Sana'a University
Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

53. Course Specification of Refrigeration and Air Conditioning

I. Course Identification and General Information:						
1.	Course Title:	Refrigeration and Air Conditioning.				
2.	Course Code & Number:	ME356.				
3.	Credit Hours:	C.H				Total Cr. Hrs.
		Th.	Seminar/Tu.	Pr	Tr.	
		2	2	2	-	4
4.	Study level/ semester at which this course is offered:	Fourth Year- Second Semester.				
5.	Pre –requisite (if any):	ME251 (Thermodynamics -I), ME252 (Thermodynamics – II), ME354 (Heat and Mass Transfer) and ME353 (Thermal / Fluid Lab.).				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	Location of teaching the course:	Mechanical Engineering Department.				
10.	Prepared By:	Asst. Prof. Dr. Eng. Hamoud A. Al-Nehari..				
11.	Date of Approval:					

II. Course Description:

The course is designed to give fundamentals knowledge of types of refrigeration, refrigeration cycles, refrigerants and behavior under various conditions, different air conditioning terms and load calculation, designing of components of air distribution system.

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	III. Alignments of the Course Intended learning outcomes (CILOs)	Referenced PILOs
a1	Depict fundamental principles of refrigeration and air conditioning systems.	A1
a2	Describe various refrigeration cycles.	A4
b1	Create Air Conditioning system using cooling load calculations.	B1
b2	Analyze problems; conclude software solutions associated with refrigeration and air conditioning.	
c1	Implement calculations of psychometric properties, processes, heating and cooling load requirements.	C1
c2	Perform various important components of the refrigeration and air conditioning systems.	
c3	Prescribe RAC systems for physical systems and predict their performance.	C2
c4	Conduct investigation on complex problems of RAC systems.	
d1	Cooperate in work successfully as a part of a team through training on simulation software and presentations.	D1
d2	Review results and defend his ideas.	D5

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
a1- Depict fundamental principles of refrigeration and air conditioning systems.	• Lectures. • Tutorials. • Interactive Class Discussion.	• Written Tests and Quizzes. • Homework and Assignments.
a2- Describe various refrigeration cycles.		

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
b1- Create Air Conditioning system using cooling load calculations.	• Lectures.	

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b2- Analyze problems, conclude software solutions associated with refrigeration and air conditioning.	• Tutorials. • Interactive Class Discussion.	• Written Tests and Quizzes. • Homework and Assignments.

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
c1- Implement calculations of psychometric properties, processes, heating and cooling load requirements.	• Lectures. • Exercise and Homework. • Laboratory Projects. • Simulation Tools.	• Written Tests and Quizzes. • Laboratory Reports Evaluation. • Presentations Evaluation. • Project Reports.
c2- Perform various important components of the refrigeration and air conditioning systems.		
c3- Prescribe RAC systems for physical systems and predict their performance.		
c4- Conduct investigation on complex problems of RAC systems.		

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
d1- Cooperate in work successfully as a part of a team through training on simulation software and presentations.	• Lectures. • Tutorials. • Simulations using Computer Software.	• Written Tests and Quizzes. • Homework and Assignments.
d2- Review results and defend his ideas.		

IV. Course Content:

A – Theoretical Aspect: Lectures

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction, Refrigerants and their characteristics	a1, a2, b1, b2	Brief history, need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems. Classification, nomenclature, desirable properties, secondary refrigerants, future industrial refrigerants	1	2
2.	Air Refrigeration.	a1, a2, b1, b2, c1, d1, d2	Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of Simple; Bootstrap; Reduced ambient and Regenerative air refrigeration systems	2	4

3.	Vapor Compression system & Compound Compression System.	a1, a2, b1, b2, c1, d1, d2	Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle Compound compression with intercooler, flash gas removal and flash intercooler, multiple evaporators with back pressure valves and with multiple expansion valves without flash inter cooling, analysis of two evaporators with flash intercooler and individual expansion valve and multiple expansion valve, cascade refrigeration system	2	4
4.	Absorption Refrigeration System.	a1, a2, b1, b2, c1, d1, d2	Desirable characteristics of refrigerant, selection of pair, practical H2O -NH3 cycle, LiBr – H2O system and its working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer, throttling, Electrolux refrigeration system.	1	2
5.	Refrigeration System Components.	a1, a2, b1, b2, c1, d1, d2	Types; construction; working; comparison and selection of compressors; condensers; expansion devices; and evaporators, refrigeration piping accessories, evacuation and charging of refrigerant,	1	2

			properties and classification of thermal insulation.		
6.	Mid-Term Exam.	a1, a2, b1, b2, c1, c2, c3,	The First 5 Chapters.	1	2
7.	Psychrometry.	a1, a2, b1, b2, c1, d1, d2	Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychrometric chart, psychrometric processes.	1	2
8.	Human Comfort.	a1, a2, b1, b2, c1, d1, d2	Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions	1	2
9.	Load Analysis.	a1, a2, b1, b2, c1, d1, d2	Site survey, outdoor and indoor design conditions, classification of loads, flywheel effect of building material and its use in design, effect of wall construction on cooling load, instantaneous heat gain (IHG) and instantaneous cooling load (ICL) heat transmission through sunlit and shaded glass using tables, method of reduction of solar heat gain through glass, calculations of cooling load TETD due to sunlit and shaded roof and walls using tables, ventilation and air infiltration, load due to	2	4

			outside air, heat gain from occupants; electric lights; product; electric motor and appliances, load calculations for automobiles, use of load estimation sheet, introduction of CLTD method		
10.	Air-Conditioning Systems.	a1, a2, b1, b2, c1, d1, d2	Classification, system components, all air; all water; and air-water systems, room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems	2	4
11.	Controls and Applications.	a1, a2, b1, b2, c1, d1, d2	Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation, Freeze Drying, A/c in textile, printing pharmaceutical industry and Hospitals, Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning	1	2
12.	Final Exam	a1, a2, b1, b2, c1, c2, c3,	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B: Tutorial Aspects

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Order	Units/Topics List	Number of Weeks	Contact Hours	Learning Outcomes
1.	Introduction, Refrigerants and their Characteristics.	1	2	a1, a2, b1, b2
2.	Air Refrigeration.	2	4	a1, a2, b1, b2, c1, d1, d2
3.	Vapor Compression System & Compound Compression System.	2	4	a1, a2, b1, b2, c1, d1, d2
4.	Absorption Refrigeration System.	1	2	a1, a2, b1, b2, c1, d1, d2
5.	Refrigeration System Components.	1	2	a1, a2, b1, b2, c1, d1, d2
6.	Psychrometry.	1	2	a1, a2, b1, b2, c1, d1, d2
7.	Human Comfort.	1	2	a1, a2,b1, b2, c1, d1, d2
8.	Load Analysis.	2	4	a1, a2, b1, b2, c1, d1, d2
9.	Air-Conditioning Systems.	2	4	a1, a2, b1, b2, c1, d1, d2
10.	Controls and Applications.	1	2	a1, a2, b1, b2, c1, d1, d2
Total number of weeks and hours		**14**	**28**	

C - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes
1.	Introduction	1	2	a1, a2, b1, b2
2.	Experiment on Components of VCR System and to Determine its COP.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2

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3.	Experiment on Electrolux Refrigerator and to Determine its COP.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
4.	Experiment on Working of Reciprocating, Rotary and Centrifugal Compressor used for R&AC.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
5.	Experiment on Different Psychrometric Processes and Analyze the Same using Psychrometric Chart.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
6.	Experiment on Construction and Working of Window Air-Conditioner/ Split Air-Conditioner and to Determine its Capacity.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
7.	Experiment on COP and Apparatus Dew point of an Air Conditioning Test Rig.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
8.	Calculate Cooling Load of a Confined Space-Using Table and Compare the Same with Load Estimation Sheet.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
9.	Study of Domestic Refrigerator and to Determine % Running Time at Different Thermostat Settings.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
10.	Experiment on (COP)C and (COP)H of Heat Pump.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
11.	Experiment on Saturation Efficiency of Air Cooler/Air Washer.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
12.	Study of Packaged Plant.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2

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13.	To Understand Various Tools used for Refrigeration Tubing to Perform Various Operations Like Flaring, Swaging, Bending, Brazing etc.	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
14.	Review	1	2	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching Strategies of the Course:

1. Lectures.
2. Tutorials.
3. Exercise and Homework.
4. Laboratory Projects.
5. Simulation Tools.

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	**Assignment** 1: Introduction, Refrigerants and their Characteristics.	a1, a2, b1, b2, c1, c2, d1, d2	1st	1
2.	**Assignment** 2: Air Refrigeration.	a1, a2, b1, b2, c1, c2, d1, d2	3rd	1
3.	**Assignment** 3: Vapor Compression System & Compound Compression System.	a1, a2, b1, b2, c1, c2, d1, d2	5th	1
4.	**Assignment** 4: Absorption Refrigeration System.	a1, a2, b1, b2, c1, c2, d1, d2	6th	1
5.	**Assignment** 5: Refrigeration System Components.	a1, a2, b1, b2, c1, c2, d1, d2	7th	1
6.	**Assignment** 6: Psychrometry.	a1, a2, b1, b2, c1, c2, d1, d2	8th	1
7.	**Assignment** 7: Human Comfort.	a1, a2, b1, b2, c1, c2, d1, d2	9th	1
8.	**Assignment** 8: Load Analysis.	a1, a2, b1, b2, c1, c2, d1, d2	11th	1
9.	**Assignment** 9: Air-Conditioning Systems.	a1, a2, b1, b2, c1, c2, d1, d2	13th	1
10.	**Assignment** 10: Controls and Applications.	a1, a2, b1, b2, c1, c2, d1, d2	14th	1
Total				**10**

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Assignment	Weekly	10	5 %	a1, a2, b1, b2, c1, d1, d2

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2.	Project (Single /Group).	13	10	5 %	a1, a2, b1, b2, c1, d1, d2
3.	Quiz 1.	7	10	5 %	a1, a2, b1, b2, c1, d1, d2
4.	Quiz 2.	12	10	5 %	a1, a2, b1, b2, c1, d1, d2
5.	Mid-Term Exam.	8	20	10 %	a1, a2, b1, b2, c1, c2, c3,
6.	Practical.	13-14	40	20 %	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
7.	Final Exam (Theoretical).	16	100	50 %	a1, a2, b1, b2,c1, c2, c3,
	Total		**200**	**100 %**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. C. P. Arora, 2000, "Refrigeration and Air Conditioning", McGraw-Hill.
2. Stoecker, W. F.; Jones, J. W. "Refrigeration and Air Conditioning", Published by McGraw-Hill.

2- Essential References.

1- Ramesh Arora, 2010, "Refrigeration and Air-Conditioning".
2- ASHRAE Refrigeration Handbook.
3- Prof. P.L. Ballaney, "Refrigeration and Air Conditioning" .

3- Electronic Materials and Web Sites *etc*.

1. http://www.springer.com/engineering/mechanical+engineering/journal/231
2. http://nptel.iitm.ac.in/courses/Webcourse-contents/IISc
3. http://www.faculty.virginia.edu/ribando/modules/

I. Course Policies:

1	**Class Attendance:**

	- The student should be attending not less than 75% of total contact hours of the subject, otherwise he will not able to take exam and be considerd as an exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic.
2	**Tardy:** - For lateness in attending the class, the student will be initially notified. If he repeates late in attending class he will be considered absent.
3	**Exam Attendance/Punctuality:** - The student should attend the exam on time. He is permitted to attend the exam half one hour from exam beginning, after that he/she will not be permitted to take exam and he/she is considered absent in the exam.
4	**Assignments & Projects:** - In general one assignment is given after each chapter of a course. The student should submit the assignment on time, mostly one week after giving the assignment
5	**Cheating**: - For cheating in exam, the student is considered as failure. In case the cheating is repeated three times during study the student will be disengaged from the Faculty
6	**Plagiarism**: Plagiarism is the attending of the student the exam of a course instead of other student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Affair Council of the university.
7	**Other policies:** - The mobile phone is not allowable to be used during class lecture. It must be switched off, otherwise the student will be ordered to leave the lecture room. - The mobile phone is not allowed to be taken during the examination time. - Lecture notes and assignments may be given directly to students using soft or hard copy.

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Assoc. Prof. Dr. Abdul-Malik Momin**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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53. Template for Course Plan of Refrigeration and Air Conditioning

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Asst. Prof. Dr. Eng. Hamoud A. Al-Nehari	**Office Hours**					
Location& Telephone No.		**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	h_nahary@hotmail.com						

II. Course Identification and General Information:

1.	Course Title:	Refrigeration and Air Conditioning.				
2.	Course Number & Code:	ME356.				
3.	Credit Hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar/Tu.	Pr	Tr.	
		2	2	2	-	4
4.	Study level/year at which this course is offered:	Fourth Year- Second Semester.				
5.	Pre –requisite (if any):	ME251 (Thermodynamics -I), ME252 (Thermodynamics – II), ME354 (Heat and Mass Transfer) and ME353 (Thermal / Fluid Lab.).				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	System of Study:	Semesters.				
10.	Mode of Delivery:	Lectures, Tutorials and Practical.				
11.	Location of teaching the course:	Mechanical Engineering Department.				

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III. Course Description:

The course is designed to give fundamentals knowledge of types of refrigeration, refrigeration cycles, refrigerants and behavior under various conditions, different air conditioning terms and load calculation, designing of components of air distribution system.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Demonstrate fundamental principles of refrigeration and air conditioning systems.
2. Understand various refrigeration cycles.
3. Design Air Conditioning system using cooling load calculations.
4. Analyze problems; conclude software solutions associated with refrigeration and air conditioning.
5. Make calculations of psychometric properties, processes, heating and cooling load requirements.
6. Identify and locate various important components of the refrigeration and air conditioning systems.
7. Design RAC systems for physical systems and predict their performance.
8. Conduct investigation on complex problems of RAC systems.
9. Cooperate in work successfully as a part of a team through training on simulation software and presentations.
10. Discuss results and defend his ideas.

V. Course Content:

A – Theoretical Aspect: Lectures

Order	Units/Topics List	Sub Topics List	Week Due	Contact Hours
1.	Introduction, Refrigerants and their characteristics	Brief history, need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems.	1st	2

		Classification, nomenclature, desirable properties, secondary refrigerants, future industrial refrigerants		
2.	Air Refrigeration .	Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of Simple; Bootstrap; Reduced ambient and Regenerative air refrigeration systems	2nd, 3rd	4
3.	Vapor Compression system & Compound Compression System.	Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle Compound compression with intercooler, flash gas removal and flash intercooler, multiple evaporators with back pressure valves and with multiple expansion valves without flash inter cooling, analysis of two evaporators with flash intercooler and individual expansion valve and multiple expansion valve, cascade refrigeration system	4th, 5th	4
4.	Absorption Refrigeration System.	Desirable characteristics of refrigerant, selection of pair, practical H2O -NH3 cycle, LiBr – H2O system and its working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer, throttling, Electrolux refrigeration system.	6 th	2
5.	Refrigeration System Components.	Types; construction; working; comparison and selection of compressors; condensers; expansion devices; and evaporators, refrigeration piping accessories, evacuation and charging of refrigerant, properties and classification of thermal insulation.	7 th	2
6.	Mid-Term Exam.	The First 5 Chapters.	8 th	2
7.	Psychrometry.	Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring	9th	2

		instruments, psychrometric chart, psychrometric processes.		
8.	Human Comfort.	Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions	10th	2
9.	Load Analysis.	Site survey, outdoor and indoor design conditions, classification of loads, flywheel effect of building material and its use in design, effect of wall construction on cooling load, instantaneous heat gain (IHG) and instantaneous cooling load (ICL) heat transmission through sunlit and shaded glass using tables, method of reduction of solar heat gain through glass, calculations of cooling load TETD due to sunlit and shaded roof and walls using tables, ventilation and air infiltration, load due to outside air, heat gain from occupants; electric lights; product; electric motor and appliances, load calculations for automobiles, use of load estimation sheet, introduction of CLTD method	11th, 12th	4
10.	Air-Conditioning Systems.	Classification, system components, all air; all water; and air-water systems, room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems	13 th, 14th	4
11.	Controls and Applications.	Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation, Freeze Drying, A/c in textile, printing pharmaceutical industry and	15 th	2

		Hospitals, Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning		
12.	Final Exam	All the Chapters.	16 th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B: Tutorial Aspects			
Order	**Units/Topics List**	**Week Due**	**Contact Hours**
1.	Introduction, Refrigerants and their Characteristics.	1st	2
2.	Air Refrigeration.	2nd, 3rd	4
3.	Vapor Compression System & Compound Compression System.	4th, 5th	4
4.	Absorption Refrigeration System.	6 th	2
5.	Refrigeration System Components.	7 th	2
6.	Psychrometry.	9 th	2
7.	Human Comfort.	10 th	2
8.	Load Analysis.	11 th, 12 th	4
9.	Air-Conditioning Systems.	13 th, 14 th	4
10.	Controls and Applications.	15 th	2
Total number of weeks and hours		**14**	**28**

C - Practical Aspect:			
Order	**Tasks/ Experiments**	**Week Due**	**Contact Hours**
1.	Introduction	1st	2
2.	Experiment on Components of VCR System and to Determine its COP.	2nd	2
3.	Experiment on Electrolux Refrigerator and to Determine its COP.	3rd	2
4.	Experiment on Working of Reciprocating, Rotary and Centrifugal Compressor used for R&AC.	4th	2
5.	Experiment on Different Psychrometric Processes and Analyze the Same using Psychrometric Chart.	5th	2
6.	Experiment on Construction and Working of Window Air-Conditioner/ Split Air-Conditioner and to Determine its Capacity.	6th	2
7.	Experiment on COP and Apparatus Dew point of an Air Conditioning Test Rig.	7th	2
8.	Calculate Cooling Load of a Confined Space-Using Table and Compare the Same with Load Estimation Sheet.	8th	2

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9.	Study of Domestic Refrigerator and to Determine % Running Time at Different Thermostat Settings.	9th	2
10.	Experiment on (COP)C and (COP)H of Heat Pump.	10th	2
11.	Experiment on Saturation Efficiency of Air Cooler/Air Washer.	11th	2
12.	Study of Packaged Plant.	12th	2
13.	To Understand Various Tools used for Refrigeration Tubing to Perform Various Operations Like Flaring, Swaging, Bending, Brazing etc.	13th	2
14.	Review	14th	2
Number of Weeks /and Units Per Semester		**14**	**28**

VI. Teaching Strategies of the Course:

1. Lectures.
2. Tutorials.
3. Exercise and Homework.
4. Laboratory Projects.
5. Simulation Tools.

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VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	**Assignment** 1: Introduction, Refrigerants and their Characteristics.	a1, a2, b1, b2, c1, c2, d1, d2	1st	1
2.	**Assignment** 2: Air Refrigeration.	a1, a2, b1, b2, c1, c2, d1, d2	3rd	1
3.	**Assignment** 3: Vapor Compression System & Compound Compression System.	a1, a2, b1, b2, c1, c2, d1, d2	5th	1
4.	**Assignment** 4: Absorption Refrigeration System.	a1, a2, b1, b2, c1, c2, d1, d2	6th	1
5.	**Assignment** 5: Refrigeration System Components.	a1, a2, b1, b2, c1, c2, d1, d2	7th	1
6.	**Assignment** 6: Psychrometry.	a1, a2, b1, b2, c1, c2, d1, d2	8th	1
7.	**Assignment** 7: Human Comfort.	a1, a2, b1, b2, c1, c2, d1, d2	9th	1
8.	**Assignment** 8: Load Analysis.	a1, a2, b1, b2, c1, c2, d1, d2	11th	1
9.	**Assignment** 9: Air-Conditioning Systems.	a1, a2, b1, b2, c1, c2, d1, d2	13th	1
10.	**Assignment** 10: Controls and Applications.	a1, a2, b1, b2, c1, c2, d1, d2	14th	1
Total				**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Exercises & Homework.	Weekly	10	5 %	a1, a2, b1, b2, c1, d1, d2
2.	Project (Single /Group).	13	10	5 %	a1, a2, b1, b2, c1, d1, d2
3.	Quiz 1.	7	10	5 %	a1, a2, b1, b2, c1, d1, d2

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4.	Quiz 2.	12	10	5 %	a1, a2, b1, b2, c1, d1, d2
5.	Mid-Term Exam.	8	20	10 %	a1, a2, b1, b2,c1, c2, c3,
6.	Practical.	13-14	40	20 %	a1, a2, b1, b2, c1, c2, c3,c4, d1, d2
7.	Final Exam (Theoretical).	16	100	50 %	a1, a2, b1, b2,c1, c2, c3,
	Total		**200**	**100 %**	

IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. C. P. Arora, 2000, "Refrigeration and Air Conditioning", McGraw-Hill.
2. Stoecker, W. F.; Jones, J. W. 1982, "Refrigeration and Air Conditioning", Published by McGraw-Hill.

2- Essential References.

1. Ramesh Arora, 2010, "Refrigeration and Air-Conditioning".
2. ASHRAE Refrigeration Handbook.
3. Prof. P.L. Ballaney, "Refrigeration and Air Conditioning" .

3- Electronic Materials and Web Sites *etc*.

1. http://www.springer.com/engineering/mechanical+engineering/journal/231
2. http://nptel.iitm.ac.in/courses/Webcourse-contents/IISc
3. http://www.faculty.virginia.edu/ribando/modules/

II. Course Policies:

1	**Class Attendance:** - The student should be attending not less than 75% of total contact hours of the subject, otherwise he will not able to take exam and be considerd as an exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic.
2	**Tardy:** - For lateness in attending the class, the student will be initially notified. If he repeates late in attending class he will be considered absent.
3	**Exam Attendance/Punctuality:**

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	- The student should attend the exam on time. He is permitted to attend the exam half one hour from exam beginning, after that he/she will not be permitted to take exam and he/she is considered absent in the exam.
4	**Assignments & Projects:** - In general one assignment is given after each chapter of a course. The student should submit the assignment on time, mostly one week after giving the assignment
5	**Cheating**: - For cheating in exam, the student is considered as failure. In case the cheating is repeated three times during study the student will be disengaged from the Faculty
6	**Plagiarism**: Plagiarism is the attending of the student the exam of a course instead of other student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Affair Council of the university.
7	**Other policies:** - The mobile phone is not allowable to be used during class lecture. It must be switched off, otherwise the student will be ordered to leave the lecture room. - The mobile phone is not allowed to be taken during the examination time. - Lecture notes and assignments may be given directly to students using soft or hard copy.

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