INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**THERMAL ENGINEERING**			
Course Code	**A50326**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	1	-	4
Course Coordinator	Dr. CHVKNSN Moorthy, Professor			
Team of Instructors	Dr. CHVKNSN Moorthy, Professor, Mr. S. Srikrishnan, Assistant Professor			

I. COURSE OVERVIEW

Thermal Engineering is the applications of thermodynamics. The objective of the course is to introduce the mechanical engineering students an understanding of the performance of rankine cycle, parameters to improve the performance like reheating, regenerating and also Gas turbines and rocket engines and their performance. The knowledge of thermal engineering helps us in improving and designing the various parts of machine elements. The course content is designed in such a way that efficiencies of different turbines could be achieved by the calculation of different empirical values.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	5	Basic Thermodynamics, Thermal Engineering I

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective type and Objective type tests. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each midterm exam shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks with duration of 20minutes. It consists of 10 Multiple choice and 10 objective type questions. The student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first 2 ½ units of syllabus and second midterm examination shall be conducted for the remaining 2 ½ units. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course reason whatsoever, will get zero marks(s).	75	100

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

I. **Knowledgeable** in steam power plants and their components, performance and analysis of steam turbines, gas turbines.
II. **Understand** nozzles and condensers and their performances in industries.
III. **Understand** the concept of jet propulsion and their effects.
IV. **Visualize** the concepts of rockets and propellants.
V. **Evaluate** the performance of critical components and accessories of steam and gas power plants.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to:

1. **Describe** knowledge of Rankine cycle and heat equation in different processes, and improving efficiency techniques.
2. **Demonstrate** knowledge of ability to identify & apply fundamentals to solve problems involving nozzles and turbines, jet propulsion systems and rockets.
3. **Explore** their knowledge & ability to design the constructional features of various types of boilers in various fields of energy transfer equipments.
4. **Design** nozzles, turbines and condensers with desired needs within realistic constraints such as economic, environmental, social, political, ethical, and safety manufacturability and sustainability related thermal fields like different types of power plants etc.
5. **Understand** modern engineering tools, software and equipment to analyze energy transfer in required applications.
6. **Knowledge** of impact of engineering solutions on the society and also on contemporary issues related to different types of steam cycles and propulsion systems.

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

			Exams
PO10	An ability to assimilate, comprehend, communicate, give & receive instructions to present effectively with engineering community and society.	S	-----
PO11	An ability to provide leadership in managing complex engineering projects at multidisciplinary environment and to become a Technocrat.	H	Mini Projects
PO12	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**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	H	Lectures, Assignments
PSO 2	**Design/ Analysis:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	S	Lectures, Assignments
PSO 3	**Successful Career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	H	Guest Lectures

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

IX. SYLLABUS

UNIT-I

BASIC CONCEPTS: Rankine cycle - Schematic layout, Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance – Regeneration & reheating. Combustion: fuels and combustion, adiabatic flame temperature, stoichiometry, flue gas analysis

UNIT-II

BOILERS: Classification – Working principles – with sketches including H.P.Boilers – Mountings and Accessories – Working principles,

STEAM NOZZLES: Function of nozzle – applications - types, Flow through nozzles, thermodynamic analysis

UNIT-III

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: Simple gas turbine plant – Ideal cycle, essential components – parameters of performance – actual cycle – regeneration, inter cooling and reheating –Closed and Semi-closed cycles – merits and demerits. Brief concepts of compressors - combustion chambers and turbines of gas turbine plant.

UNIT-V

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:

T1. Thermal Engineering / R.K Rajput / Lakshmi publications

T2. Gas Turbines / V. Ganesan / TMH

REFERENCE BOOKS:

R1. Thermal Engineering / P.L Bellaney / Khanna publications

R2. Thermal Engineering / M.A Mathur & Mehta / Jain publications

R3. Thermal Engineering / Aja Kumar / Narosa

R4. Thermal Engineering / R.S.Kurmi &J.S.Gupta / S . Chand publishers

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	**Describe** the processes of Rankine cycle	Rankine cycle - Schematic layout	T1,R1
2-3	**Analyze** Thermodynamic Analysis of cycle on T-S diagram	Thermodynamic Analysis,	T1,R1.R2
4-6	**Concept** of Mean Temperature of Heat addition	Concept of Mean Temperature of Heat addition	T1,R2
7	**Evaluate** cycle performance	Methods to improve	T1,R2
8-9	**Explain** Regeneration & reheating processes	Regeneration & reheating	T1,R2
10-11	**Explain** different types of fuels and its classification.	Combustion: fuels and combustion	T1 R2
12	**Analyze** the Concept of adiabatic flame temperature	adiabatic flame temperature	T1 R2
13	**Concept** of stoichiometry	stoichiometry	T1R1
14	**Concept** of flue gas analysis	flue gas analysis	T1 R1
15-17	**Classify** boilers	BOILERS : Classification – Working principles	T1 R1
18-24	**Working** principles of boilers	with sketches including H.P.Boilers	T1 R1
25-26	**Functions** of Nozzle and its applications	Function of nozzle – applications- types	T1 R2
27	**Function** of nozzle flow	Flow through nozzles	T1 R1
28	**Determine** the Thermodynamic properties	thermodynamic analysis	T1 R1
29	**Classify** Steam Turbines	STEAM TURBINES: Classification	T1 R2
30	**Working** of Impulse Turbines	Impulse turbine; Mechanical details	T1 R2
31-32	**Evaluate** the performance using velocity diagram	Velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency	T1 R2
33	**Derive** condition for maximum	condition for maximum efficiency	T1 R2

	efficiency		
34-35	**Working** Principle of Reaction Turbine	Reaction Turbine: Mechanical details – principle of operation	T1 R2
36	**Define** the Degree of Reaction	thermodynamic analysis of a stage, degree of reaction	T1 R2
37-38	**Obtain** the Conditions for maximum efficiency with velocity diagrams	velocity diagram Parson's reaction turbine – condition for maximum efficiency	T1 R2
39	**List out** the Requirements of condenser plant	STEAM CONDENSERS : Requirements of steam condensing plant —	T1 R1
40	**Classify** the condensers	Classification of condensers working principle of different types	T1 R1
41-45	**Classify** Gas Turbines and its process	GAS TURBINES : Simple gas turbine plant – Ideal cycle, essential components – parameters of performance – actual cycle	T1R3
46-49	**Explain** Improving efficiency methods	regeneration, inter cooling and reheating	T1 R3
50-52	**Analyze** Cycle operation	Closed and Semi-closed cycles – merits and demerits.	T1 R3
53-60	**Classify** jet propulsive engines	JET PROPULSION: Principle of Operation – Classification of jet propulsive engines – Working Principles with schematic diagrams and representation on T-S diagram	T1R4
61	**Evaluate** the Performance of propulsive engines	Thrust, Thrust Power and Propulsion Efficiency	T1 R4
62-64	**Analyze** the Thermal analysis of Turbojets	Turbo jet engines – Needs and Demands met by Turbo jet – Schematic Diagram, Thermodynamic Cycle, and Performance Evaluation Thrust Augmentation – Methods.	T1 R4
65-68	**Classify** the Rockets and its working Principles	ROCKETS: Application – Working Principle – Classification – Propellant Type – Thrust, Propulsive Efficiency – Specific Impulse –Engines.	T1 R4
69	**Distinguish** Different Propellants	Solid and Liquid propellant Rocket Engines.	T1 R4

XI MAPPING COURSE OBJECTIVES LEADING TO THE 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

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

XI I MAPPING COURSE OUTCOMES LEADING TO THE 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	PSO2	PSO3
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

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

Prepared by:
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