INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**THERMODYNAMCS**				
Course Code	AMEB04				
Program	B. Tech				
Semester	THREE				
Course Type	CORE				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Course Coordinator	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 law, 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
UG	AHSB02	I	Linear Algebra Calculus
UG	AHSB04	II	Waves And Optics

III. MARKS DISTRIBUTION:

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

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	✓	Assignments	✗	MOOCs
✓	Open Ended Experiments	✓	Seminars	✗	Mini Project	✗	Videos
✗	Others:						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

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. **There could be a maximum of two sub divisions in a question.**

The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE.

Percentage of Cognitive Level	Blooms Taxonomy Level
10 %	Remember
50 %	Understand
25 %	Apply
15 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 2: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four 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 - Online Examination:

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT):

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours / classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3.

Table 3: Assessment pattern for AAT

5 Minutes Video	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30%	10%	10%

VI. COURSE OBJECTIVES:

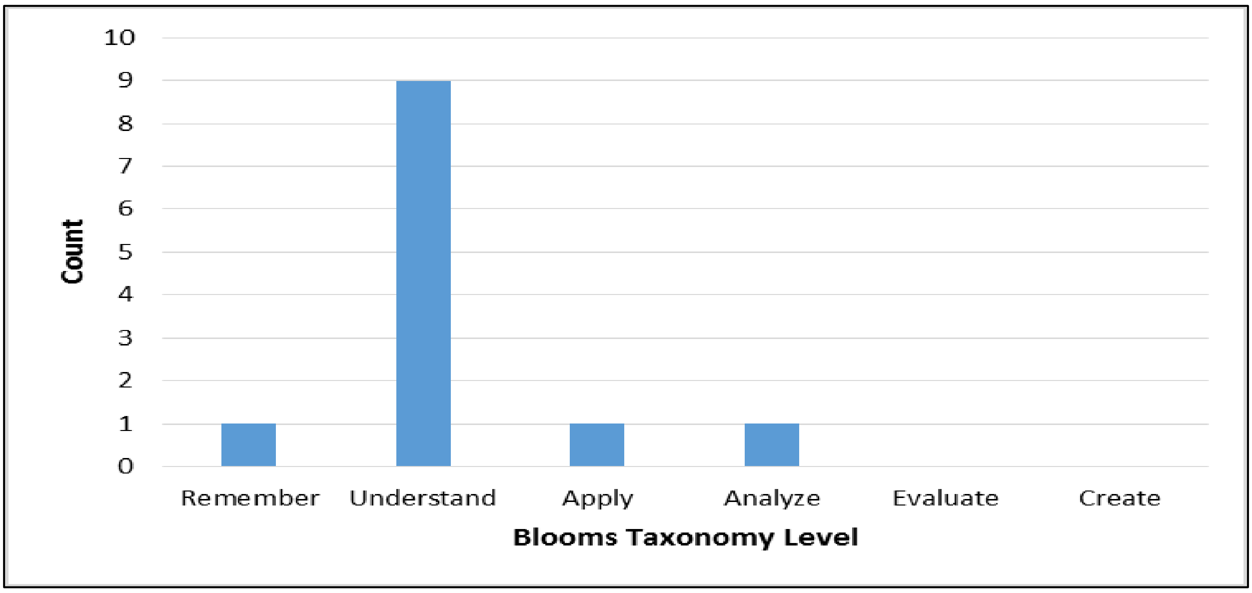
The students will try to learn:	
I	The fundamental knowledge on concepts of physics and chemistry for obtaining the axiomatic principles using thermodynamic co-ordinates.
II	The thermodynamic disorderness in the real time physical systems like external/internal heat engines, heat pumps to get the measure of performance characteristics.
III	The performance characteristics of open and closed systems of thermodynamic cycles for effective delineation of real time applications.
IV	The thermodynamic cycles such as power and refrigerant cycles to yield alternative solutions to conserve the environment.

VII. COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
	Course Outcomes	**Knowledge Level (Bloom's Taxonomy)**
CO 1	**Recall** the thermodynamic properties and discern the path and point functions through exact differentials.	Remember
CO 2	**Summarize** working principles of energy conversions in physical systems by fundamental laws of thermodynamics.	Understand
CO 3	**Explain** the various energy transfer mechanisms which leads to the ascertaining of properties involving thermodynamic cycles.	Understand
CO 4	**Identify** the laws of conservation of energy to yield the relationship between heat, work and change in internal energy.	Apply

CO 5	**Contrast** between various statements of purpose in heat to work conversion and notice that thermodynamic direction laws defining them are mutually complementary.	Understand
CO 6	**Relate** various relations involving pressure, temperature and volume to discern the change in entropy generation in universe.	Understand
CO 7	**Interpret** the properties of pure substances and steam to emit relevant inlet and exit conditions of thermodynamic work bearing systems.	Understand
CO 8	**Describe** fundamental relationship between intensive properties in form of partial derivatives implemented for perfect gases.	Understand
CO 9	**Show** the significance of partial pressure and temperature to table the performance parameters of gaseous mixtures.	Understand
CO 10	**List** the properties of air conditioning systems by practicing psychrometry chart and gas property tables.	Analyze
CO 11	**Illustrate** the working of various air standard cycles and work out the performance characteristics.	Understand
CO 12	**Infer** the performance of power and refrigerant cycles, and their significance in real world systems.	Understand

COURSE KNOWLEDGE COMPETENCY LEVELS



VIII.HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	CIE/Quiz/AAT
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

IX. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency assessed by
PSO 1	Formulate and evaluate engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing.	2	AAT/ Group discussion/ Short term courses

3 = High; 2 = Medium; 1 = Low

X. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	√	-	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 3	√	-	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 4	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 5	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 7	√	-	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 8	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	√	√	√	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	√	√	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 11	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	√		√	-	-	-	-	-	-	-	-	-	√	-	-

XI. JUSTIFICATIONS FOR CO-PO/PSO MAPPING - DIRECT:

Course Outcomes	POs / PSOs	Justificationfor mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	Recall the thermodynamic properties and discern the path and point functions through exact differentials **using the knowledge of mathematics, science and engineering fundamental.**	3
CO 2	PO 1	Understand the working principles of energy conversions in physical systems by fundamental laws of thermodynamics **using the knowledge of engineering fundamentals and mathematics.**	2
	PSO 1	Discuss the various fundamentals of thermodynamics applied in energy conversion **problems to real world systems and provide solutions for digital manufacturing.**	1

CO 3	**PO 1**	Understand the necessity of various energy transfer mechanisms and their involvement in properties of systems **using mathematical knowledge and engineering fundamentals.**	3
	PSO 1	Establish the relationship between properties and functions applied to **thermal** systems and utilize such relations to solve **engineering problems** applied in **manufacturing** industry.	1
CO 4	**PO 1**	Using the law of conservation of energy from **engineering fundamentals** evaluate the relationship between heat, work and internal energy by applying basic **mathematical equations.**	2
	PO 2	Analyze the relationship of heat and work to discern **problems and identify solutions.** Balance the equation using fundamental laws and internal energy to **develop solution** in real world problems.	5
	PSO 1	Understand the significance of law of conservation of energy applied to the relationship of heat and work to determine **thermal** properties.	1
CO 5	**PO 1**	Remember the second law of thermodynamics and compare the Kelvin Planck & Clausius statements to evaluate the equivalence and similarity between them **using the fundamentals of engineering, science and mathematics.**	3
	PO 2	Recall the relationship between the various statements of second law of thermodynamics to develop different metaphysical system and interpret solutions for **engineering problems. Further, apply the basic engineering knowledge to derive futuristic solutions and solve engineering problems.**	5
	PSO 1	Understand the veracity of second law of thermodynamics and its applications in **thermal problems to be applied in manufacturing industry.**	1
CO 6	**PO 1**	Remember the properties applied to various thermodynamic systems using **engineering fundamentals** and derive the relationship between them using basic **mathematical equations.**	3
	PO 2	Equate the fundamental properties of thermodynamics like pressure, volume and temperature to recognize the significance of them in **solving various engineering problems and creating solutions for thermal systems.**	5
CO 7	**PO 1**	Interpret the properties of pure substances and steam using **fundamental knowledge of science and engineering** to evolve relationships using partial derivative **mathematical functions**	3
	PO 3	**Understand the customer requirement, identify the cost** to correlate the properties of pure substances and steam to emit relevant inlet and exit conditions of thermodynamic **work bearing systems used in various day to day applications**	5
	PSO 1	Recall the properties of steam and pure substances used in **thermal applications** to be applied in real life physical systems	1
CO 8	**PO 1**	Describe fundamental relationship between intensive properties in form of partial derivatives implemented for perfect gases **using fundamental engineering and mathematical knowledge**	2

CO 9	**PO 1**	Show the significance of partial pressure and temperature using **fundamental engineering and science** to table the performance parameters of gaseous mixtures **in mathematical form**.	3
	PO 2	Discuss partial pressure and temperature to **evaluate the performance, solve problems and identify avenues of research.** Use parameters of gaseous mixtures to evaluate the performance characteristics of various systems.	7
	PO 3	**Investigate and define a problem** and identify constraints including environmental and **sustainability limitations, health and safety and risk assessment issues** when dealing with performance of gaseous mixtures and their application **on real world problems**	6
CO 10	**PO 1**	Understand the significance of psychrometry charts and Mollier diagram to determine the properties of refrigeration system **using the fundamentals of engineering and mathematical equations**	2
	PO 2	**Model and validate** the various refrigeration system in **real world applications** to **enumerate the various problems and effective solutions that can be proposed/**	7
	PO 3	Find **creative solution** for various problems related to refrigeration and air conditioning systems in adverse climatic conditions across the various tropics of the world. **Explore the problems** in current HVAC systems and find **avenues of innovations**. **Define problems** in integration of air-conditioning and HVAC systems to **find effective solutions**.	5
	PSO 1	Understand the significance of refrigeration and air-conditioning as a **thermal problem related to multiple manufacturing systems in the current digital era** of robotic system cooling	1
CO 11	**PO 1**	Evaluate the performance characteristics of various air standard cycles using the **basic understanding of engineering science and mathematical equations**	3
	PO 2	Using the fundamentals of air standard cycles **explore the possibilities** of combined cycles for **creating effective systems** to be **used in real world having better efficiencies.**	7
CO 12	**PO 1**	Understand the performance relationship between various power and refrigeration cycles using the **fundamental engineering properties and mathematical equations.**	2
	PO 3	**Postulate problems** in power and refrigeration cycles to **create opportunities of improvement** in design and **development of superior systems** in **comparison to currently** available models.	7
	PSO 1	Apply the knowledge of power and refrigeration cycles for various **thermal problems** found in the industry and find effective solutions.	1

XII. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING

Course Outcomes	Program Outcomes / No. of Key Competencies Matched												PSOs/ No. of key competencies		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**2**	**2**
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	-	-		-	-	-	-	-	-	-	-	1	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	2	5	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	3	5	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	5	-	-	-	-	2	-	-	-	-	-	-	-	-
CO 7	3	-	5	-	-	-	-	-	-	-	-	-	1	-	-
CO 8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	3	7	6	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	2	7	5	-	-	-	-	-	-	-	-	-	1	-	-
CO 11	3	7	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	2	-	7	-	-	-	-	-	-	-	-	-	1	-	-

XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

Course Outcomes	Program Outcomes / No. of key competencies												PSOs/ No. of key competencies		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**2**	**2**
CO 1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 2	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 4	66.6	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 5	100.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 6	100.0	50.0	0.0	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 7	100.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 8	66.7	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CO 9	100.0	70.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 10	66.7	70.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 11	100.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
CO 12	66.6	0.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0

XIV. COURSE ARTICULATION MATRIX - PO/PSO MAPPING:

COs and POs & COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 – 0≤ C≤ 5% – No correlation; **2** − 40 % <C< 60% – Moderate.

1 – 5 <C≤ 40% – Low/ Slight; **3** – 60% ≤ C< 100% – Substantial /High

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 7	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 11	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
TOTAL	36	15	10	-			-						14		
AVERAGE	**3.0**	**3.0**	**2.0**										**2.0**		

XV. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 3	SEE Exams	PO 1, PO 2, PO 3	Assignments	PO 2	Seminars	PO 1,PO 2, PO3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 1, PO 2, PO 3	5Minutes Video	PO 1, PO 2	Tech talk	PO2		

XVI. ASSESSMENT METHODOLOGIES - INDIRECT

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✗	Assessment of Mini Projects by Experts		

XVII. SYLLABUS

MODULE-I	**BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS**
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.	
MODULE -II	**SECOND LAW OF THERMODYNAMICS**
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	
MODULE -III	**PURE SUBSTANCES &GAS LAWS**
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. Equation of state, specific and universal gas constants, throttling and free expansion processes, deviations from perfect gas model, Vander Waals equation of state.	
MODULE -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, specific heats and entropy of mixture of perfect gases; psychometric properties, dry bulb temperature, wet bulb temperature, dew point temperature, thermodynamic wet bulb temperature, specific humidity, relative humidity, saturated air, vapor pressure, degree of saturation, adiabatic saturation, Carrier‘s equation, Psychometric chart.	
MODULE -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, 4th Edition, 2008. 2. Yunus Cengel, Michael A. Boles, “Thermodynamics-An Engineering Approach”, Tata McGraw Hill, 7th Edition, 2011.	
Reference Books:	
1. J. B. Jones, R. E. Dugan, “Engineering Thermodynamics”, Prentice Hall of India Learning, 1st Edition, 2009. 2. Y. V. C. Rao, “An Introduction to Thermodynamics”, Universities Press, 3rd Edition, 2013. 3. K. Ramakrishna, “Engineering Thermodynamics”, Anuradha Publishers, 2nd Edition, 2011. 4. Holman. J.P, “Thermodynamics”, Tata McGraw Hill, 4th Edition, 2013.	

XVIII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Topics to be covered	Course Outcomes	Text (T) book / Reference (R) book
1	System, control volume, surrounding, boundaries, universe, types of systems.	CO1	T2:2.3
2	Macroscopic and microscopic viewpoints, concept of continuum,	CO1	R1:2.6
3	Thermodynamic equilibrium, state, property, process, cycle, reversibility.	CO1	T1:2.6
4	Quasi static process, irreversible process, causes of irreversibility.	CO3	T2:2.7 R1:2.18
5	Various flow and non-flow processes ,energy in state and in transition, types-work	CO2	T2:2.22
6	Heat, point and path function, Zeroth law of thermodynamics.	CO1	T2:2.25
7	Concept of quality of temperature, Principles of thermometry, reference points.	CO2	T2:2.26 R1:2.55
8	Constant volume gas thermometer, ideal gas scale, PMMI Joule‘s experiments,	CO3	T2:2.16 R1:2.61
9	First law of thermodynamics, corollaries first law applied to a process	CO3	T2:2.30 R1:2.58
10	Applied to a flow system, steady flow energy equation.	CO3	T2:3.6 R1:4.29
11	Thermal reservoir, heat engine, heat pump	CO4	T2:3.14 R1:4.31
12	Parameters of performance, second Law of thermodynamics	CO4	T2:3.14 R1:4.33
13	Kelvin Planck, Claussius statements and their equivalence	CO4	R1:4.36
14	Corollaries, PMM of second kind, Carnot‘s principle	CO5	T2:3.18 R1:4.64
15	Carnot cycle and its specialties	CO5	T2:3.22
16	thermodynamic scale of temperature, Claussius inequality	CO5	T2:3.28 R1:4.67
17	Entropy, principle of Entropy increase, availability and irreversibility	CO5	T2:4.2
18	Thermodynamic potentials	CO6	T2:4.3 R1:4.71
19	Gibbs and Helmholtz functions, Maxwell relations	CO6	R2:4.68
20-21	Elementary treatment of the Third Law of thermodynamics	CO6	T2:4.15 R1:5.74
22	Phase transformations, T-S and H-S diagrams, P-V-T surfaces,	CO6	T1:4.12 R2:5.75
23-24	Triple point at critical state properties during change of phase,	CO6	T1:4.8 R1:5.72
25	Dryness fraction, Mollier charts, various thermodynamic processes	CO6	T1:5.8 R1:5.73
26-27	Energy transfer, steam calorimeter.	CO7	T1:5.14 R1:6.78

28	Equation of state, specific and universal gas constants.	CO7	T2:5.19 R1:6.81
29-30	Throttling and free expansion processes	CO7	T1:6.4 R2:6.8
31	Deviations from perfect gas model, Vander Waals equation of state.	CO8	T2:7.7 R1:7.74
32-33	Mole fraction, mass friction, gravimetric and volumetric analysis, volume fraction,	CO8	T1:7.12 R2:8.75
34	Dalton's law of partial pressure, Avogadro's laws of additive volumes, and partial pressure	CO8	T1:7.8 R1:8.72
35	Equivalent gas constant, internal energy, enthalpy, specific heats	CO8	T1:8.8 R1:8.73
36	Entropy of mixture of perfect gases; psychometric properties	CO9	T1:9.14 R1:10.78
37-38	Dry bulb temperature, wet bulb temperature, dew point temperature,	CO9	T2:9.19 R1:10.814
39-40	Thermodynamic wet bulb temperature, specific humidity, relative humidity, saturated air.	CO10	T1:10.4 R2:11.68
41-43	Vapor pressure, degree of saturation, adiabatic saturation, Carrier's equation, Psychometric chart.	CO10	T2:10.7 R1:12.74
44-48	Otto, Diesel, Dual combustion cycles, Problems on cycles	CO10	T1:11.12 R2:12.75
49-50	Description and representation on P-V and T-S diagram,	CO11	T1:12.4 R2:13.68
51-54	Thermal efficiency, mean effective pressures on air standard basis. Comparison of cycles	CO12	T2:13.7 R1:14.74
55-58	Introduction to Brayton cycle and Bell Coleman cycle.	CO12	T1:14.12 R2:15.75

Signature of Course Coordinator
Ms. N SanthiSree, Assistant Professor **HOD, ME**