INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION

Course Title	**:**	**THERMODYNAMICS**			
Course Code	**:**	**A30306**			
Course Structure	**:**	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	:	4	1	-	4
Course Coordinator	**:**	Mr. S.V.Durga Prasad, Assistant Professor.			
Team of Instructors	**:**	Ms. N.Santhi Sree, Assistant Professor.			

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. PREREQUISITE(S)

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Engineering Mathematics, Engineering Physics, Engineering chemistry

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of one objective paper, one subjective paper and one assignment. The objective paper is for 10 marks and subjective paper is for 10 marks, with duration of 1 hour 20 minutes (20 minutes for objective and 60 minutes for subjective paper). Objective paper is set for 20 bits of – multiple choice questions, fill-in the blanks, 10 marks. Subjective paper contains of 4 full questions (one from each unit) of which, the student has to answer 2 questions, each question carrying 5	75	100

marks. First midterm examination shall be conducted for 1-4 units of syllabus and second midterm examination shall be conducted for 5-8 units. 5 marks are allocated for Assignments (as specified by the concerned subject teacher) – first Assignment should be submitted before the conduct of the first mid, and the second Assignment should be submitted before the conduct of the second mid. The total marks secured by the student in each midterm examination are evaluated for 25 marks, and the average of the two midterm examinations shall be taken as the final marks secured by each candidate		

IV. EVALUATION SCHEME

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES:

To get the basic concepts of thermodynamics, temperature measurement, first law and also ability to determine the heat, work in various flow & non-flow processes.

I. To gain the knowledge about second law of thermodynamics and determine the change in entropy, availability in various processes.

II. To get the knowledge various phases of pure substance and calculate its properties using steam tables and Mollier chart to determine properties of perfect gases in various processes.

III. To develop to learn the concepts of mixture of gases and to calculate the property values during any process.

IV. To get the knowledge about the working of different types of cycles and their performance which emphasizes knowledge in IC engines.

VI. COURSE OUTCOMES

1. Describe knowledge of energy transfer and work done and heat equation in different processes, power cycles and thermodynamic laws.
2. Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like system properties, amount of work transfer and heat during various processes, steam properties at different temperatures and pressures using steam tables.
3. Explore their knowledge & ability to design the thermal related components in various fields of energy transfer equipments.
4. An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, and safety manufacturability and sustainability related thermal fields like I.C engines, different types of power plants etc.
5. The ability to use modern engineering tools, software and equipment to analyze energy transfer in required applications.
6. A knowledge of impact of engineering solutions on the society and also on contemporary issues related to different types of power cycles.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Practicals, Midterm and University examination
PO2	An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	H	Assignments, Practicals, Midterm and University examination
PO3	Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments, Practicals, Midterm and University examination
PO4	To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	H	Assignments, Practicals, Midterm and University examination
PO5	An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	H	Assignments, Practicals, Midterm and University examination
PO6	To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	S	Practicals, Projects
PO7	To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	S	Practicals, Projects
PO8	An understanding and implementation of professional and ethical responsibilities.	S	Practicals, Projects
PO9	To function as an effective individual and as a member or leader in multi disciplinary environment and adopt in diverse teams.	S	Practicals, Midterm and University examination,

			Projects, Technical activites.
PO10	An ability to assimilate, comprehend, communicate, give & receive instructions to present effectively with engineering community and society.	S	Practicals, Midterm and University examination, Projects, Technical activites.
PO11	An ability to provide leadership in managing complex engineering projects at multidisciplinary environment and to become a Technocrat.	H	Practicals, Midterm and University examination, Projects, Technical activites. Mini Projects
PO12	Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	H	Practicals, Midterm and University examination, Projects, Technical activites.

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills:** Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Practicals, Midterm and University examination
PSO 2	**Engineering practices:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	S	Assignments , Practicals, Midterm and University examination
PSO 3	**Successful Career:** Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments , Practicals, Midterm and University examination

IX. 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 .

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:

T1. P. K. Nag (2008,Third Reprint), *Engineering Thermodynamics*, 4th edition, Tata McGraw-Hill, New Delhi, India.

T2. Yunus Cengel, Boles (2011), *Thermodynamics - An Engineering Approach,* 7th edition, Tata McGraw-Hill, New Delhi, India.

REFERENCE BOOKS:

R1. J. B. Jones, R. E. Dugan (2009), *Engineering Thermodynamics*, 1st edition, Prentice Hall of India Learning, New Delhi, India.

R2. Y. V. C. Rao (2013), *An introduction to Thermodynamics*, 3rd Edition, Universities Press, Hyderabad, India.

R3. K. Ramakrishna (2011), Engineering *Thermodynamics*, 2nd edition, Anuradha Publishers, India.

X. Course Plan:

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

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1	**Explain** the basics of Thermodynamics	Surrounding, Boundaries, Universe, Types of Systems, properties	**T2: 1.3 &1.4/pg.10-12**
2-3	**Describe** Importance of Equilibrium	Concept of Continuum, Thermodynamic Equilibrium, Process, Cycle – Reversibility ,Quasi – static process	**T1: 1.3 -1.8/pg.3-7**
4	**Different** Types of Energies	Energy transfer by heat	**T2: 2.3/pg.60-61**
5-7	**Explain** Work Transfer	Work transfer, p dV-work ,path and point function	**T1: 3.1-3.4/pg.33-44**
8-9	**Explain** the methodology measurement of temperature.	Concept of quality of Temperature – Principles of Thermometry – Reference Points – Const. Volume gas	**T1: 2.1-2.10/pg.18-26**
10-12	**Establish** relation between work and heat.	First law for a closed system,PMM-1	**T1: 4.1-4.9/pg.57-65**
13-15	**Define** First law to flow process and energy balance equation	applied to a flow system – Steady Flow Energy Equation	**T1: 5.1-5.6/pg.74-84**
16	**Define** Second Law Of Thermodynamics	Energy reservoirs, Kelvin-Planck and Clausius Statements	**T1: 6.1-6.5/pg.104-109**
17	**Illustrate** applications of Second law	Refrigerator and heat pump, causes of irreversibility	**T1: 6.6-6.10/pg.109-118**
18-20	**Illustrate** the Carnot principle.	Carnot's principle, Carnot cycle and its specialties	**T1: 6.11– 6.18/pg.118-129**
21-24	**Understand** the concept of Entropy	Entropy, Principle of Entropy Increase – Energy Equation, Clausius Inequality	**T1: 7.1-7.12/pg.142-163 R3:6.1-6.3/pg.6.2-6.5**
25-26	**Explain** Available Energy ,3 rd law of thermodynamics	Availability and Irreversibility, Maxwell relations, Third Law	**T1: 8.1-8.11/pg.192-215**
27-28	**Define** pure substance and p-v-T surface.	Pure Substances, p-V-T- surfaces, T-S and h-s diagrams	**T2: 3.1 – 3.4 /pg.111-125**
29-30	To **calculate** the property values from steam tables, Mollier chart	Mollier charts – Various Thermodynamic processes and energy Transfer	**T2: 3.5/pg.126-135**

31-32	**Describe** gas laws	Gas laws, Universal gas constants	**T2: 3.6-3.7 /pg.137-139**
33-35	**Differentiate** gas laws and ideal gas laws	Deviations from perfect Gas Model – Vander Waals Equation of State	**T2: 3.8 /pg.144-146**
36-38	**Calculate** the property values for gas mixtures.	Mole Fraction, Mass friction Gravimetric and volumetric Analysis	**R3:11.1/pg.11.1-11.3**
39-41	**Explain** the Daltons law of partial pressures	Dalton's Law of partial pressure, Avogadro's Laws of additive volumes	**R3:11.2-11.3/pg.11.3-11.4**
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	**R3:11.4,11.6/pg.11.511.9**
44-45	**Describe** the features of Otto cycle	Air standard cycle, Otto Cycle	**T1: 13.5-13.6/pg.486**
46-48	**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 /pg.493 & 13.8/pg.495**
49-50	**Derive** thermal efficiency of dual cycle	Dual Combustion- Description and representation on P–V and T-S diagram	
51-52	Derive Expression for Mean effective pressure	Thermal Efficiency Mean Effective Pressures	
53-56	To **compare** the different cycles.	comparison of Cycles. and problems	**T1: 13.9/ pg.497**
57-60	**Describe** Bell Coleman cycle.	Introduction to Bell Coleman cycle and problems on cycle	**T1: 7.3**
61-63	**Describe** Brayton cycle	Brayton cycle.	**T1: 13.12 /pg.501**

XI. MAPPING COURSE OBJECTIVES LEADING TO ACHIEVEMENT OF THE PROGRAM OUTCOMES.

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H	S		H						H	S	H	H	S
II	H	H	S		H				H				H	H	S
III	H	H	S	S				S	H			S	H	H	S
IV	H	H	S		H							S	H	H	S
V	H	H	S		H								H	H	S

S=Supportive **H=Highly Related**

XII. MAPPING COURSE OUTCOMES LEADING TO ACHIEVEMENT OF THE PROGRAM OUTCOMES.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	H	H	S	S	H		S						H	H	S
2	H	H	S			S		S	H			S	H	H	S
3	H	H	S		H		S					S	H	H	S
4	H	H	S		H			S			H	S	H	H	S
5	H	H	S	S	H		S		H		H		H	H	S
6	H	H	S		H			S	H			S	H	H	S

S=Supportive **H=Highly Related**

Prepared By:

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