INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING
COURSE DESCRIPTION FORM

Course Title	**REFRIGERATION & AIR-CONDITIONING**			
Course Code	**A60334**			
Regulation	**R15**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	1	-	4
Course Coordinator	Dr. CH V K N S N Moorthy, Professor, Department of Mechanical Engineering			
Team of Instructors	Dr. CH V K N S N Moorthy, Professor Mr. A. Somaiah, 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. PREREQUISITE(S):

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Thermal Engineering

III. MARKS DISTRIBUTION:

Sessional Marks (25)	University End Exam Marks	Total Marks
Continuous Assessment Tests (Midterm examinations): There shall be 2 midterm examinations. Each midterm examination consists of one objective paper, one subjective paper and two assignments. The objective paper is for 10 marks and subjective paper is for 10 marks, with duration of 1 hour 20 minutes (20 minutes for objective and 60 minutes for subjective paper). Objective paper is set for 20 bits of – multiple choice questions, fill-in the blanks, 10 marks. Subjective paper contains of 4 full questions (one from each unit) of which, the student has to answer 2 questions, each question carrying 5 marks. First midterm examination shall be conducted for 2.5 units of syllabus and second midterm examination shall be conducted for another 2.5 units. 5 marks are allocated for Assignment. The total marks secured by the student in each midterm examination are evaluated for 25 marks.	75	100

IV. EVALUATION SCHEME:

S. No.	Component	Duration	Marks
1	I Mid Examination	1 hour and 20 min	20
2	I Assignment		5
		TOTAL	**25**
3	II Mid Examination	1 hour and 20 min	20
4	II Assignment		5
		TOTAL	**25**
MID Examination marks to be considered as average of above 2 MID's TOTAL			
5	EXTERNAL Examination	3 hours	75
		GRAND TOTAL	**100**

V. COURSE OBJECTIVES:

The objectives of the course are to enable the student to;

I. Understand vapour compression, vapour absorption and air refrigeration systems.
II. Familiarize the components of refrigeration systems.
III. Analyze the refrigeration cycles and methods for improving the performance using standard data hand book with p-h chart.
IV. Identify various psychometric properties and processes.
V. Design air conditioning systems using cooling load calculations.

VI. COURSE OUTCOMES:

On successful completion of the course, the student will be able to;

1. Analyze the Carnot refrigeration.
2. Understand the practical and actual vapour compression cycles.
3. Explain the working of expansion devices.
4. Describe the performance of evaporators.
5. Formulate the COP of vapour absorption systems.
6. Analyze the Bell-Coleman cycle for air refrigeration systems.
7. Illustrate various psychometric processes
8. Evaluate cooling load calculations.
9. Design a component to meet desired need of refrigeration.
10. Demonstrate various heat pump circuits.

VII. HOW COURSE 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.	H	Assignments, Tutorials
PO2	**Problem analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	H	Assignments, Mid Examinations
PO3	**Design/development of solutions**: Competence to design a system, compone nt or process to meet societal needs within realistic constraints.	S	Mini Projects

PO4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	S	Projects
PO5	**Modern tool usage**: An ability to formulate, solve complex engineering problems using modern engineering and Information Technology tools.	S	Mini Projects
PO6	**The engineer and society**: To utilize the Engineering practices, Techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	H	Assignment
PO7	**Environment and sustainability**: To understand impact of Engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	N	--
PO8	**Ethics**: An understanding and Implementation of professional and Ethical responsibilities.	H	Guest Lecture
PO9	**Individual and teamwork**: To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.	N	--
PO10	**Communication**: An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society.	S	Mini Project
PO11	**Project management and finance**: An ability to provide leadership in mana ging complex engineering projects at Multidisciplinary environment and to become a professional engineer.	N	--
PO12	**Life-long learning**: Recognition of the need and an ability to engage in life-long learning to keep abreast with technological changes.	S	Guest Lecture

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** To produce engineering professional capable of synt hesizing and analyzing mechanical systems including allied engineering streams.	H	Lectures, Assignments
PSO2	**Design/Analysis:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	H	Projects
PSO3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrat.	S	Guest Lectures

IX. SYLLABUS:

REFRIGERATION AND AIR CONDITIONING

UNIT – I

Introduction to Refrigeration: Basic concepts - unit of refrigeration and COP- refrigerators – heat pump – Carnot refrigerator – applications of refrigerators – Vapour Compression refrigation - ideal cycle – effect of sub cooling of liquid – super heating of vapour – deviations of practical (actual cycle) from ideal cycle – construction and use of P-H chart problems.

UNIT – II

COMPONENTS:

Compressors- Classification- Working-Advantages and Disadvantages.

Condensers- Classification- Working Principles
Evaporators:-Classification – Working Principles
Expansion devices - Types – Working Principles.

UNIT-III

VAPOUR ABSORPTION REFRIGERATION: Description and working of NH3-Water, Li Br –water System – Calculation of HCOP, . Principle and operation of three fluid vapour absorption refrigeration system.

Air Refrigeration: Bell-Coleman cycle - open and dense air system- ideal and actual refrigeration-applications-steam jet refrigeration system - working principle – basic operation.

UNIT – IV

INTRODUCTION TO AIR CONDITIONING:

Psychometric Properties & 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.

X. LIST OF TEXT BOOKS / REFERENCES / WEBSITES / JOURNALS / OTHERS

TEXT BOOKS:

T1. A textbook of Refrigeration and Air Conditioning by R.S. Khurmi & J.K. Gupta / S Chand Publications
T2. A course in Refrigeration and Air Conditioning/ S.C. Arora & Domkundwar. S /Dhanpatrai Publications

REFERENCES:

R1. Refrigeration and Air Conditioning/C.P. Arora/TMH
R2. Basic Refrigeration and Air Conditioning/Ananthanarayanan/TMH
R3. Refrigeration and Air Conditioning/Manohar Prasad/New Age
R4. Principles of Refrigeration/Roy J. Dossat/Pearson Education Asia
R5. Refrigeration and Air Conditioning/ P. L. Ballaney.

XI. 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
UNIT – I: INTRODUCTION TO REFRIGERATION			
1	**Introduction** to refrigeration and air conditioning.	Introduction to Refrigeration:	T2
2	**Review** of thermodynamics & **Define** TR	Basic concepts - unit of refrigeration	T1, T2
3-4	**Derive** COP of HP, R & HE	COP- refrigerators – heat pump	T1
5-6	**Describe** the working of Carnot refrigerator and its appications	Carnot refrigerator – applications of refrigerators.	T1, T2

7	**Describe** the working of VCR cycle	Vapor Compression refrigeration - ideal cycle	T1
8-9	**Discuss** the effect of sub cooling	Effect of sub cooling of liquid	T2
10-11	**Discuss** the effect of superheating	Super heating of vapor	T1, T2
12	**Analyze** the Deviations of cycles	Deviations of practical (actual cycle) from ideal cycle.	T1
13	**Construction** of PH chart & Solve the problems.	Construction and use of P-H chart problems.	T1, T2
14	**Discuss** the influence of various parameters on system performance.	Cycle analysis, actual cycle Influence of various parameters on system performance	T2
UNIT-II: COMPONENTS OF REFRIGERATOR			
15	**Introduction** refrigerator components	COMPONENTS OF REFRIGERATOR: Compressors classification	T1, T2
16-17	**Classifying and Demonstration** of compressors	Working of compressors	T1
18	**Discuss** the merits and demerits of compressors.	Advantages and Disadvantages.	T1
19	**Classifying** condensers	Condensers- Classification	T1, T2
20-21	**Demonstration** of working of condensers	Working Principles of condensers.	T1
22	**Classifying** evaporators	Evaporators- Classification	T1
23	**Demonstration** of working of evaporators	Working Principles of evaporators	T2
24	**Classifying** expansion devices.	Expansion devices- Types	T1, T2
25-26	**Demonstration** of working of expansion devices.	Working Principles of expansion devices	T1, T2
UNIT – III: VAPOUR ABSORPTION & AIR REFRIGERATION			
27	**Introduction** to VARS and Demonstration of Aqua-Ammonia VARS.	**VAPOUR ABSORPTION REFRIGERATION:** Description and working of NH3-Water	T2, T1
28	**Demonstration** of Li-Br VARS	Li Br –water System	T2, T1
29	**Calculate** COP of VARS	Calculation of HCOP	T1, T2
30	**Explanation** of principle **& Demonstration** of Electrolux	Principle and operation of three fluid vapour absorption refrigeration system.	T2, T1
31	**Introduction** to air refrigeration	**Air Refrigeration:** Bell-Coleman cycle	T1, T2
32	**Discuss** the refrigeration cycles and its applications	open and dense air system- ideal and actual refrigeration-applications	T2, T1
33-34	**Demonstration** of SJRS	Steam jet refrigeration system - working principle – basic operation.	T1, T2
UNIT – IV: INTRODUCTION TO AIR CONDITIONING:			
35-40	**Explain** various properties of air	Psychometric Properties & Processes	T1, T2

41-42	**Calculate** heat loads	Sensible and latent heat loads-Characterization	T1, T2
43	**Describe** the importance of ventilation and infiltration.	Need for Ventilation, Consideration of Infiltration	T1, T2
44-50	**Draw and Calculate** Various sensible heat factors	Load concepts of RSHF, ASHF, ESHF and ADP.	T2, T1
51	**Discuss** the human comfort parameters	Concept of human comfort and effective temperature	T2
52-54	**Draw & Describe** comfort and industrial air conditioning	Comfort air conditioning- industrial air conditioning and Requirements	T2
55-60	**Calculate** the air conditioning loads.	Air Conditioning load calculations	T2, T1
UNIT – V: AIR CONDITIONING SYSTEMS:			
61-62	**Classify** the equipment of air conditioning	Classification of equipment, cooling, heating humidification and dehumidification	T2, T1
63-64	**Describe** the importance of filters, grills, registers & **Explain** the working of fans and blowers.	Filters, grills and registers, deodorants, fans and blowers.	T2, T1
65-66	**Discuss** the various heat pump sources.	Heat Pump – Heat sources	T2, T1
67-69	**Draw** heat pump circuits and **Discuss** their applications.	Different heat pump circuits - Applications	T2, T1

XII. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	H		S							H			S		
II		H												H	
III					H				S				H		
IV		H	S										S		
V			S						S					S	

S – Supportive **H - Highly Related**

XIII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	PSO 2	PSO 3
1		H			H					S			S		
2	H		S		H					H				H	
3	H	H	S			S	H						H		
4			S							S					S
5		H			H	S		H		S				S	

6	H			H					S			S		S	
7		S							H				H		S
8	H	S			S							H			
9		S							S			S		H	
10	H			H	S				S				S		

S – Supportive **H - Highly Related**

Prepared by: **Dr. CH V K N S N Moorthy, Professor**
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