INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**THERMAL ENGINEERING**				
Course Code	AME013				
Programme	B Tech				
Semester	V	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. P. Sadanandam, Assistant Professor				
Course Faculty	Dr. CH VKNSN Moorthy, Professor Mr. P. Sadanandam, Assistant Professor				

I. COURSE OVERVIEW:

Thermal engineering is a course which comprise the combination of mechanical power systems used in automotive, power generation and aerospace industries. Extensive study is done based on the different cycles in vapor power. Steam generators of different class and different utilities are explored. Critical knowledge about aircraft and space propulsion methods are analyzed and a detailed study is made on the significant parts and the performance parameters of the propulsion systems. Introduction to rocket and space propulsion is studied comprising of the various types of space vehicle propulsion motors and the fuels that may be used in said motors with physical and chemical properties are expertly taken into account and briefly discussed.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	III	Thermodynamics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Thermal Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

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 emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	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 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 25 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, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO 2	**Problem analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminar
PO 4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignment

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand ideal and air standard vapor cycle and evaluate the performance in open systems like steam power plant, gas turbine etc.
II	Analyse different air standard cycles specifically related to IC engines and solve problems on the intricacies of performance of the cycle
III	Understand the direction law and concept of entropy increase of the universe.

IX. COURSE OUTCOMES (COs)

COs	Course Outcome	CLOs	Course Learning Outcome
CO1	Discuss the Carnot vapor cycle and basic concept of steam power plant working cycle & modification of Rankine cycle.	CLO 1	Discuss the basic concepts of thermodynamics in the analysis for Carnot vapor power cycle.
		CLO 2	Determine the efficiency and output of a basic and modern Rankine cycle steam power plant from given data.
		CLO 3	Determine the efficiency of a modified Rankine cycle including superheat, reheat, and regeneration techniques.
		CLO 4	Discuss the concept of stoichiometric analysis of fuels and combustion.
CO2	Understand the working principles of different types of steam	CLO 5	Discuss different types of steam generators and its working principles.
		CLO 6	Discuss mountings and accessories of boilers.

COs	Course Outcome	CLOs	Course Learning Outcome
	generators, mounting and accessories and also understand the types of nozzles as well as turbines	CLO 7	Understand the working of different types of steam nozzles and its applications, conditions for maximum discharge of steam through it.
		CLO 8	Classify different types of steam turbines and working of impulse turbine and its performance parameters and methods of compounding to reduce rotor speed of an impulse turbine.
CO3	Understand the shape of blades, there work output of typical turbine stages with its velocity diagram and also working principles of condensers. Understand the turbine design and its applications.	CLO 9	Explain the blade shapes, and calculate work output of typical turbine stages with its velocity diagrams.
		CLO 10	Demonstrate different types of condensers and its working principles.
		CLO 11	Recognize the different gas turbine arrangements, their advantages and disadvantages and different applications application.
		CLO 12	Applying the relation between gas turbine design, application and environment.
CO4	Explore the concept of heat transfer principles in gas turbines and Carry out performance calculations of real Gas turbines	CLO 13	Applying the basic thermodynamic and heat transfer principles in performance calculation of industrial gas turbines
		CLO 14	Recognizing the differences of a real cycle (from the theoretical ones)
		CLO 15	Carry out performance calculations of real Gas turbines
		CLO 16	Examine the effect of various design parameters on the GT performance (pressure ratio, temperature ratio, pressure drop, polytrophic efficiency ...etc.).
CO5	Understand the fundamentals of jet propulsion and understand the concepts of Rocket propulsion and its classification	CLO 17	Explain the fundamentals of jet propulsion and basic propulsion cycle
		CLO 18	Examine the effect of various design parameters of the jet propulsion performance and its efficiency etc.
		CLO 19	Discuss the concepts of Rocket propulsion and its classification.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME013.01	CLO 1	Discuss the basic concepts of thermodynamics in the analysis for Carnot vapor power cycle.	PO 1	3
AME013.02	CLO 2	Determine the efficiency and output of a basic and modern Rankine cycle steam power plant from given data.	PO 4	1
AME013.03	CLO 3	Determine the efficiency of a modified Rankine cycle including superheat, reheat, and regeneration techniques.	PO 1	3
AME013.04	CLO 4	Discuss the concept of stoichiometric analysis of fuels and combustion.	PO 2	2
AME013.05	CLO 5	Discuss different types of steam generators and its working principles.	PO 4	1
AME013.06	CLO 6	Discuss mountings and accessories of boilers.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME013.07	CLO 7	Understand the working of different types of steam nozzles and its applications, conditions for maximum discharge of steam through it.	PO 4	1
AME013.08	CLO 8	Classify different types of steam turbines and working of impulse turbine and its performance parameters and methods of compounding to reduce rotor speed of an impulse turbine.	PO 4	1
AME013.09	CLO 9	Explain the blade shapes, and calculate work output of typical turbine stages with its velocity diagrams.	PO 4	1
AME013.10	CLO 10	Demonstrate different types of condensers and its working principles.	PO 2	2
AME013.11	CLO 11	Recognize the different gas turbine arrangements, their advantages and disadvantages and different applications application.	PO 1	3
AME013.12	CLO 12	Applying the relation between gas turbine design, application and environment.	PO 1	3
AME013.13	CLO 13	Applying the basic thermodynamic and heat transfer principles in performance calculation of industrial gas turbines	PO 4	1
AME013.14	CLO 14	Recognizing the differences of a real cycle (from the theoretical ones)	PO 1, PO 2	3
AME013.15	CLO 15	Carry out performance calculations of real Gas turbines	PO 2	2
AME013.16	CLO 16	Examine the effect of various design parameters on the GT performance (pressure ratio, temperature ratio, pressure drop, polytrophic efficiency ...etc.).	PO 4	1
AME013.17	CLO 17	Explain the fundamentals of jet propulsion and basic propulsion cycle	PO 1, PO 2	3
AME013.18	CLO 18	Examine the effect of various design parameters of the jet propulsion performance and its efficiency etc.	PO 2	3
AME013.19	CLO 19	Discuss the concepts of Rocket propulsion and its classification.	PO 1	3

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM

Course Outcomes (COs)	Program Outcomes (POs)				
	PO 1	PO 2	PO 4	PSO1	PSO3
CO 1	3	2	1	1	1
CO 2		2	1		1
CO 3	3	2	1	1	1
CO 4	3	2	1	1	1
CO 5	3	2		1	1

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

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2				1											1
CLO 3	3												1		
CLO 4		2													
CLO 5				1											
CLO 6		2													1
CLO 7				1											
CLO 8				1											
CLO 9				1											
CLO 10		2											1		
CLO 11	3														1
CLO 12	3														
CLO 13				1											
CLO 14	3	2											1		
CLO 15		2													
CLO 16				1											1
CLO 17	3	2											1		
CLO 18		2													
CLO 19	3												1		1

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XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 4, PSO1, PSO3.	SEE Exams	PO 1, PO 2, PO 4, PSO1, PSO3.	Assignments	PO 2.	Seminars	PO 4.
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	BASIC CONCEPTS OF RANKINE CYCLE	Classes:12
Rankine cycle schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance, regeneration and reheating. Combustion: fuels and combustion, adiabatic flame temperature, stoichiometry, flue gas analysis.		
UNIT-II	**BOILERS AND STEAM NOZZLES**	**Classes:12**
Boilers: Classification, working principles with sketches including, high pressure boilers, mountings and accessories, working principles, steam nozzles: Function of nozzle, applications, types, flow throughnozzles, thermodynamic analysis.		
UNIT-III	**STEAM TURBINE AND CONDESERS**	**Classes:12**
Steam turbines: Classification, impulse turbine, mechanical details, velocity diagram, effect of friction, power developed, axial thrust, blade or diagram efficiency, condition for maximum efficiency; Reaction turbine: Mechanical details, principle of operation, thermodynamic analysis of a stage, degree of reaction, velocity diagram, Parson's reaction turbine, condition for maximum efficiency. Steam condensers: Requirements of steam condensing plant, classification of condensers, working principle of different types.		
UNIT-IV	**GAS TURBINES**	**Classes:12**
Gas turbines: Simple gas turbine plant, ideal cycle, essential components, parameters of performance, actual cycle, regeneration, inter cooling and reheating, closed and Semi-closed cycles, merits anddemerits, brief concepts of compressors combustion chambers and turbines of gas turbine plant.		
UNIT-V	**JET PROPULSION AND ROCKETS**	**Classes:12**
Jet propulsion: Principle of operation, classification of jet propulsive engines, working Principles with schematic diagrams and representation on T-S diagram, thrust, thrust power and propulsion efficiency, turbo jet engines, needs and demands met by turbo jet, schematic diagram, thermodynamic cycle, performance evaluation thrust augmentation methods; Rockets: Application, working Principle,classification, propellant type, thrust, propulsive efficiency, specific impulse, solid and liquid propellant rocket engines.		
Text Books:		
1. R. K. Rajput, "Thermal Engineering", Lakshmi Publications, 8th Edition, 2015 2. V. Ganesan, "Gas turbines", Tata McGraw-Hill, 3rd Edition, 2010.		
Reference Books:		
1. P. Khajuria, S. P Dubey, "Gas Turbines and Propulsive systems", Dhanpat Rai Publishers., 1st Edition, 2012. 2. Ballaney, "Thermal Engineering", Khanna Publishers, 1st Edition, 2012. 3. R. Yadav, "Thermodynamics and Heat Engines", Central Book Depot, 1st Edition, 2002.		

XVI. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Describe the processes of Rankine cycle	CLO 1	T1 1.1 R1 1.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
2-3	Analyze Thermodynamic Analysis of cycle on T-S diagram	CLO 2	T1 1.2 R2 1.2
4-6	Concept of Mean Temperature of Heat addition	CLO 2	T2 1.3 R1 1.3
7	Evaluate cycle performance	CLO 4	T1 1.4 R3 1.4
8-9	Explain Regeneration & reheating processes	CLO 4	T1 1.5 R3 1.5
10-11	Explain different types of fuels and its classification.	CLO 7	T2 1.6 R1 1.6
12	Analyze the Concept of adiabatic flame temperature	CLO 9	T2 1.7 R2 1.6
13	Concept of stoichiometry	CLO 9	T2 1.8 R1 1.8
14	Concept of flue gas analysis	CLO 11	T1 1.8 R1 1.8
15-17	Classify boilers	CLO 11	T1 2.1 R1 2.1
18-24	Working principles of boilers	CLO 13	T2 2.2 R2 2.2
25-26	Functions of Nozzle and its applications	CLO 11	T1 2.3 R2 2.3
27	Function of nozzle flow	CLO 9	T2 2.4 R1 2.4
28	Determine the Thermodynamic properties	CLO 14	T2 2.5 R1 2.5
29	Classify Steam Turbines	CLO 14	T1 3.1 R3 3.1
30	Working of Impulse Turbines	CLO 14	T2 3.2 R1 3.2
31-32	Evaluate the performance using velocity diagram	CLO 14	T1 3.2 R1 3.2
33	Derive condition for maximum efficiency	CLO 14	T1 3.3 R3 3.3
34-35	Working Principle of Reaction Turbine	CLO 15	T2 3.4 R1 3.4
36	Define the Degree of Reaction	CLO 15	T2 3.5 R1 3.5
37-38	Obtain the Conditions for maximum efficiency with velocity diagrams	CLO 16	T1 3.5 R1 3.5
39	List out the Requirements of condenser plant	CLO 16	T1 3.6 R3 3.6
40	Classify the condensers	CLO 16	T1 3.7 R2 3.7
41-42	Classify Gas Turbines and its process	CLO 16	T2 4.1 R3 4.1
43-45	Explain Improving efficiency methods	CLO 17	T1 4.3 R1 4.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
46-47	Analyze Cycle operation	CLO 17	T1 4.5 R3 4.5
47-52	Classify jet propulsive engines	CLO 18	T1 5.1 R1 5.1
53	Evaluate the Performance of propulsive engines	CLO 18	T2 5.2 R1 5.2
54-56	Analyze the Thermal analysis of Turbojets	CLO 19	T2 5.4 R1 5.4
57-63	Classify the Rockets and its working Principles	CLO 19	T1 5.5 R2 5.5

XVII. 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	PSO2
2	Gas laws applied to cooling of electronic chips	SEMINAR	PO2	PSO3
3	cooling of spindle bearings by using chillers	SEMINAR	PO1	PSO3

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