INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**REFRIGERATION AND AIR CONDITIONING**				
Course Code	AME017				
Program	B. Tech				
Semester	SEVEN				
Course Type	CORE				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Course Coordinator	Mr. A Somaiah, Assistant Professor				

I. COURSEOVERVIEW:

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 aircraft refrigeration, vapour compression, vapor absorption and steam jet refrigeration systems, also describes some unconventional refrigeration systems; thermoelectric refrigeration, Hilsch tube, etc.. The course introduces the psychrometry, cooling load calculations, thermodynamics of human body, industrial and comfort air conditioning, equipment required for air conditioning systems and heat pump circuits.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B. Tech	AME003	IV	Thermodynamics
B. Tech	AME013	V	Thermal Engineering

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Refrigeration and Air Conditioning	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✗	Chalk & Talk	✓	Assignments	✗	MOOCs
✓	Open Ended Experiments	✓	Seminars	✗	Mini Project	✓	Videos
✗	Others:						

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 expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE.

Percentage of Cognitive Level	Blooms Taxonomy Level
10 %	Remember
50 %	Understand
25 %	Apply
15 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 2: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	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 20 marks of 2 hours duration consisting of five descriptive type questions out of which four 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 - Online Examination:

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT):

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours / classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3.

Table 3: Assessment pattern for AAT

5 Minutes Video	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30%	10%	10%

VI. COURSE OBJECTIVES:

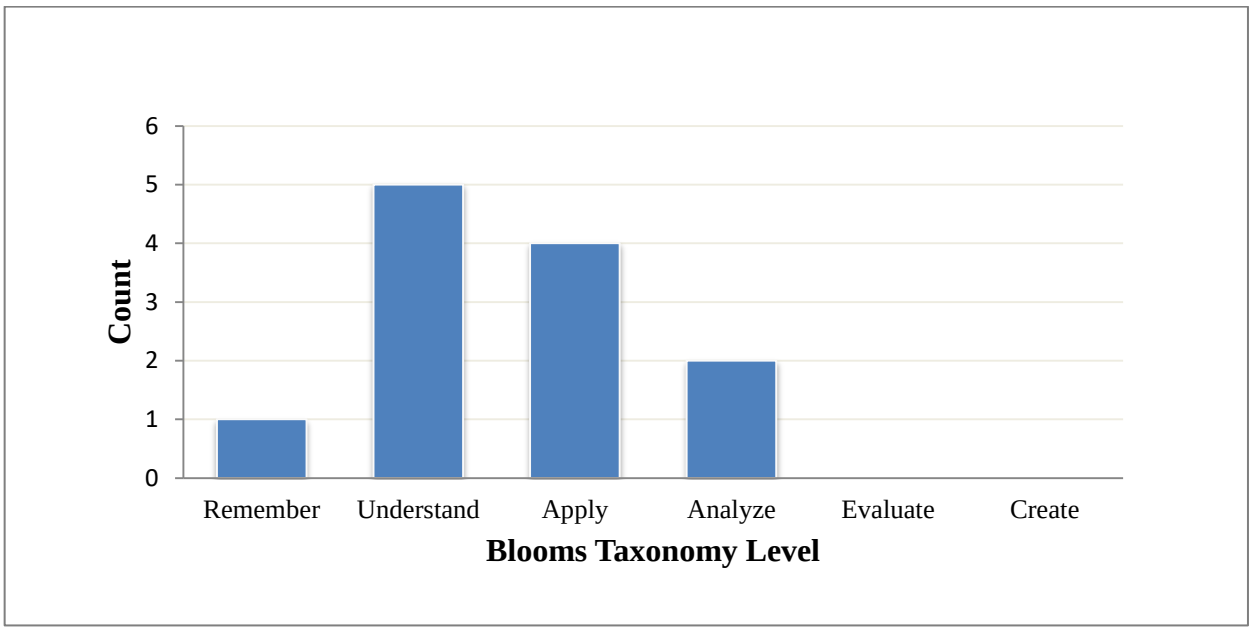
The students will try to learn:	
I	The principles of thermodynamics in refrigeration and air conditioning, analyze the methods of refrigeration, recognize the necessity and ideal cycle of refrigeration.
II	The nomenclature of refrigerants, realize the desirable properties of refrigerants to probe their ozone depleting and global warming potential.
III	The working principles, limitations, maintenance of refrigeration and air conditioning equipment and study their impact on the performance of the system.
IV	The psychrometric relations, processes, utilize their principles to resolve cooling load calculations and design of air conditioning systems.

VII. COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
Course Outcomes		Knowledge Level (Bloom's Taxonomy)
CO 1	**Relate** the performance of a vapour compression refrigeration cycles under specified inlet and outlet conditions.	Remember
CO 2	**Identify** the modifications required in an impossible reversed Carnot cycle to convert it into practical cycle for refrigeration applications.	Understand

CO 3	**Demonstrate** the working principle and coefficient of performance of a heat pump, heat engine and refrigerator.	Understand
CO 4	**Illustrate** the working principles, limitations of practical aqua ammonia, Li Br-Water and Electrolux vapour absorption refrigeration systems.	Apply
CO 5	**Analyze** theoritical, practical aircraft refrigeration and steam jet refrigeration cycles with T-S diagrams, by stating merits, limitations, etc.	Analyze
CO 6	**Discuss** the measures to protect the ozone layer through global control, eventually elimination of production and utilization of ozone depleting substances.	Understand
CO 7	**Classify** the equipment used for the refrigeration, air conditioning purposes with suitable materials and refrigerant pairs.	Understand
CO 8	**Construct** the sensible heat factor lines, locate alignment circle and SHF scale on a psychrometric chart for the cooling load calculations of air conditioning systems.	Apply
CO 9	**Explain** thermal comfort conditions with respect to effective temperature, relative humidity, etc. and their impact on human comfort, productivity and health.	Apply
CO 10	**Distinguish** the equipment required for air conditioning systems, study the operating principles, safety controls employed in air conditioning systems.	Analyze
CO 11	**Apply** the principles of psychrometry to calculate and design the air conditioning systems for particular purpose.	Apply
CO 12	**Compare** the various heat pump circuits for heating, cooling purposes with suitable industrial applications.	Understand

COURSE KNOWLEDGE COMPETENCY LEVELS



VIII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and	3	CIE / Quiz / AAT

Program Outcomes		Strength	Proficiency Assessed by
	an engineering specialization to the solution of complex engineering 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	CIE / Quiz / AAT
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.	2	CIE / Quiz / AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

IX. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency assessed by
PSO 1	Formulate and evaluate engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing.	2	Research papers/ Group discussion/ Short term courses

3 = High; 2 = Medium; 1 = Low

X. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	√	-	√	-	-	-	-	-	-	-	-	-	-	-
CO 3	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	√	-	-	-	-	-	-	-	-
CO 7	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 9	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-

CO 10	√		-	-	-	-	-	-	-	-	-	-	-	-	-
CO 11	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 12	-	√	-	√	-	-	-	-	-	-	-	-	√	-	-

XI. JUSTIFICATIONS FOR CO-PO/PSO MAPPING - DIRECT:

Course Outcomes	POs / PSOs	Justificationfor mapping (Students will be able to)	No. of key competencies
CO 1	**PO 1**	**Understand** the principle of vapour compression refrigeration system and the working of principal components of a mechanical refrigeration system, in order to **mathematically relate the performance of** various vapour compression cycles.	**2**
	PO 2	**Define** the type of vapour compression cycle, **identify** various processes involved in the cycle, then **formulate** it for the determination of COP and interpret the results for the **improvement** of the system performance.	**5**
CO 2	**PO 2**	**Analyse the reversed Carnot cycle** to understand its practical impossibilities and **identify modifications** required to make it practical to **apply in refrigeration purposes.**	**5**
	PO 4	**Identify** the modifications required in an actual reversed Carnot cycle, **analyse and interpret** the data to convert it into practical cycle for refrigeration applications.	**5**
CO 3	**PO 1**	**Apply the knowledge of science**, engineering fundamentals to demonstrate the working principles and **determination of COP** of the heat pump, heat engine and refrigerator.	**2**
CO 4	**PO 1**	**Recall the principles** of thermodynamics, vapor absorption refrigeration to **illustrate ammonia-water and lithium bromide two shell and four shell – water** absorption and Electrolux refrigeration systems.	**1**
CO 5	**PO 1**	**Explain the principle** of steam jet refrigeration system, **analyse** theoritical, practical steam jet refrigeration cycles with T-S diagrams and **state** the limitations.	**2**
	PO 2	**Illustrate** the working of a steam jet refrigeration system, **formulate and analyse** theoritical and practical steam jet refrigeration cycles with T-S and P-h charts and **interpret**, stating merits, limitations, etc.	**6**
CO 6	**PO 7**	**Understand the impact of ozone** depleting substances like chlorine, fluorine, etc. in societal and environmental contexts, and **demonstrate the knowledge** of, and need for sustainable development.	**2**
CO 7	**PO 1**	**Classify the equipment** used for the refrigeration and air conditioning purposes and **relate** the performance, limitations of compressors, condensers, expansion devices and evaporators.	**2**
CO 8	**PO 1**	**Construct the sensible heat factor lines,** locate alignment circle, SHF scale on a psychrometric chart for the cooling load calculations of air conditioning systems by **applying** knowledge of science and engineering fundamentals.	**3**

	PO 2	**Identify,** the various psychrometric processes by plotting a skeleton psychrometric chart and **solve** the problems related to cooling load of air conditioning systems.	**5**
	PSO 1	**Understand** thermodynamics of a human body and environmental indices to **design** refrigeration and air conditioning systems for residential and public buildings, industrial applications, etc.	**1**
CO 9	**PO 1**	**Determine the** thermal comfort conditions with respect to effective temperature, relative humidity, etc**. and their impact on human comfort, productivity and health.**	**2**
	PO 2	**Identify and analyse human thermodynamic comfort conditions** like effective temperature, relative humidity, etc., **state** the influence on health and productivity.	**5**
CO 10	**PO 1**	**Distinguish** the equipment required for air conditioning systems, study the operating principles and safety controls employed in air conditioning systems.	**2**
CO 11	**PO 1**	**Assess** the principles of psychrometry to **calculate** and design the air conditioning systems for a particular purpose.	**2**
	PO 2	**Formulate and analyse the principles of psychrometry** to **construct** grand sensible heat factor, effective room sensible heat factor lines and **design** the air conditioning systems for particular purpose.	**5**
	PSO 1	**Understand, analyse and design to** calculate and design the air conditioning systems for residential and public buildings, **industrial applications and for any particular purpose.**	**2**
CO 12	**PO 2**	**Identify** various heat pump circuits for heating, cooling purposes and **analyse** them stating suitable domestic and industrial applications.	**4**
	PO 4	**Understand** the difference between heat pump, heat engine and refrigerator, **analyse and interpret** the data in design of heat pump circuits for different purposes.	**5**
	PSO 1	**Analyse** the air to air, air to liquid, liquid to liquid design and **construct** the heat pump circuits for residential and public buildings, industrial applications, etc.	**1**

XII. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING

Course Outcomes	**Program Outcomes / No. of Key Competencies Matched**												**PSOs/ No. of key competencies**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**2**	**2**
CO 1	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	5	-	5	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-

CO 6	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO 7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	3	5	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 9	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 11	2	5	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 12	-	4	-	5	-	-	-	-	-	-	-	-	1	-	-

XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

Course Outcomes	**Program Outcomes / No. of key competencies**												**PSOs/ No. of key competencies**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**2**	**2**
CO 1	66.7	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 2	0.0	50.0	0.0	45.45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 3	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 4	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 5	66.7	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 6	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 7	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 8	100	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 9	66.7	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 10	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 11	66.7	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
CO 12	0.0	40.0	0.0	45.45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0

XIV. COURSE ARTICULATION MATRIX - PO/PSO MAPPING:

COs and POs & COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 – **0**≤ ***C***≤ 5% – No correlation;
1 – 5 <***C***≤ 40% – Low/ Slight;
2 − 40 % <***C***< 60% – Moderate.
3 – 60% ≤ ***C***< 100% – Substantial /High

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 7	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 9	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 11	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 12	-	2	-	2	-	-	-	-	-	-	-	-	2	-	-
TOTAL	25	15		4			3						7		
AVERAGE	**2.77**	**2.14**		**2.0**			**3.0**						**2.33**		

XV. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 4,PSO 1	SEE Exams	PO 1, PO 2, PO 4,PSO 1	Assignments	PO 2	Seminars	PO 4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4	5Minutes Video	PO 1, PO 2	Tech talk	PO 7	Open Ended Experiments	PO 1, PO 2

XVI. ASSESSMENT METHODOLOGIES - INDIRECT

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✗	Assessment of Mini Projects by Experts		

XVII. 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 NH_3-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. 3. S. N. Sapali, "Refrigeration and Air-conditioning", PHI Learning, 2nd Edition, 2011.	
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.	

XVIII. COURSE PLAN:

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

Lecture No.	Topics to be covered	Course Outcomes	Text (T) book / Reference (R) book
1	Introduction to refrigeration and air conditioning.	CO 2	T2:2.3
2	Review of thermodynamics and define TR	CO 2	R1:2.6
3	Derive COP of heat pump, refrigerator and heat engine.	CO 3	T1:2.6
4	Numerical problems on heat pump, refrigerator and heat engine.	CO 3	T1:2.7
5	Describe the working of Carnot refrigerator and its applications.	CO 2	T2:2.7 R1:2.18
6	Air refrigeration: Bell-Coleman cycle, open and dense air system	CO 3	T3:3.6.5

7	Ideal, actual refrigeration and applications.	CO 2	T3:3.6.7
8	Describe the working of vapor compression refrigeration cycle and ideal cycle of refrigeration.	CO 1	T2:2.22
9	Discuss the effect of sub cooling	CO 1	T2:2.2
10	Discuss the effect of superheating	CO 1	T2:2.26 R1:2.55
11	Numerical problems on sub cooling and super heating.	CO 1	T3:4.162
12	Construction and description of PH chart & Solve the problems.	CO 1	T3:4.162
13	Introduction to vapor absorption refrigeration.	CO 4	T1:4.8 R2:4.68
14	Description and working of NH_3-Water (actual and practical cycles).	CO 4	T1:4.8 R2:4.68
15	Illustrate Li Br–water system (two shell and four shell).	CO 4	T2:4.15 R1:5.74
16	Derivation for COP of a VARS and Numerical problems.	CO 4	T1:4.12 R2:5.75
17	Principle and operation of three fluid vapor absorption refrigeration systems.	CO 5	T1:4.8 R1:5.72
18	Introduction to steam jet refrigeration system and working principle.	CO 5	T3:2.3.5
19	Explain basic operation of SJRS.	CO 5	T3:2.3.5
20	Analysis of SJRS cycle and Numerical problems.	CO 5	T3:2.3.5
21	Introduction to refrigerants and discuss the properties of refrigerants.	CO 7	T3:5.4
22	Nomenclature and selection of refrigerants.	CO 7	T3:5.7
23	Discuss the effects of refrigerants on global warming.	CO 7	T3:5.13
24	Describe alternate refrigerants.	CO 7	T3:5.15
25	Introduction to compressors and classification.	CO 7	T2:3.14 R1:4.31
26-27	Working principles of compressors.	CO 7	T2:3.14 R1:4.31
28	Advantages and disadvantages of compressors.	CO 7	T2:3.14 R1:4.31
29	Classification and working principles of condensers.	CO 7	T2:3.18 R1:4.64
30	Advantages and disadvantages of condensers.	CO 7	T2:3.18 R1:4.64
31-32	Classification and working principles of expansion devices.	CO 7	T2:4.2
33	Advantages and disadvantages of expansion devices.	CO 7	T2:4.3 R1:4.71
34-35	Classification and working principles of evaporators.	CO 7	T2:3.28 R1:4.67
36	Advantages and disadvantages of evaporators.	CO 7	T2:3.28 R1:4.67
37-38	Describe psychometric properties.	CO 11	T3:8.2

39-40	Explain psychometric processes and solve numerical problems.	CO 11	T2:5.19 R1:6.81
41	Describe sensible, latent heat loads and characterization.	CO 11	T1:6.4 R2:6.8
42	Discuss need for ventilation and consideration of infiltration.	CO 11	T2:7.7 R1:7.74
43-44	Load concepts of RSHF, GSHF and ESHF, ADP and solve numerical problems.	CO 8	T3:9.18
45	Concept of human comfort and effective temperature.	CO 9	T3:9.4
46	Describe summer, winter and year round air conditioning systems.	CO 11	T3:9.19
47	Comfort air conditioning, industrial air conditioning and requirements,	CO 11	T1:8.8 R1:8.73
48	Air conditioning load calculations.	CO 8	T1:9.14 R1:10.78
49	Classification of equipment required for air conditioning.	CO 10	T2:9.19 R1:10.814
50-51	Equipment required for cooling, heating, humidification and dehumidification	CO 10	T2:9.19 R1:10.814
52	Describe various types of filters used in A.C systems.	CO 10	T1:10.4 R2:11.68
53	Discuss the functions of grills, registers and deodorants.	CO 10	T1:10.4 R2:11.68
54-55	Demonstrate various types of fans and blowers.	CO 10	T1:10.4 R2:11.68
56	Introduction and working of a heat pump.	CO 12	T2:10.7 R1:12.74
57	Discuss various types of heat sources required for heat pumps.	CO 12	T2:10.7 R1:12.74
58-59	Demonstrate different heat pump circuits.	CO 12	T1:11.12 R2:12.75
60	Discuss applications of heat pump circuits.	CO 12	T1:11.12 R2:12.75

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