INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**REFRIGERATION AND AIR CONDITIONING**				
Course Code	AME017				
Programme	B.Tech.				
Semester	VII	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. A Somaiah, Assistant Professor				
Course Faculty	Mr. M Prashanth Reddy, Assistant Professor				

I. COURSE OVERVIEW:

Refrigeration and air conditioning continues to grow in importance in every segment of our day-to-day living. The course covers various conventional refrigeration systems like air, vapour compression, vapour absorption and steam jet refrigeration systems, also describes some unconventional refrigeration systems; thermoelectric refrigeration, Hilsch tube, etc.. The course introduces the psychometry, various air conditioning systems and heat pump circuits.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	IV	Thermodynamics	4
UG	AME013	V	Thermal Engineering	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Refrigeration and Air Conditioning	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**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Presentation on real-world problems
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	2	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Term Paper

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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Understand vapour compression, vapour absorption and air refrigeration systems.
II	Analyze the refrigeration cycles and methods for improving the performance using standard data hand book with p-h charts.
III	Familiarize the components of refrigeration system.
IV	Identify various psychometric properties and processes.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the concept of vapour compression refrigeration, effect of subcooling, super heating, construction of P-H charts.	CLO 1	Derive COP of HP, R & HE
		CLO 2	Describe the working of Carnot refrigerator and its applications.
		CLO 3	Describe the working of vapor compression refrigeration cycle.
		CLO 4	Construction of PH charts & Solve the problems.
CO 2	Understand the working of vapor absorption refrigeration, it's components and air refrigeration systems.	CLO 5	Classifying and Demonstration of compressors.
		CLO 6	Demonstration of working of condensers.
		CLO 7	Demonstration of working of evaporators.
		CLO 9	Demonstration of Aqua-Ammonia VARS.
CO 3	Understand the functions of various refrigeration components like, compressor, condenser, expansion valve and evaporator.	CLO 8	Classifying and Demonstration of expansion devices.
		CLO 10	Illustration of Li-Br VARS.
		CLO 11	Explanation of principle & Demonstration of Electrolux.
		CLO 12	Discuss the air refrigeration cycles and its applications.
CO 4	Explore the concept Psychometry, it's properties, RSHF, ESHF, GSHF and concept of human comfort and temperature.	CLO 13	Discuss the various properties of air.
		CLO 14	Draw and Calculate Various sensible heat factors.
		CLO 15	Draw & Describe comfort and industrial air conditioning.
		CLO 16	Calculate the air conditioning loads.
CO 5	Classification of air conditioning equipment and description of heat pumps.	CLO 17	Classify the equipment of air conditioning.
		CLO 18	Describe the importance of filters, grills, registers & Explain the working of fans and blowers.
		CLO 19	Discuss the various heat pump sources.
		CLO 20	Draw heat pump circuits and Discuss their applications.

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
AME017.01	CLO 1	Derive COP of HP, R & HE	PO 1	3
AME017.02	CLO 2	Describe the working of Carnot refrigerator and its applications.	PO 2	2
AME017.03	CLO 3	Describe the working of vapor compression refrigeration cycle.	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME017.04	CLO 4	Construction of PH charts & Solve the problems.	PO 1	3
AME017.05	CLO 5	Classifying and Demonstration of compressors.	PO 2	2
AME017.06	CLO 6	Demonstration of working of condensers.	PO 2	2
AME017.07	CLO 7	Demonstration of working of evaporators.	PO 2	2
AME017.08	CLO 8	Classifying and Demonstration of expansion devices.	PO 2	2
AME017.09	CLO 9	Demonstration of Aqua-Ammonia VARS.	PO 4	1
AME017.10	CLO 10	Illustration of Li-Br VARS.	PO 4	1
AME017.11	CLO 11	Explanation of principle & Demonstration of Electrolux.	PO 2	2
AME017.12	CLO 12	Discuss the air refrigeration cycles and its applications.	PO 2	2
AME017.13	CLO 13	Discuss the various properties of air.	PO 1	3
AME017.14	CLO 14	Draw and Calculate Various sensible heat factors.	PO 1	3
AME017.15	CLO 15	Draw & Describe comfort and industrial air conditioning.	PO 1	3
AME017.16	CLO 16	Calculate the air conditioning loads.	PO 1	3
AME017.17	CLO 17	Classify the equipment of air conditioning.	PO 2	3
AME017.18	CLO 18	Describe the importance of filters, grills, registers & Explain the working of fans and blowers.	PO 1	3
AME017.19	CLO 19	Discuss the various heat pump sources.	PO 2	3
AME017.20	CLO 20	Draw heat pump circuits and Discuss their applications.	PO 2	3

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

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

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES 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	2											1		
CLO 2	3	2		1											
CLO 3	3												1		
CLO 4		2		1									1		
CLO 5	3	2													
CLO 6	3			1											
CLO 7		2													
CLO 8	3	2													
CLO 9		2		1											
CLO 10	3			1											
CLO 11													1		
CLO 12	3	2											1		
CLO 13	3														
CLO 14		2													
CLO 15	3														
CLO 16	3	2											1		
CLO 17				1									1		
CLO 18	3	2											1		
CLO 19		2											1		
CLO 20	3	2	1										1		

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO4, PSO1	SEE Exams	PO1, PO2, PO4, PSO1	Assignments	-	Seminars	PO1, PO2, PO4, PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO4, PSO1						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT

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

XV. SYLLABUS

Unit-I	INTRODUCTION TO REFRIGERATION
Basic concepts: unit of refrigeration and COP, refrigerators, heat pump, Carnot refrigerator, applications of refrigerators, air refrigeration: Bell-Coleman cycle, open and dense air system, ideal and actual refrigeration, applications, vapor compression refrigeration, ideal cycle, effect of sub cooling of liquid, super heating of vapor, deviations of practical (actual cycle) from ideal cycle, construction and use of p-h chart problems.	
Unit-II	**VAPOUR ABSORPTION REFRIGERATION AND AIR REFRIGERATION**
Vapor absorption refrigeration: description, working of NH3-Water, Li Br–water system, calculation of HCOP, Principle and operation of three fluid vapor absorption refrigeration systems. steam jet refrigeration system, working principle, basic operation; Refrigerants: Properties, nomenclature selection of refrigerants, effects of refrigerants on global warming, alternate refrigerants.	
Unit-III	**REFRIGERATOR COMPONENTS**
Compressors: classification, working, advantages and disadvantages; Condensers: classification, working Principles. Evaporators: classification, working Principles; Expansion devices: types, working principles.	
Unit-IV	**INTRODUCTION TO AIR CONDITIONING**
Psychometric properties and processes, sensible and latent heat loads, characterization, need for ventilation, consideration of Infiltration, load concepts of RSHF, ASHF, ESHF and ADP; concept of human comfort and effective temperature, comfort air conditioning, industrial air conditioning and requirements, air conditioning load calculations.	
Unit-V	**AIR CONDITIONING SYSTEMS**
Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, deodorants, fans and blowers, heat pump, heat sources, different heat pump circuits, applications.	
Text Books:	
1. Manohar Prasad, "Refrigeration and Air Conditioning, New Age International, 3rd Edition, 2015 2. S. C. Arora, Domkundwar, "A Course in Refrigeration and Air-conditioning", Dhanpatrai Publications, Edition 2014.	
Reference Books:	
1. C. P. Arora, "Refrigeration and Air Conditioning" Tata McGraw-Hill, 17th Edition, 2006. 2. Ananthanarayanan, "Basic Refrigeration and Air Conditioning", Tata McGraw-Hill, 2015. 3. R.K.Rajput, "A text of Refrigeration and Air Conditioning" S. K. Kataria & Sons, 3rd Edition, 2009. 4. P. L. Ballaney, "Refrigeration and Air Conditioning" Khanna Publishers, 16th Edition, 2015.	

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	Introduction to refrigeration and air conditioning.	CLO 1	T2:2.3
2	Review of thermodynamics & Define TR	CLO 1	R1:2.6
3	Derive COP of HP, R & HE	CLO 2	T1:2.6
4	Describe the working of Carnot refrigerator and its appications	CLO 2	T2:2.7 R1:2.18
5	Describe the working of VCR cycle	CLO 3	T2:2.22
6	Discuss the effect of sub cooling	CLO 3	T2:2.2
7	Discuss the effect of superheating	CLO 3	T2:2.26 R1:2.55
8	Construction of PH chart & Solve the problems.	CLO 4	T2:2.16 R1:2.61
9	Discuss the influence of various parameters on system performance.	CLO 4	T2:2.30 R1:2.58
10	Introduction refrigerator components	CLO 5	T2:3.6 R1:4.29
11	Classifying and Demonstration of compressors	CLO 5	T2:3.14 R1:4.31
12	Discuss the merits and demerits of compressors.	CLO 6	T2:3.14 R1:4.33
13	Classifying condensers	CLO 6	R1:4.36
14	Demonstration of working of condensers	CLO 6	T2:3.18 R1:4.64
15	Classifying evaporators	CLO 7	T2:3.22
16	Demonstration of working of evaporators	CLO 7	T2:3.28 R1:4.67
17	Classifying expansion devices.	CLO 8	T2:4.2
18	Demonstration of working of expansion devices.	CLO 8	T2:4.3 R1:4.71
19	Introduction to VARS and Demonstration of Aqua-Ammonia VARS.	CLO 9	T1:4.8 R2:4.68
20-21	Demonstration of Li-Br VARS	CLO 9	T2:4.15 R1:5.74
22	Calculate COP of VARS	CLO 10	T1:4.12 R2:5.75
23-24	Explanation of principle & Demonstration of Electrolux	CLO 11	T1:4.8 R1:5.72
25	Introduction to air refrigeration	CLO 12	T1:5.8 R1:5.73
26-27	Discuss the refrigeration cycles and its applications	CLO 12	T1:5.14 R1:6.78
28	Explain various properties of air	CLO 13	T2:5.19 R1:6.81
29-30	Calculate heat loads	CLO 13	T1:6.4 R2:6.8
31	Describe the importance of ventilation and infiltration.	CLO 14	T2:7.7 R1:7.74

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
32-33	Draw and Calculate Various sensible heat factors	CLO 14	T1:7.12 R2:8.75
34	Discuss the human comfort parameters	CLO 15	T1:7.8 R1:8.72
35	Draw & Describe comfort and industrial air conditioning	CLO 15	T1:8.8 R1:8.73
36	Calculate the air conditioning loads.	CLO 16	T1:9.14 R1:10.78
37-38	Classify the equipment of air conditioning	CLO 17	T2:9.19 R1:10.814
39-40	Describe the importance of filters, grills, registers & Explain the working of fans and blowers.	CLO 18	T1:10.4 R2:11.68
41-43	Discuss the various heat pump sources.	CLO 19	T2:10.7 R1:12.74
44-45	Draw heat pump circuits and Discuss their applications.	CLO 20	T1:11.12 R2:12.75

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

S NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	To understand the technology of thermo-electric refrigeration, solar powered refrigeration, etc.	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

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