3	Describe Importance of Equilibrium	Concept of Continuum, Thermodynamic Equilibrium, Process, Cycle – Reversibility,Quasi – static process	T1(1.8-1.11)
4	Different Types of Energy	Energy transfer by heat and work	T1(3.1,3.2)
5-7	Explain Work Transfer	Work transfer, p-dVwork,path and point function	T1(3.3,3.4,3.5)
8-9	Explain the methodology measurement of temperature.	Concept of quality of Temperature – Principles of Thermometry – ReferencePoints – Const. Volume gas	T1(2.1-2.8)
10-12	Establish relation between work and heat.	First law for a closed system, PMM-1	T1(4.1-4.8)
13-15	Define First law to flow process and energy balance equation	applied to a flow system – Steady Flow Energy Equation	T1(5.1-5.5)

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
16	Define Second Law Of Thermodynamics	Energy reservoirs, Kelvin-Planck and Clausius Statements	T1(6.1-6.5)
17	Illustrate applications of Second law	Refrigerator and heat pump, causes of irreversibility	T1(6.6-6.8)
18-20	Illustrate the Carnot principle.	Carnot's principle, Carnot cycle and its specialties	T1(6.11-6.13)
21-24	Understand the concept of Entropy	Entropy, Principle of Entropy Increase – Energy Equation, Clausius Inequality	T1(7.1-7.6)
25-26	Explain Available Energy ,3 rd law of thermodynamics	Availability and Irreversibility, Maxwell relations, Third Law	T1(8.1-8.8)
27-28	Define pure substance and p-v-T surface.	Pure Substances, p-V-T- surfaces, T-Sand h-s diagrams	T1(9.1-9.4)
29-30	To calculate the property values from steam tables, Mollier chart	Mollier chart– Various Thermodynamic processes and energyTransfer	T1(9.5-9.9)
31-32	Describe gas laws	Gas laws, Universal gas constants	T1(10.1-10.3)
33-35	Differentiate gas laws and ideal gas laws	Deviations from perfect Gas Model – Vander Waals Equation of State	T1(10.4-10.7)
36-38	Calculate the property values for gas mixtures.	Mole Fraction, Mass friction Gravimetric and volumetric Analysis	T1(10.8)
39-41	Explain the Daltons law of partial pressures	Dalton's Law of partial pressure, Avogadro's Laws of additive volumes	T1(10.9-10.10)
42-43	Determine the property values for gas mixtures.	Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases	T1(10.10-10.11)
44-49	Concept of psychrometry and its properties	Psychrometric properties-Dry bulb temperature, wet bulb temperature, specific humidity, Relative humidity, saturated air, Degree of saturation-adiabatic saturation, carrier equation, psychrometric chart.	T1(15.1-15.3)
50-51	Describe the features of Otto cycle	Air standard cycle, Otto Cycle	T1(13.5-13.6)
52-54	Derive thermal efficiency of diesel cycle	Diesel, cycles, – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis	T1(13.7)
55-56	Derive thermal efficiency of dual cycle	Dual Combustion- Description and representation on P–V and T-S diagram	T1(13.8)
57-58	Derive Expression forMean effective pressure	Thermal Efficiency Mean Effective Pressures	T1(13.6-13.8)
59-64	Compare the different cycles.	Comparison of Cycles. and problems	T1(13.9)
65-67	Describe Bell Coleman cycle.	Introduction to Bell Coleman cycle and problems on cycle	T1(14.8)
68-70	Describe Brayton cycle	Brayton cycle.	T1(14.6)

XIII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	Directional law applied to automobile sector	GUEST LECTURE/SEMIAR	PO1,PO2,PO4,PO5	PSO2
2	Gas laws applied to cooling of electronic chips	SEMINAR	PO6,PO5,PO10	PSO2,PSO3
3	cooling of spindle bearings by using chillers	SEMINAR	PO3,P011	PSO1,PSO3

XIV. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H	H	H			H	S				S	S	H	H
II	H	S	S	H	H				S		H	H			H
III	H	H	S								H	H		S	S
IV	H			S	S	S	H		H	S	H	S	H		S
V	H	H	S		S	H	H	S	H	S	S		H	H	H

N- None **S-Supportive** **H - Highly Related**

XV. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CAME003.01	H			H		H					S			H	
CAME003.02			S						S				H		H
CAME003.03	H			H		H				H		H		H	
CAME003.04	H				S			H		H				H	
CAME003.05	H			S	H					S			H		S
CAME003.06	S	H			H		H				H				H
CAME003.07	S		H						H					H	
CAME003.08				H					S			H		S	
CAME003.09					H				S				H		H
CAME003.10	S		S					S			S				
CAME003.11	H									S				H	H
CAME003.12				S				S			H		H		
CAME003.13	S				H					H		H			S
CAME003.14	S			S			S	S			H			S	
CAME003.15	S					H			S			S	H		S
CAME003.16												S			S

S-Supportive **H - Highly Related**

XVI. DESIGN BASED PROBLEMS (DP) / OPEN ENDED PROBLEM:

1. Compare the pumping of water to a higher elevation to isentropic of air into a compressed air tank as means of storing energy for later use.
2. What are the most recent developments on the two stroke engines and find out when we might be seeing cars powered by two-stroke engines in the market. Why do the major car manufacturers have a renewed interest in two-stroke engines?
3. Cooled air sometimes reheated in summer before it is discharged to room. Why
4. A rigid tank is equipped with a pressure gauge. Describe a procedure by which you could use this tank to blend ideal gases in prescribed mole fraction portions.

Prepared by:

Mrs. N. SanthiSree,
Assistant Professor,
Department of Mechanical Engineering
IARE.

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