

Branch Name:	Mechanical Engineering
Program Code:	ET402
Course Title:	Refrigeration and Air-conditioning
Course Code:	2ET4020606
Pre-requisite Course:	-----

Course Objectives:

1. The course is designed to give fundamental knowledge of types of refrigeration, refrigeration cycles
2. Discuss Refrigerants and behavior under various conditions
3. Different air conditioning terms and load calculation, designing of components of air distribution system.

TEACHING AND EVALUATION SCHEME:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)			
Lecture	Tutorial	Practical	Credit	Theory		Practical	
				University Assessment	Continuous Assessment	University Assessment	Continuous assessment
3	-	2	4	60	40	20	30

COURSE DETAILS.

Sr.No.	Topic	Total Hours	Weightage (%)
1	INTRODUCTION 1.1 Refrigeration and Air conditioning: Importance, concept, basic principle, cycle of operation, need classification and definition, Unit used. 1.2 Application of Refrigeration and Air conditioning in domestic and industrial context.	02	5
2	REFRIGERATION SYSTEM 2.1 Bell-Coleman cycle, representation on P-V and S-T diagram. 2.2 C.O.P. 2.3 Types of refrigeration systems and their applications. 2.4 Simple vapor absorption system, working principle (NH ₃ - H ₂ O) and applications.	02	5
3	VAPOUR COMPRESSION SYSTEM 3.1 Simple, standard vapor compression cycle and its analysis on P-h chart. 3.2 Calculations of refrigerating effect, work done and C.O.P., wet and dry compression, simple examples. 3.3 Effect of different parameters on vapor compression cycle. 3.4 Practical vapor compression system. 3.5 VCRS components, types, their construction, material of construction, specifications, working, common troubles -their causes and remedies, applications, (components include compressor (Reciprocating, Rotary, Screw and scroll), condensers (Air cooled and water cooled), evaporators (Dx type, flooded, shell and tube type), expansion devices (Automatic, thermostatic and capillary tube, High side float	12	20

	valve) and others. 3.6 Application of refrigeration and air conditioning in domestic and industrial context. 3.7 Ice Plant, cold storage, water cooler, domestic refrigerator, deep freezer, dessert cooler, window and split air conditioners- cycle and block diagram, components, working, Common troubles-their causes and remedies.		
4	REFRIGERANTS 4.1 Primary and secondary Refrigerant. 4.2 Classification. 4.3 Designation 4.4 Need of new refrigerants. 4.5 Desirable properties of Refrigerants. 4.6 Properties of R22, R134a, R717.	02	05
5	THERMAL INSULATION 5.1 Types of Insulation 5.2 Salient features of thermocol & fiber glass	02	5
6	APPLIED PSYCHROMETRY 6.1 Psychrometric properties of air such as Dry Bulb Temperature (DBT), Wet Bulb Temperature (WBT), Dew Point Temperature (DPT), absolute humidity, relative humidity, specific humidity, humidity ratio, degree of saturation, specific volume, enthalpy, familiarization with tables of psychrometric properties of air, simple calculations. 6.2 Psychrometric charts and their use. 6.3 Psychrometric processes-sensible heating, sensible cooling, addition and removal of latent heat, adiabatic mixing of air streams, cooling and dehumidification, heating and humidification, adiabatic saturation, solution of problems using psychrometric chart. 6.4 Psychrometry- sensible heat factor (SHF) and its determination with the help of psychrometric chart, condition Line room apparatus and coil apparatus dew point and their determination with the help of chart, estimation of dehumidified air quantity, bypass and contact factor. 6.5 Human Comfort-body temperature regulation, environmental influence on comfort, effective temperature and factors affecting it. 6.6. Comfort chart and its limitations. 6.7 Instruments for measuring psychrometric properties-sling psychrometer dew point psychrometer, organic hygrometer, aspiration psychrometer-working and applications.	10	25
7	ESTIMATION OF COOLING LOADS 7.1 Types, classification and normal values of cooling loads. 7.2 Design conditions. 7.3 Overall heat transfer co-efficient and its calculation. 7.4 Flywheel effect of building material. 7.5 Effect of wall construction on cooling load. 7.6 Concept of IHG and ICL. 7.7 Heat gain through glass. 7.8 Air infiltration and load due to it.	03	10

8	AIR CONDITIONING AND AIR HANDLING SYSTEMS 8.1 Working principles and working of central plant and packaged plant. 8.2 Air filtration-various types, principles of working of different air filters. 8.3 Fans-classification, types, working, selection method, terminology used in fans, applications. 8.4 Velometer and pitot tube their construction and working. 8.5 Duct design, installation and commissioning- estimation of duct size by equal friction method with the help of charts and tables, estimation of losses in ducts, different material & layouts, installation and commissioning steps and precautions Air Distribution-importance, terms used different types of outlets, grill register, diffusers, location of outlets.	07	20
	REFRIGERATION AND AIR CONDITIONING SERVICING 9.1 Tube operations-service tools and special tools-applications and specifications. 9.2 System operation such as-vacuumization, leak detection, charging the system, pumping down, etc.- process, equipments used and their specifications..	02	5

SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (outcomes in psychomotor and affective domain) so that students are able to acquire the competencies/program outcomes. Following is the list of practical exercises for guidance.

Experience Type.	Experience Number	Description of Laboratory Experience	Hrs
Preparatory	01	1. Appreciate main objectives of learning this subject: a. Familiarize with refrigeration and air conditioning applications. b. Identify simple and common faults in commercially available refrigeration and air conditioning equipment's / systems and repair the same. 2. Strengthen know how for fundamental thermodynamic units, systems and cycles.	02
	02	Vapour Compression Refrigeration System (VCRS) components-compressor, condenser, expansion devices and evaporators-types, construction, working, common troubles, their causes and remedies.	04
Study and demonstration	03	Domestic refrigerator, window air conditioner and split air conditioner.	04
	04	Air handling equipments / elements.	02
	05	Tubing Operations.	06
Performance	06	Leak detection, evacuation of system refrigerant and Refilling the same.	04
	07	Determination of COP of water cooler /any VCRS based system.	04
	08	Determination of properties of air by using different instruments	02
Industrial visit	09	Visit cold storage plant, ice plant and air- conditioning plant.	-
Total Hours			28

SUGGESTED LEARNING RESOURCES

A. List of Books:

1. Principle of Refrigeration Dossat R.J. Prentice Hall, USA
2. Basic Refrigeration and air Conditioning (2nd Edition) P.N. Ananthanarayan Tata McGraw Hill
3. Refrigeration and Air conditioning Domkundwar Dhanpat Rai & Sons
4. Refrigeration and Air conditioning Khurmi & Gupta S.Chand, New Delhi
5. Refrigeration and Air conditioning C.P. Arora Tata McGraw Hill
6. Refrigeration & Air conditioning M. Prasad Wiley Easter, Delhi
7. Refrigeration & Air Conditioning P.S. Desai L.F. Rajput by Atul P. Rakshan

Additional Reference Books:

1. Refrigeration and Air conditioning P.L. Balleney Khanna Publishers
2. Ind. Refrigeration Handbook Stoecker McGraw Hill, USA
3. Modern Refrigeration & Air Conditioning Alt hous eetc Galgotia Booksource New Delhi
4. Fundamental of refrigeration Longely Delmar Pub. USA
5. Refrigeration & Air conditioning ARIP.H.I., USA
6. Handbook of Air-conditioning Wang McGraw Hill
7. Air Conditioning Lang CBS Pub. Co. Delhi
8. Heating, Ventilation and air conditioning Clifford Reston Pub. USA
9. Air conditioning (4th Edition) Jones Edward Arnold
10. Air conditioning Principles & Systems Pita John Wiley USA
11. Refrigeration & air-conditioning Trott McGraw Hill Uk
12. HVAC Principles & applications Mull McGraw Hill USA
13. Principles of Heating, Ventilation and air conditioning Howellsaucercoad Ashree98
14. HVAC Systems Duct Design-SMACNA, USA
15. HVAC Systems Monger Prentice Hall, USA
16. HVAC Systems Design Hand Book Hains & Wilson McGraw Hill USA
17. Fan Application Manual- AMCA, USA
18. Cooling Towers Gurney & Cotter Maclaren & Sons, UK
19. ASHRAE Handbook Fundamentals-ASHRAE
20. ASHRAE Handbook Refrigeration-ASHRAE
21. ASHRAE Handbook Applications-ASHRAE
22. ASHRAE Handbook System and Applications-ASHRAE

List of Open Source Software/learning website:

1. <http://nptel.ac.in/>
2. www.learnerstv.com

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understanding needs and applications of refrigeration and air conditioning relevant to present and projected industrial development	1 Remembering, 2 Understand, 3 Applying
CLO2	Interpret thermodynamic analysis of refrigeration and air conditioning system	2 Understand, 3 Applying, 4 Analyze, 5 Evaluate,
CLO3	Design refrigeration and air conditioning equipment for given design conditions using standard tables and charts	3 Applying, 4 Analyze, 5 Evaluate,
CLO4	Understand basic procedure for operation and maintenance of refrigeration and air conditioning plants.	3 Applying, 2 Understanding
CLO5	Able to estimate the cooling load of space	2 Understand, 3 Applying, 4 Analyze, 5 Evaluate
CLO6	Understand the air conditioning and air handling system	2 Understand, 3 Applying,

Course Learning Outcomes	Program Outcomes(Pos)												Program Specific Outcomes(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO1	L						L						L		
CLO2	L	M	M	M			L						M	M	L
CLO3	L	M	M				L						M	M	
CLO4	L					M	M						M	L	H
CLO5	L	M	M	M			M						L		M
CLO6	L						L						M	M	

H: High, M: Medium, L: Low