Savitribai Phule Pune University, Pune

Refrigeration and Air Conditioning
(For 2012 course TE passed students and those who are admitted for BE 2015 pattern)

Code	Subject	Teaching Scheme Hrs / week			Examination Scheme					Total	Credits
		Lecture	Tut	Pract.	In-Sem	End sem	TW	PR	OR		
302049	Refrigeration and Air Conditioning	3	-	2	**30**	70	-	-	50	**150**	--

Prerequisites:
Basic Thermodynamics- Laws of thermodynamics, Ideal gas processes, Thermodynamic cycles, Properties of pure substance, Mollier Charts, Basic Psychrometry terms and process, Fluid properties, Fluid dynamics, Modes of heat transfer, Governing Equations in Heat Transfer, Extended Surfaces, Condensation and Boiling, Heat Exchangers.

Course Objectives:
- Learn the fundamental principles and different methods of refrigeration and air conditioning.
- Study of various refrigeration cycles and evaluate performance using Mollier charts and/ or refrigerant property tables.
- Comparative study of different refrigerants with respect to properties, applications and environmental issues.
- Understand the basic air conditioning processes, calculate cooling load for its applications in comfort and industrial air conditioning.
- Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems

Course Outcomes:
At the end of this course the students should be able to
- Illustrate the fundamental principles and applications of refrigeration and air conditioning system
- Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
- Present the properties, applications and environmental issues of different refrigerants
- Calculate cooling load for air conditioning systems used for various applications
- Operate and analyse the refrigeration and air conditioning systems.

Unit I Applications of Refrigeration and Air Conditioning and Refrigerants   [6 hrs]
Applications: Domestic Refrigerator, Domestic Air Conditioners, Automotive Air Conditioners, Evaporative coolers, water coolers, Air refrigeration – Bell Coleman cycle, Cryocooler- Pulse tube refrigerator. Concept of Cold chain.

Commercial Refrigeration- Dairy, Cold storage, Ice plant.
Commercial Air Conditioning- Multiplex, Hospitals.

Refrigerants: Classification of refrigerants, Designation of refrigerants, Desirable properties of refrigerants, environmental issues, Ozone depletion and global warming, ODP, GWP & LCCP, selection of environment friendly refrigerants, secondary refrigerants, anti-freeze solutions, Zeotropes and Azeotropes, refrigerant: recovery reclaims, recycle and recharge.

Unit II Vapour Refrigeration Systems [6 hrs]
Vapour compression systems: Working of simple vapour compression system, representation of vapour compression cycle (VCC) on T-s and P-h diagram, COP, EER, SEER, IPLV, NPLV, effect of operating parameters on performance of VCC, actual VCC, methods of improving COP using flash chamber, sub-cooling, liquid vapour heat exchanger.
Vapour absorption systems: Introduction, Working of simple vapour absorption system (VAS), desirable properties of binary mixture (aqua-ammonia), performance evaluation of simple VAS (simple numerical treatment), actual VAS, Li-Br absorption system, three fluid system (Electrolux refrigeration), applications of VAS, comparison between VCC and VAC

Unit III Multipressure Refrigeration Systems [6 hrs]
Introduction, need of multistage system, Intermediate pressure, two stage compression with flash gas removal and liquid intercooler, single compressor with multiple evaporator: individual and multiple expansion valves, individual compressors, cascade system: application and numerical (numerical only by using p-h chart).

Unit IV Applied Psychrometry and Human comfort [6 hrs]
Air conditioning processes, adiabatic mixing of air streams, BPF of coil, ADP, SHF, RSHF, GSHF, ESHF. Factors contributing to cooling load, Numerical based on load analysis and phycrometric calculations for cooling and dehumidification.
Thermodynamics of human body, comfort and comfort chart, factors affecting human comfort, concept of infiltration and ventilation, indoor air quality requirements. Indoor and Outdoor design conditions.

Unit V Air Conditioning Systems and Components [6 hrs]
Working of summer, winter and all year round AC systems, all air system, all water system, air water system, variable refrigerant flow and variable air volume systems, unitary and central air conditioning.
Compressors - reciprocating, screw and scroll compressors,
Condensers- air cooled, water cooled and evaporative condensers,
Evaporators- DX, Flooded, Forced feed evaporators,
Expansion devices –Capillary tube, TXV, EXV, operating and safety controls.
(Simple numerical treatment)

Unit VI Air Distribution Systems [6 hrs]
Classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct (friction losses, dynamic losses), air flow through simple duct system, equivalent diameter,

Methods of duct system design: equal friction, velocity reduction, static regain method (numerical on duct system design)
Air handling unit, Fan coil unit, types of fans used air conditioning applications, fan laws, filters, supply and return grills, sensors (humidity, temperature, smoke).

Term work:
The term work shall consist of **minimum eight experiments** out of the following:
1. Test on Domestic Refrigerator for evaluation of EER
2. Test on vapour compression test rig
3. Test on air conditioning test rig
4. Test on ice plant test rig
5. Test on Heat Pump test rig
6. Test/visit on Vapour absorption refrigeration test rig
7. Estimation of cooling load of simple air conditioning system (case study)
8. Visit to cold storage plant.
9. Visit to any air conditioning plant
10. Thermal analysis of refrigeration cycle using suitable software
11. Installation and servicing of split air conditioner

Text Books
1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill
2. Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983
3. McQuiston, ― Heating Ventilating and air Conditioning: Analysis and Design‖ 6th Edition, Wiley India
4. Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpatrai& Company, New Delhi
5. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi,1994.
6. Ballaney P.L., Refrigeration and Air conditioning, Khanna Publishers, New Delhi, 1992

Reference Books
1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000
2. Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International editions 1982.
3. Threlkeld J.L, Thermal Environmental Engineering, Prentice Hall Inc., New Delhi4.
4. Aanatnarayan, Basics of refrigeration and Air Conditioning, Tata McGraw Hill Publications
5. Roger Legg, Air Conditioning System Design, Commissioning and Maintenance
6. ASHRAE & ISHRAE handbook