INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**HEAT TRANSFER LABORATORY**			
Course Code	AME112			
Programme	**B. Tech**			
Semester	**VI**			
Course Type	**Core**			
Regulation	**IARE - R16**			
Course Structure	**Lectures**	**Tutorials**	**Practical**	**Credits**
	-	-	**3**	**2**
Course Coordinator	**Dr. K. Ch Apparao, Associate Professor**			
Course Faculty	**Dr. K. Ch Apparao, Associate Professor** **Dr. Ch Sandeep, Associate Professor**			

I. COURSE OVERVIEW:

Heat transfer lab is a complementary laboratory given as a supplement for the practical version of the subject Heat Transfer taught in same semester. The various experiments in the lab are subjected to give an onsite exposure to the students in terms of the various forms of heat transfers available in everyday life and their calculation procedures. Further, a live review of the machines include the approach by which the students learn the effect of multiple forms of heat transfer and their application in practical scenarios

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME016	VI	Heat Transfer	4

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Heat Transfer Laboratory	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:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by the Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	**Laboratory**		**Total Marks**
Type of Assessment	Day to day performance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

Preparation	**Performance**	**Calculations and Graph**	**Results and Error Analysis**	**Viva**	**Total**
2	2	2	2	2	10

VI. 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.	3	Calculations of the observations/ Student Viva
PO2	**Problem Analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Characteristic curves/ Student Viva
PO4	**Conduct investigations of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	2	Term observations/ Student Viva

Program Outcomes		Level	Proficiency Assessed by
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	Day to Day Evaluation

3 = High; 2 = Medium; 1 = Low

VII. 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.	1	Seminar & SEE
PSO2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the various forms of heat transfer and their applications in real life problems.
II	Analyse different methods to calculate the heat transfer coefficient in various heat transfer problems.
III	Analyse the theoretical knowledge and apply it in conducting experiments in the forms of heat transfer.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Perform steady state conduction experiments to estimate thermal conductivity of different materials for plane, cylindrical and spherical geometries	CLO 1	Determine the overall heat transfer coefficient for a composite slab
		CLO 2	Determine the thermal conductivity of a lagged pipe apparatus
		CLO 3	Determine the thermal conductivity of a concentric sphere apparatus
		CLO 4	Determine the thermal conductivity of a metal rod apparatus
CO 2	Perform the transient heat conduction experiment and obtain variation of temperature along the length of the pin fin.	CLO 5	Determine the effectiveness and the efficiency of fins in pin fin apparatus
		CLO 6	Determine the thermal conductivity in transient mode
CO 3	Estimate heat transfer coefficients in forced convection, free convection and determine effectiveness of heat exchangers	CLO 7	Determine the convective heat transfer coefficient in forced convection
		CLO 8	Determine the convective heat transfer coefficient in natural convection
		CLO 9	Determine the effectiveness of parallel and counter flow heat exchanger in both theoretical and experimental methods

CO 4	Perform radiation experiments:determine surface emissivity of a test plane and stefan-Boltzmann's constant and compare with theritical values	CLO 10	Determine the emissivity of a grey and black body in the emissivity apparatus
		CLO 11	Determine the Stefan Boltzmann constant and compare the value in the Stefan Boltzmann apparatus
CO5	Estimate heat transfer coefficients in condensation, boiling and effectiveness of heat pipe	CLO 12	Evaluate the critical heat flux value by studying different zones of boiling
		CLO 13	Demonstrate the effectiveness of a heat pipe in the cooling of complex systems
		CLO 14	Determine the condensation temperature in the film wise and drop wise condensation methods.

X. COURSE LEARNING OUTCOMES:

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

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME112.01	CLO 1	Determine the overall heat transfer coefficient for a composite slab	PO 1, PO 2, PO 4, PO 9	3
AME112.02	CLO 2	Determine the thermal conductivity of a lagged pipe apparatus	PO 1, PO 2, PO 4, PO 9	3
AME112.03	CLO 3	Determine the thermal conductivity of a concentric sphere apparatus	PO 1, PO 2, PO 4, PO 9	2
AME112.04	CLO 4	Determine the thermal conductivity of a metal rod apparatus	PO 1, PO 2, PO 4, PO 9	3
AME112.05	CLO 5	Determine the effectiveness and the efficiency of fins in pin fin apparatus	PO 1, PO 2, PO 4, PO 9	3
AME112.06	CLO 6	Determine the thermal conductivity in transient mode	PO 1, PO 2, PO 4, PO 9	2
AME112.07	CLO 7	Determine the convective heat transfer coefficient in forced convection	PO 1, PO 2, PO 4, PO 9	3
AME112.08	CLO 8	Determine the convective heat transfer coefficient in natural convection	PO 1, PO 2, PO 4	2
AME112.09	CLO 9	Determine the effectiveness of parallel and counter flow heat exchanger in both theoretical and experimental methods	PO 1, PO 2, PO 4, PO 9	2
AME112.10	CLO 10	Determine the emissivity of a grey and black body in the emissivity apparatus	PO 1, PO 2, PO 4, PO 9	3
AME112.11	CLO 11	Determine the Stefan Boltzmann constant and compare the value in the Stefan Boltzmann apparatus	PO 1, PO 2, PO 4	2
AME112.12	CLO 12	Evaluate the critical heat flux value by studying different zones of boiling	PO 1, PO 2, PO 4, PO 9	2
AME112.13	CLO 13	Demonstrate the effectiveness of a heat pipe in the cooling of complex systems	PO 1, PO 2, PO 4	2
AME112.14	CLO 14	Determine the condensation temperature in the film wise and drop wise condensation methods.	PO 1, PO 2, PO 4	2

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

Course Outcomes (COs)	Program Outcomes (POs)				Program Specific Outcomes(PSOs)		
	PO1	PO2	PO4	PO9	PSO1	PSO2	PSO3
CO 1	3	3	2	1	1		
CO 2	2	3	1	1	1		
CO 3	3	2	2	1	1		
CO 4	2	2	1	1	1		
CO 5	3	2	2	1	1		

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

Course Learning 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	3		2					1				1		
CLO 2	3	3		1					1				1		
CLO 3	2	2		2					1				1		
CLO 4	3	3		1					1				1		
CLO 5	2	2		2					1						
CLO 6	3	2		1					1				1		
CLO 7	3	2		2					1				1		
CLO 8	2	3		2									1		
CLO 9	3	3		1					1						
CLO 10	2	3		2					1				1		
CLO 11	3	2		1									1		
CLO 12	2	2		2					1						
CLO 13	2	2		1									1		
CLO 14	3	1		2									1		

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 4, PO 9	SEE Exams	PO 1, PO 2 PO 4, PO 9	Lab Exercises	PO 1, PO 2 PO 4, PO 9	Seminars	-
Laboratory Practices	PO 1, PO 2 PO 4	Student Viva	PO 1, PO 2 PO 4	Mini Project	-	Certification	-

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS:

LIST OF EXERCISES	
WEEK - 1	**COMPOSITE SLAB APPRATUS – OVERALL HEAT TRANSFER COEFFICIENT**
Determination of the overall heat transfer coefficient for a composite slab	
WEEK - 2	**HEAT TRANSFER THROUGH LAGGED PIPE**
Determination of the thermal conductivity of a lagged pipe	
WEEK - 3	**HEAT TRANSFER THROUGH CONENCTRIC SPHERE**
Determination of thermal conductivity of given concentric sphere	
WEEK - 4	**THERMAL CONDUCTIVITY OF GIVEN METAL ROD**
Determination of thermal conductivity of the given metal rod	
WEEK - 5	**HEAT TRANSFER IN PIN FIN APPARATUS**
Determination of the effectiveness and efficiency of pin fin	
WEEK - 6	**EXPERIMENT ON TRANSIENT HEAT CONDUCTION**
Determination of thermal conductivity in transient mode.	
WEEK - 7	**HEAT TRANSFER IN FORCED CONVECTION APPRATUS**
Determination of convective heat transfer coefficient in forced convection	
WEEK - 8	**HEAT TRANSFER IN NATURAL CONVECTION APPRATUS**
Determination of convective heat transfer coefficient in natural convection	
WEEK - 9	**PARALLEL AND COUNTER FLOW HEAT EXCHANGERS**
Determination of effectiveness of parallel and counter flow heat exchangers by experimental and theoretical methods	
WEEK - 10	**EMISSIVITY APPARATUS**
Determination of emissivity of grey and black body	
WEEK - 11	**STEFAN BOLTZMANN APPARATUS**
Determination of Stefan Boltzmann constant and compare its value.	
WEEK - 12	**CRITICAL HEAT FLUX APPARATUS**
Evaluate the critical heat flux value by studying different zones of boiling	
WEEK - 13	**STUDY OF HEAT PIPE**
Study the effectiveness of a heat pipe in cooling complex electromechanical systems	
WEEK - 14	**FILM AND DROPWISE CONDENSATION APPARATUS**
Determination of different methods of condensation	

TEXT BOOKS:

1	Yunus A. Cengel, "Heat Transfer a Practical Approach", Tata McGraw-Hill Education, 4th Edition, 2012.
2	R. C. Sachdeva, "Fundamentals of Engineering, Heat and Mass Transfer", New Age publication, 3rd Edition, 2012.

REFERENCES:

1	https://en.wikipedia.org/wiki/Heat_Transfer
2	https://en.wikipedia.org/wiki/Heat and Mass Transfer

XVI. COURSE PLAN:

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

Exp. No.	Experiment	Course Learning Outcomes	Reference
1	Composite slab apparatus to find overall heat transfer coefficient	CLO 1	T1, T2
2	Heat transfer through lagged pipe	CLO 2	T1, T2
3	Heat transfer through concentric sphere	CLO 3	T1, T2
4	Thermal conductivity of given metal rod	CLO 4	T1, T2
5	Heat Transfer in pin fin apparatus	CLO 5	T1, T2
6	Experiment on transient heat conduction	CLO 6	T1, T2
7	Heat transfer in forced convection	CLO 7	T1, T2
8	Heat transfer in natural convection	CLO 8	T1, T2
9	Parallel and Counterflow, heat exchangers	CLO 9	T1, T2
10	Emissivity of black and gray body	CLO 10	T1, T2
11	Stefan Boltzmann apparatus	CLO 11	T1, T2
12	Critical heat flux apparatus	CLO 12	T1, T2
13	Study of Heat Pipe	CLO 13	T1, T2
14	Film and drop wise condensation apparatus	CLO 14	T1, T2

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

S. No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Combined Heat Transfer – Conduction, Convection and Radiation	Classroom Teaching, Video Lecture	PO1, PO4	PSO 1

Prepared by:

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HOD, ME