HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

Hindustan Institute of Technology & Science

Padur, Kancheepuram District 603 103.

Syllabus with Curriculum

2013-14

M.Tech.

REFRIGERATION AND AIR - CONDITIONING

Hindustan University
Hindustan Institute of Technology and Science

M.Tech. - Refrigeration And Air-Conditioning

Semester - I

Sl. No	Course Code	Course Title	L	T	P	C	TCH
THEORY							
1	PMA 101	Advanced Engineering Mathematics	4	0	0	4	**4**
2	PTE101	Advanced Heat Transfer	4	0	0	4	**4**
3	PTE102	Advanced Thermodynamics	4	0	0	4	**4**
4	PTE 104	Instrumentation in Thermal Systems	4	0	0	4	**4**
5	PRA101	Refrigeration Systems Design	4	0	0	4	**4**
6	PTE707	Thermal Energy Systems	4	0	0	4	**4**
PRACTICAL							
7	PRA151	R & AC Lab – I	0	0	3	1	**3**
		Total				**25**	**27**

Semester – II forwarded

Sl. No	Course Code	Course Title	L	T	P	C	TCH
THEORY							
1	PRA201	Air-conditioning Systems Design	4	0	0	4	**4**
2	PRA 202	Computer Simulation of Refrigeration & Air-conditioning Systems	4	0	0	4	**4**
3	PRA 203	Refrigeration Machinery and Components	4	0	0	4	**4**
4	-	Elective –I*	4	0	0	4	**4**
5	-	Elective – II*	4	0	0	4	**4**
6	-	Elective – III*	4	0	0	4	**4**
PRACTICAL							
7	PRA251	R & AC Lab – II	0	0	3	1	**3**
8	PRA252	Design Project	0	0	6	2	**6**
		Total				**27**	**33**

Semester - III

Sl. No	Course Code	Course Title	L	T	P	C	TCH
THEORY							
1	-	Elective – IV*	4	0	0	4	**4**
2	-	Elective – V*	4	0	0	4	**4**
3	-	Elective – VI*	4	0	0	4	**4**
PRACTICAL							
5	PRA352	Project Work Phase -I	0	0	12	6	**12**
4	PRA351	Practical Industrial Training and viva voce (during Previous summer vacation}	-	-	-	1	**0**
		Total				**19**	**24**

Semester - IV

Sl. No	Course Code	Course Title	L	T	P	C	TCH
Practical							
1	PRA451	Project Work Phase -II	0	0	24	12	**24**
		Total				**12**	**24**

Elective Courses

Sl. No	Course Code	Course Title	L	T	P	C	TCH
THEORY							
1	PTE 701	Computational Fluid Dynamics	4	0	0	4	**4**
2	PRA 701	Cryogenic Engineering	4	0	0	4	**4**
3	PRA 702	Food Processing Preservation & Transport	4	0	0	4	**4**
5	PRA 703	Building Architecture and HVACR Systems	4	0	0	4	**4**
6	PRA 704	Energy Conservation HVACR Systems	4	0	0	4	**4**
7	PTE 708	Fans, Blowers and Compressors	4	0	0	4	**4**
8	PRA 705	Erection and Maintenance of Refrigeration & Air-conditioning Equipments	4	0	0	4	**4**
9	PTE 709	Quantitative and Qualitative Research	4	0	0	4	**4**
10	PRA 706	Air Handling Systems Design	4	0	0	4	**4**
11	PTE 103		4	0	0	4	**4**

* Student is permitted to choose an elective from other programmes. The electives may include the core subjects offered by other programmes.

Semester wise Credits	
Semester I	25
Semester II	27
Semester III	19
Semester IV	12
Total Credits	**83**

SEMESTER - I

PMA 101 - ADVANCED ENGINEERING MATHEMATICS

L	T	P	C
4	0	0	4

PMA 101	ADVANCED ENGINEERING MATHEMATICS	4 Credits
Goal	Develop the Mathematical skills to formulate certain practical problems, solve them and analytically and numerically and to interpret the results.	

Objectives	Outcomes
The course should enable the student to	The students should be able to:
1. Functional and the concepts of calculus of variation and its properties. Learns techniques to find the extremals of the variational problems involving one many unknown functions, functional dependent on higher order derivatives and isoperimetric problems.	1. Find the extremals of the functional of different types and uses their technique to find the geodesic and solves isoperimetric problems. Using direct method finds the approximate solution and compares with the exact solutions using Ritz and Kantorovich methods.
2. Classify the initial and boundary value problems. Understands the D'Alemberts solution of the one dimensional wave equation. Understand the Fourier transform techniques for solving heat flow problems in infinite and semi infinite rod.	2. Form the wave equations with initial conditions and solve them using D'Alemberts solutions. Solves the wave equations using Laplace transform for displacements in long string – long string under its weight and free and forced vibrations. Applies Fourier transform techniques for solving the heat flow problems with infinite and semi infinite rods.
3. Learn Harmonic functions and their properties. Understands solving the Laplace equation using Fourier transforms in a half plane with infinite strip and in a semi infinite strip.	3. Find the steady state temperature by solving the Laplace equation using Fourier transform techniques. Solves the heat flow problems in a half plane with infinite strip and in a semi infinite strip
4. Classify the partial differential equations. Learn the methods of solving second order partial differential equations numerically.	4. Solve the initial and boundary value problems related heat flow, both one and two dimensional and vibration problems and obtains their numerical solutions. Understands the numerical techniques of solving the partial differential equation in engineering applications.
5. Mapping and learns the concept of conformal mapping by doing the transformation from z plane to w plane	5. Apply conformal mapping to fluid and heat flow problems.

UNIT – I CALCULUS OF VARIATIONS 12

Concept of variation and its properties- Euler's Equation-Functional dependant on first and higher order derivatives - Functional dependant on functions of several independent variables-Isoperimetric problems – Direct methods-Ritz and Kantrovich methods

UNIT – II TRANSFORM METHODS 12

Laplace transform methods for one dimensional wave equation – Displacements in a long string – Longitudinal vibration of an elastic bar - Fourier Transform methods for one dimensional heat conduction problems in infinite and semi-infinite rod

UNIT – III ELLIPTIC EQUATIONS 12

Laplace equation – Properties of Harmonic functions – Solutions of Laplace equation by means of Fourier transform in a half plane in an infinite strip and in a semi-infinite strip

UNIT – IV NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 12

Solution of Laplace and Poisson equation on a rectangular region by Lieebmann's method – Diffusion equation by the explicit and Crank Nicolson – Implicit methods – Solution of wave equations by explicit scheme Cubic spline interpolation

UNIT – V CONFORMAL MAPPING AND APPLICATIONS 12

The Schwarz – Christoffel transformation – Transformation of boundaries in parametric form – Physical applications - Application to fluid and heat flow

Total - 60

REFERENCE BOOKS

1. Gupta, A.S. – Calculus of Variations with Applications, Prentice Hall of India(P) Ltd., NewDelhi, 6th print, 2006
2. Sankar Rao, .K. – Introduction to Partial Differential Equations, Prentice Hall of India(P) Ltd., New Delhi, 5th print, 2004
3. Jain.R.K, Iyengar.S.R.K. - Advanced Engineering Mathematics, Narosa publications 2nd Edition, 2007.
4. Grewal, B.S – Numerical Methods in Science and Engineering, Kanna Publications, New Delhi, 6th Edition, 2004.
5. Kandasamy.P , Thilagavathy. K and Gunavathy, K – Numerical Methods, S Chand and Co., Ltd., New Delhi, 5th Edition, 2007
6. Spiegel , M. R – Theory and problems of Complex Variables with an Introduction to Conformal Mapping and Its applications, Schaum's outline series, McGraw Hill Book Co., 1987.

PTE 101 - ADVANCED HEAT TRANSFER

L	T	P	C
4	0	0	4

PTE 101	ADVANCED HEAT TRANSFER	4 Credits
Goal	The course is intended to build up necessary background for understanding the physical behaviour of various modes of heat transfer like conduction, Turbulent convective Heat Transfer, Phase change Heat Transfer and radiation	

Objectives	**Outcome**
The course should enable the students to: 1. Learn the physical behaviour of various modes of heat transfer like conduction, Turbulent convective Heat Transfer, Phase change Heat Transfer and radiation 2. Know the application of various experimental heat transfer correlations in engineering calculations. 3. Understand the thermal analysis and sizing of heat exchangers. 4. Understand the concepts of Radiation Heat Transfer. 5. Learn the concepts of Turbulent boundary layer and its importance in convection phenomenon. 6. Give insight to Numerical Methods In Heat Transfer	The students should be able to: 1. Understand the difference between various modes of Heat Transfer. 2. Know about Finite Difference Method and Finite Volume Method. 3. Understand various correlations involve in Compact Heat Exchanger and Fins. 4. Learn to apply various correlations used in Convective Heat Transfer. 5. Design/size Heat Exchanger.

UNIT – I CONDUCTION AND RADIATION HEAT TRANSFER 12

One dimensional energy equations and boundary condition, three-dimensional heat conduction equations, Extended surface heat transfer, Conduction with moving boundaries, Radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

UNIT – II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 12

Momentum and Energy Equations, Turbulent Boundary Layer Heat Transfer, Mixing length concept, Turbulence Model – K-Є Model, Analogy between Heat and Momentum Transfer – Reynolds, Colburn, Vou Karman, Turbulent flow in Tube,a High speed flows.

UNIT – III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12

Condensation with shear edge on bank of tubes, Boiling – pool and flowboiling, Heat exchanger, Є – NTU approach and design procedure, compact heat exchangers.

UNIT – IV NUMERICAL METHODS IN HEAT TRANSFER 12

Finite difference formulation of steady and transient heat conduction problems – Discretization schemes – Explicit, Crank Nicolson and Fully Implicit schemes, Control volume formulation, Steady one dimensional convection and Diffusion Problems, Calculation of the flowfield– SIMPLER
Algorithm.

UNIT – V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION 12

Mass Transfer, Vaporization of droplets, Combined heat and mass transfer, Heat Transfer Correlations in various applications like I.C. Engines, Compressors & turbines.

TOTAL: 60

REFERENCE BOOKS

1. Incropera F.P. and DeWitt. D.P., 'Fundamentals of Heat & Mass Transfer', John Wiley & Sons, 2009.
1. Ozisik. M.N., 'Heat Transfer – Basic Approach', McGraw-Hill Co., 1985
2. Schlichting, Gersten, 'Boundarylayer Theory', Springer, 8th Edition , 2009.
3. P.K. Nag, 'Heat Transfer', Tata McGraw-Hill,2nd Edition, 2009.
4. Rohsenow. W.M., Harnett. J.P., and Ganic. E.N., 'Handbook of Heat Transfer Applications', McGraw-Hill, NY1985
5. Ghoshdasdidar. P.S., 'Computer simulation of flow and HeatTransfer, Tata McGraw-Hill, 1998
6. Patankar. S.V.' Numerical heat Transfer and Fluid flow' ,Hemisphere Publishing Corporation,2009.
7. Carnahan.B, Luther.H.A., and Wilkes, J.O., Applied Numerical Methods, Wiley and Sons, 1976

PTE 102 - ADVANCED THERMODYNAMICS

L	T	P	C
4	0	0	4

PTE 102	ADVANCED THERMODYNAMICS	4 Credits
Goal	To provide the students with knowledge on various thermodynamic properties and make them aware of the practical implications of themodynamic relations.	

Objectives	**Outcomes**
The course should enable the students to 1. Gain knowledge availability analysis and thermodynamic properties. 2. Understand real gas behaviours and multi - component systems. 3. Learn chemical thermodynamics and equilibrium. 4. Gain knowledge on statistical thermodynamics. 5. Learn irreversible thermodynamics.	The students has knowledge of 1. Availability analysis and thermodynamic properties. 2. Real gas behaviours and multi - component systems. 3. Chemical thermodynamics and equilibrium. 4. Statistical thermodynamics and it impact on various applications. 5. Irreversible thermodynamics and it's varied application.

UNIT - I AVAILABILITY ANALYSIS AND THERMODYNAMICS PROPERTY RELATIONS 12

Reversible work, Availability, Irreversibility and Second-Law Efficiencyfor a closed System and Steady-State Control Volume. Availability Analysis of Simple Cycles. Thermodynamics Potentials, Maxwell relations, Generalised relations for changes in Entropy. Internal Energy and Enthalpy,

Generalised Relations for Cp and Cv' Clausius Clayperon Equation, Joule-Thomson Coefficient, Bridgman Tables for Thermodynamics relations.

UNIT - II REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS 12

Different Equations of State, Fugacity, Compressibility, Principles of Corresponding states, Use of generalised charts for enthalpy and entropy departure, fugacity coefficient,Lee-Kesler generalised three parameter tables.

Fundamental property relations for systems of variable composition, partial molar properties, Real gas mixtures, ideal solution of real gases liquids, Activity, Equilibrium in multi phase systems, Gibbs phase rule for non-reactive components.

UNIT - III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM 12

Thermochemistry, First Law analysis of reacting systems, Adiabatic Flame temperature. Entropy change of reacting systems. Second Law analysis of reacting systems, Criterion for reaction equilibrium, Equilibrium constant for gaseous mixtures, evaluation of equilibrium composition, Chemical availability, Availability of reacting systems.

UNIT - IV STATISTICAL THERMODYNAMICS 12

Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Partion function, Calculation of the Macroscope properties from partition functions, Equilibrium

constant statistical thermodynamics approach.

UNIT - V IRREVERSIBLE THERMODYNAMICS 12

Conjugate Fluxes and Forces, Entropy Production, Onsager's Reciprocity relations, Thermo-electric phenomena, formulations, Power Generation, Refrigeration.

TOTAL : 60

REFERENCES

1. Kenneth Wark Jr., Advanced Thermodynamics for Engineers , McGraw-Hill Inc., 1995.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 3rd Edition, 2006.
3. Holman, J.P. Thermodynamics, 4th edition, McGraw-Hill Inc., 4th Edition , 1988.
4. Smith, J.M. and Van Ness., H.C., Introduction to Chemical Engineering Thermodynamics, McGraw-Hill Inc., 6th Edition , 2007.
5. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical and statistical, Third Edition, John Wiley and Sons, 1991.
6. Sears, F.W. and Salinger G.I. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third Edition, Narosa Publishing House, New Delhi, 1998.
7. Dehoff, R.T., Thermodynamics in Materials Science, McGraw-Hill, 1993.
8. Rao, Y.R.C., Postulational and Statistical Thermodynamics, Allied Publisher Limited, New Delhi, 1994.

PTE 104 - INSTRUMENTATION IN THERMAL SYSTEMS

L	T	P	C
4	0	0	4

PTE 104	INSTRUMENTATION IN THERMAL SYSTEMS	4 Credits
Goal	To provide the students with knowledge on various instrument and methods of measurement used in thermal engineering.	

Objectives	**Outcomes**
The course should enable the students to 1. Classify the measuring instruments and understand the type of errors as to arrive at the correct measurement. 2. Understand the use of microprocessors in measuring instruments. 3. Learn the methods of measuring the physical quantities 4. Gain knowledge about various flow visualization methods. 5. Learn the various measurement analysis techniques.	The students has knowledge of 1. Identifying the various measuring instruments and read error free measurement. 2. Use microprocessors as a part of measuring system. 3. Measuring various physical quantities with apt methods. 4. Various types of flow visualization methods 5. Various measurement analysis techniques for apt applications.

UNIT – I MEASUREMENT CHARACTERISTICS 12

Instrument Classification,Characteristics of Instruments – Static and dynamic, Experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

UNIT – II MICROPROCESSORS AND COMPUTERS IN MEASUREMENT 12

Data logging and acquisition, Use of intelligent instrument for error reduction, Elements of micro-computer interfacing, Intelligent instruments in use.

UNIT – III MEASUREMENT OF PHYSICAL QUANTITIES 12

Measurement of thermo-physical properties, Instruments for measuring temperature pressure and flow, Use of intelligent instruments for the physical variables.

UNIT – IV FLOW VISUALISATION 12

Techniques, Shadow graph, Schileren, interferometer, Laser Doppler anemometer, Heat flux measurement, Telemetry in engines.

UNIT – V MEASUREMENT ANALYSIS 12

Chemical,. Thermal, Magnetic and Optical gas analysers, Measurement of smoke, dust and moisture, Gas Chromatography, Spectrometry, Measurement pf pH, Review of basic measurement techniques.

TOTAL : 60

REFERENCES

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 7th Edition , 2008..
2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and 2 MIR Publishers, 2nd Edition, 1988.
4. Raman, C.S. Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw-Hill, New Delhi, 2009.
5. Doeblin, Measurement System Application and Design, McGraw-Hill, 1978.
6. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.

PRA 101 - REFRIGERATION SYSTEMS DESIGN

L	T	P	C
4	0	0	4

PRA 101	REFRIGERATION SYSTEMS DESIGN	4 Credits
Goal	To expose the principles and design of various systems involved in refrigeration	

Objectives	**Outcome**
The course should enable the students to: 1. Know about Refrigeration cycles 2. Understand the Various Components: its working and design 3. Know about system balancing and Controls involved in Refrigeration units 4. Learn about unconventional refrigeration cycles	The students should be able to: 1. Understand the various types of refrigeration systems and Psychrometric processes. 2. Learn the classification of refrigerants and its properties 3. Understand about different controls relays and motors employee in refrigeration. 4. Estimate the cooling load 5. Know about the Air-Conditioning equipments and their applications.

UNIT – I REFRIGERATION CYCLES - ANALYSIS 12

Carnot Cycle, Air Refrigeration Cycles, Vapor Compression Refrigeration Cycle from Basic - Analysis Multipressure Systems, Cascade Systems.

UNIT – II MAIN SYSTEM COMPONENTS 12

Compressors, Condensers, Evaporators - Types and performance, Expansion devices - types and selection.

UNIT – III REFRIGERANTS - HANDLING 12

Classificationof Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact - Montreal / Kyoto protocols - Eco Friendly Refrigerants.

UNIT – IV SYSTEM BALANCING & CONTROLS 12

Estimation of Cooling Load, System Equilibrium, Balancing and matching of components, and Cycling Controls, Electric Circuits in - Refrigerators, Window A/C, Types of motors, Relays,
Different Types of Refrigeration Tools, Evacuation and Charging Unit, Recovery and Recycling Unit, Vacuum Pumps.

UNIT – V UNCONVENTIONAL REFRIGERATION CYCLES 12

Vapor Absorption Systems - Aqua Ammonia & LiBr Systems, Steam Jet Refrigeration Thermo Electric Refrigeration.

TOTAL : 60

REFERENCES

1. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version ,4th Edition , 2006..
2. W.F. Stoecker, Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989.
3. Jordan and Priester, Refrigeration and Air conditioning, 1985.
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langley, Billy C., 'Solid state electronic controls for HVACR' Prentice-Hall 1989.

WEB REFERENCES

1. http://gort.ucsd.edu/newjour/i/msg02859.html
2. http://www.brazeway.com/refrigeration
3. http://Progdev.sait.ab.ca/pwen220/119.ref-com.htm
4. http://147.46.94.112/journal/sej

PTE 707- THERMAL ENERGY SYSTEMS

L	T	P	C
4	0	0	4

PTE 707	THERMAL ENERGY SYSTEMS	4 Credits
Goal	The goal of the course is to learn different aspects of designing and simulating thermal and energy systems. The course is designed in order to demonstrate how knowledge from junior level classes such as thermodynamics, heat transfer, fluid mechanics, engineering economics, and numerical analysis can be used to design and simulate energy systems.	

Objectives	**Outcome**
The course should enable the students to: 1.Utilize the students' knowledge of thermodynamics, heat transfer and fluid mechanics in the design of integrated thermal systems. 2. Utilize accurate and efficient computational methods for the solution of thermal system models.	The students should be able to: 1.design and apply knowledge of mathematics, science and engineering 2. design a system, component or process to meet desired needs 3. understand the professional and ethical responsibility 4. use statistics and linear algebra 5. work professionally in both thermal and mechanical systems areas including the design and realization of such systems 6. work effectively as team members in mechanical engineering projects

UNIT - I DESIGN OF THERMAL SYSTEM 12

Design Principles, Workable systems, Optimal systems, Matching of system components, Economic analysis, Depreciation, Gradient present worth factor.

UNIT - II MATHEMATICAL MODELLING 12

Equation fitting,Nomography, Emperical equation, Regression analysis, Different modes of mathematical models, selection, computer programmes for models.

UNIT - III MODELLING THERMAL EQUIPMENTS 12

Modelling heat exchangers, evaporators, condensers, absorption and rectificationcolumns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

UNIT - IV SYSTEMS OPTIMIZATION 12

Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, Linear programming methods, solution procedures.

UNIT - V DYNAMIC BEHAVIOUR OF THERMAL SYSTEM 12

Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties.

TOTAL : 60

REFERENCES

1 . J.N. Kapur, Mathematical Modelling, Wiley Eastern Ltd., New York, 2008. 2. F. Stoecker, Design of Thermal Systems, McGraw-Hill, 1989.

3. W.F. Stoecker, Refrigeration and Air conditioning, TMH, 1985.

4. Fanger P.O., Thermal Comport, McGraw-Hill, USA, 1972.

5. McQuiston FC & Parker TD, Heating, Ventilating and Air conditioning, Analysis and Design, John Wiley & Sons, USA, 5th Edition 2001.

WEB REFERENCES

1. http://www.engr.usak.ca/dept/mee/research/thermal_fluid.html
2. http://at.youku.ca/cgi-bin/amca/cadl-26
3. http://www.gre.ac.uk/research/cms/centre
4. http://naca.larc.nasa.gov

PRA 151 - REFRIGERATION AND AIR CONDITIONING LAB - I

L	T	P	C
0	0	3	1

PRA 151	REFRIGERATION AND AIR CONDITIONING LAB - I	1 Credits
Goal	To gain experimental knowledge on the performance and operation of Refrigeration and Air Conditioning Equipments	

Objectives	**Outcome**
The objective of this Lab is to provide opportunity for the students to expose to the various application and analysis of R & AC equipments.	The students can understand the practical working of Refrigeration and Air Conditioning Equipments

List of Experiments

1. Study of refrigeration and air conditioning system components
2. Study of refrigeration and air conditioning tools
3. Charging and leak testing of refrigerating and air conditioning equipments
4. Assembling and dismantling of a refrigerator
5. Assembling and dismantling of a window air conditioner
6. Performance study in a refrigerator with calorimeter
7. Performance comparison of a window air conditioner with air cooled and water cooled condenser

PRA 201- AIRCONDITIONING SYSTEMS DESIGN

L	T	P	C
4	0	0	4

PRA 201	AIR CONDITIONING SYSTEM DESIGN	4 Credits
Goal	To expose the fundamental concepts and design principles of air conditioning and air distribution systems.	

Objectives	Outcome
The course should enable the students to: 1. Know about Refrigeration cycles. 2. Understand the Various Components: its working and design. 3. Know about Psychrometry and Air conditioning 4. Make Cooling load estimations	The students should be able to: 1. Understand the Refrigeration Cycles and know about the various components used in Air-conditioning. 2. Understand the Psychrometric processes and use Psychrometric charts in design. 3. Appreciate the requirements of comfort Air-Conditioning and do cooling load calculation. 4. Know about the Air-Conditioning and air distribution equipments and their applications.

UNIT - I PSYCHROMETRY 12

Moist Air Properties, use of Psychrometric Chart, Various Psychrometric Processes, Air Washer, Adiabatic Saturation.

UNIT - II APPLIED PSYCHROMETRY & SYSTEM DESIGN 12

Air conditioning Processes – RSHF, Summer Air conditioning, Winter Air conditioning, Bypass Factor, Applications with specifiedventilation air quantity – use of ERSHF, Application with low latent heat loads and high latent heat loads.

UNIT - III LOAD ESTIMATION & AIR CONDITIONING CONTROL 12

Solar Radiation – Heat Gain through Glasses, Heat Transfer through Walls and Roofs – Total Cooling Load Estimation, Controls of Temperature, Humidity and Airflow.

UNIT - IV AIR DISTRIBUTION & FANS 12

Flow through Ducts, Static & Dynamic Losses, Air Outlets, Duct Design – Equal Friction Methods, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan Arrangement.

UNIT - V CHILLED WATER CIRCUITS 12

Water Piping in Chilled Water Systems, Condensers, Multiple Condensers and Cooling Towers.

TOTAL : 60

REFERENCES

1. Carrier Air conditioning Co., Handbook of Air conditioning systems design, McGraw-Hill, 1985.
2. Langley, Billy C., Refrigeration and Air conditioning Ed. 3, Engle wood Cliffs (NJ), Prentice Hall, 1986.
3. ASHRAE, Fundamentals and equipment, 4 volumes-ASHRAE Inc. 1985.
4. Jones, Air conditioning engineering, Edward Arnold pub. 1987.
5. C.P. Arora, Refrigeration and Air conditioning, Tata McGraw-Hill Pub. Company, New Delhi, 2nd Edition , 2007.

WEB REFERENCES

1. http://www.199.212.18.76/ozone/refrig_cop/fluoro_e.pdf
2. http://www.confex.com/store/ashrae/index-features.html
3. http://202.79.82/huacglobal/homepage/AIRDISTRIBUTION.htm

PRA 202 - COMPUTER SIMULATION OF REFRIGERATION & AIR-CONDITIONING SYSTEMS

L	T	P	C
4	0	0	4

PRA 202	**Computer Simulation of Refrigeration & Air-conditioning Systems**	**4Credits**
Goal	The goal of the programme is to provide **a theoretical input** towards the working knowledge on the operations of modelling, programming and executing simulation techniques for design and optimization.	

Objectives	**Outcome**
The course should enable the students to: 1. Learn the different types of R &AC system and different thermodynamic processes involved 2. Know the different programming languages and software packages that will be used in the course. 3. Learn the mathematical modelling of different thermodynamic processes in refrigeration cycle and to solve problems and able to model properties of fluids.	The students should be able to: 1. Understand the different types and cycles of Refrigeration systems. 2. Understand simulation procedures and implement in analysis. 3. Differentiate and design between a workable and optimal system.

UNIT - I INTRODUCTION 12

Principles of R&AC Systems, Different thermodynamic cycles, Computer application, Simulation methodology, Programming techniques.

UNIT - II MATHEMATICAL MODELLING FOR SIMULATION 12

Mathematical models, Principles, Types, Equation fitting,Information Flow Diagram, Workable Systems, Optimal Systems.

UNIT - III OPTIMISATION TECHNIQUES 12

Simulation of Refrigeration Cycles, Flowcharting and programming, Dynamic process simulation, Optimisation techniques, Principles, Lagrange method, Geometric programming method, Linear programming method, Case studies.

UNIT - IV SIMULATION OF REFRIGERATION SYSTEMS 12

Condenser simulation, Evaporator simulation, Simulation of refrigeration piping, Simulation of control systems.

UNIT - V SIMULATION OF AIR CONDITIONING SYSTEMS 12

Computerized cooling load calculations, Packages, Simulation of pschrometric processes, Simulation of air flowin AC systems, EER value assessment Environmental issues in simulation, Computerized exergy calculation.

TOTAL : 60

TEXT BOOKS

1. Stoecker, W.F., Design of Thermal Systems, 3rd Edition, McGraw-Hill Book Company, New York, 1989.
2. Anand A. Samuel, Computer Simulation of R&AC Systems – Web course hand book Anna University, 2000.

REFERENCES

1. Kapur J.N., Mathematical Modelling, Wiley Easter Limited, New Delhi, 1989.
2. Stoecker, W.F., Refrigeration and air conditioning, TMH 1985.

3. ASHRAE Guide, application, ASHRAE inc. USA, 1985.
4. Dossat, R. J., Principles of refrigeration, John Wiley, 4th Edition , 2006..
5. Lanqley, Billy C., Refrigeration and Air-conditioning Edn.3, engle wood chiffs (NJ), Prentice Hall, 1986.

WEB REFERENCES

1. www.dl.ac.uk/ccp/ccp5/main.html
2. www.nist.gov/srd/webguide/nist73/73_1.html
3. www.ntu.edu.sg/home/mflton/ftp.html
4. www.tecnet.co.za/mags/mol/archieve1.html
5. www.seds.org/pub/faq/ACRONYMS

PRA 203 - REFRIGERATION MACHINERY & COMPONENTS

L	T	P	C
4	0	0	4

PRA 203	REFRIGERATION MACHINERY AND COMPONENTS	4 Credits
Goal	To expose the principles, design aspects and design codes of various components involved in refrigeration design.	

Objectives	Outcome
The course should enable the students to: 1. Understand the Various Components: compressors, condensers, evaporators and expansion devices its working and design 2. Know about various refrigeration accessories and its control 3. Exposed to various codes used in design of refrigeration systems	The students should be able to: 1. Know to analyse the manufacturers catalogue. 2. Select the capacity of various components based on design requirements. 3. Understand use age of various accessories and controls involved in RAC systems 4. Use BIS codes to analyze and compare the performance of different refrigeration systems

UNIT – I REFRIGERANT COMPRESSORS 9

Hermetic compressors - Reciprocating, Rotary, Scroll Compressors, Open type compressors - Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors - Construction, working and Energy Efficiency aspects. Applications of each type.

UNIT – II DESIGN OF CONDENSERS 10

Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Designing different types of condensers, BIS Standards, Optimisation studies.

UNIT – III DESIGN OF EVAPORATORS 10

Different types of evaporators, Design procedure, Selection procedure, Thermal Stress calculations, Matching of components, Design of evaporative condensers.

UNIT – IV REFRIGERATION SYSTEM COMPONENTS 9

Evaporators and condensers - Different types, capacity control, circuitry, Oil return, Oil separators - Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.

UNIT – V SYSTEM ACCESSORIES AND CONTROLS 7

Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalising in multiple evaporators, Different Defrosting and capacity control methods and their implications - Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

TOTAL : 45

REFERENCES

1. Chlumsky, “Reciprocating & Rotary compressors”, SNTL Publishers for Technical literaure, 1965.
2. Hains, J.B, “ Automatic Control of Heating & Airconditioning” Mc Graw Hill, 1981.
3. Althose, A.D. & Turnquist, C.H. “ Modern Refrigeration and Airconditioning” Good Heart - Wilcox Co. Inc., 1985.
4. Recent release of BIS Code for relevant testing practice.
5. ASHRAE Hand book : Equipments, 1998
6. Cooper &Williams, B.“Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting “ Eagle Wood Cliffs (NT) Prentice Hall, 1989.

WEB REFERENCES

1. http://www.chensources.com/ctowers22.shtml
2. http://www.fortunecity.com/campus/german/201/ctowers.html
3. http://www.aquasystemsinsc.com/metric-files.html
4. http://www.ori.org

PRA 251 - REFRIGERATION AND AIR CONDITIONING LAB II

L	T	P	C
0	0	3	1

PRA251	**REFRIGERATION AND AIR CONDITIONING LAB - II**	**1 Credits**
Goal	To gain experimental knowledge on the performance and operation of Refrigeration and Air Conditioning Equipments	

Objectives	**Outcome**
The objective of this Lab is to provide opportunity for the students to expose to the various application and analysis of R & AC equipments.	The students can understand the practical working of Refrigeration and Air Conditioning Equipments

LIST OF EXPERIMENTS

1. Performance study in a heat pump for different indoor and outdoor conditions
2. Performance study in a deep freezer for different coil temperature
3. Performance study in a water cooler for various load conditions
4. Performance study in a walk in cooler
5. Capillary optimization study in a refrigerator using non-cfc refrigerants
6. Performance study in a cooling tower
7. Performance analysis of automobile air conditioning system
8. Performance analysis of a centralized air conditioning system

PRA 252 - DESIGN PROJECT

L	T	P	C
0	0	3	1

PRA 252	DESIGN PROJECT	1 Credits
Goal	To design and fabricate components related to refrigeration and air conditioning and demonstrate its working.	

Objectives	**Outcomes**
The course should enable the students to: 1. Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. Expose the students to Technical report writing	The students should be able to: 1. Complete understanding of making a product is achieved 2. Knowledge on preparing a technical report is gained

Cycle I:

a. Steady and Unsteady state conduction in Solids
b. Steady state natural convection
c. Steady state Radiation between Black bodies
d. Combined conduction & convection (Fluid - Solid)
e. Unsteady state Conduction & Convection Fluid - Solid
f. Steady and unsteady state conduction and convection in Fluids
g. Steady state Forced convection between Grey bodies.
h. Combined conduction & convection in Fluids

Cycle II

The students should do the simulation project individually and in exceptional cases 2 members may be permitted to take one small item for design and simulation. Every project work shall have a guide who is the member of the faculty of the institution.

The students are required to design and simulate the chosen item in the college and demonstrate its working apart from submitting the project report. The report should contain the required drawings, information flow diagrams, process charts related to simulation.

SEMESTER - III

PRA 352 - PROJECT WORK PHASE – I

L	T	P	C
4	0	12	6

PRA 352	PROJECT WORK Phase I	2 Credits
Goal	To prepare the students to identify a project in the thrust areas and to create a work plan to design, fabricate and to analyze the refrigeration and air conditioning systems.	

Objectives	**Outcomes**
The course should enable the students to: 1. Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To expose the students to do Literature survey and scheduling workplan. 3. Expose the students to Technical report writing	The students should be able to: 1. Students can identify the thrust areas in their field of interest. 2. Compare and analyze the performance of the various systems through literature survey. 3. Complete understanding of making a product is achieved 3. Knowledge on preparing a technical report is gained

Aim is to train the students in research work, writing report and presentation

Phase – I : Shall consist of identificationof the project after literature survey. Students should present a review paper & submit it to the internal examiners.

Report should summarise the methodology to be adopted and work plan for the project work Phase – II.

SEMESTER - IV

PRA 451 – PROJECT WORK PHASE – II

L	T	P	C
0	0	24	12

PRA 451	PROJECT WORK Phase - II	6 Credits
Goal	To prepare the students to identify a project in the thrust areas. To design, fabricate and to analyze the refrigeration and air conditioning systems.	

Objectives	**Outcomes**
The course should enable the students to: 1. Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems. 2. To expose the students to work as scheduled in work plan. 3. Expose the students to Technical report writing	The students should be able to: 1. Students can identify the thrust areas in their field of interest. 2. Compare and analyze the performance of the various systems both theoretically and practically through actual design and fabrication. 3. Complete understanding of making a product is achieved. 4. Students can prepare technical reports.

Requirement: Actual project work with presentation & submission of project report thesis form to the examiners. The students should publish at least one paper in National / International conference or Journal before submission of the thesis. Proof of acceptance must be enclosed in the thesis.

PTE 701 - COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
4	0	0	4

PTE 701	COMPUTATIONAL FLUID DYNAMICS	4 Credits
Goal	To teach the students about the type fluid mechanics which uses numerical methods and algorithm to solve complex problems in fluid flow	

Objectives	**Outcome**
The course should enable the students to: 1. Learn about different governing equation and boundary condition 2. Enable the students to understand the various discretisation techniques and solving solution methodologies. 3. Understanding the Navier-stroke equation for different flow field. 4. Understand the requirement of the different turbulence model for solving the Reynolds Average Navier-stroke equation 5. Learn the different grid generation methods	The students should be able to: 1. Know the formation different governing equation like continuity, momentum and Energy equation 2. Derive discretisation equation using finite difference method and finite volume methods, Numerical error associated with first order and second order. 3. Derive Reynolds average Nevier-stroke equation 4. Fix the closure problem associated with Reynolds average Nevier stroke equation using different turbulence model. 5. Generate the grid required in the computational domain for solving the Navier-stroke equation.

UNIT – I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 12

Basics of CFD, Governing equations of Fluid Dynamics – Continuity momentum and Energy equations, Physical Boundary conditions, Mathematical behaviour of PDEs on CFD – Elliptic, Parabolic and Hyperbolic equations

UNIT – II DISCRETISATION TECHNIQUES AND SOLUTION METHODOLOGIES 12

Methods of deriving discretisation equations – Finite difference & Finite volume methods, Finite difference discretisation of wave equation, Laplace equation, Burger's equation, numerical error and stability analysis. Time dependent methods – Explicit, Implicit – Crank – Nicolson methods, time split methods. Solution methodologies – Direct & iteractive methods – Thomas algorithm – Relaxation method – Alternate Direction Implicit method.

UNIT - III CALCULATION OF FLOW – FIELD FOR N – S EQUATIONS 12

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes – Discretization equations for two dimensional convection and diffusion. Representation of the pressure – gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants.

UNIT – IV TURBULENCE MODELLING 12

Time averaged equation for turbulent flow,Turbulence Models – Zero equation model, oue equation model, two equation k-ε models, Advanced models.

UNIT – V GRID GENERATION 12

Algebraic Methods – Differential Equation methods – Adaptive grids

TOTAL: 60

TEXT BOOKS

1. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman, 1998
2. D. A, Anderson, John C. Tannehill, Richard H. Pletcher – Computational Fluid Mechanics and Head Transfer, Hemisphere publishing corporation, McGraw – Hill book company, USA, 1984.

REFERENCES

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2nd Edition 2008..
2. Ghoshdasdidar, P.S., "Computer Simulation of flowand heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluidflow",Hemisphere Publishing Corporation, 2009.
4. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stokes Equation", Pineridge Press Limited, U.K., 1981.
5. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.
6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 2" SpecificTechniques for Different Flow Categories, Springer – Verlag, 1987.
7. Bose, T., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

PRA 701 - CRYOGENIC ENGINEERING

L	T	P	C
4	0	0	4

PRA 701	CRYOGENIC ENGINEERING	4 Credits
Goal	The goal of the course is to learn about cryogenic properties and cryogenic temperatures and applications of the same in various fields.	

Objectives	**Outcome**
The course should enable the students to: 1. Learn about the concept of cryogenics and applications in various fields. 2. Learn about various cycles of cryogenics. 3. Learn about the cryogenic refrigerators for different applications. 4. Learn about the handling and instrumentation of cryogenic fluids.	The students should be able to: 1. Select the proper cryogenic fluid for particular application like cryometallurgy, medical applications. 2. Select proper liquefaction cycle. 3. Decide proper cryogenic refrigerator and cooler for particular application. 4. Find the way to handle cryogenic fluid and right instrumentation to measure the properties of cryogenic fluid.

UNIT – I INTRODUCTION 12

Insight on Cryogenics, Properties of Cryogenic fluids,Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

UNIT – II LIQUEFACTION CYCLES 12

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Ortho-Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction Systems.

UNIT – III SEPARATION OF CRYOGENIC GASES 12

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification,RectificationColumn Analysis - McCabe Thiele Method. Adsorption Systems for purification.

UNIT – IV CRYOGENIC REFRIGERATORS 12

J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators

UNIT – V HANDLING OF CRYOGENS 12

Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

TOTAL : 60

REFERENCES

1. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
3. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.
4. Herald Weinstock, Cryogenic Technology, 1969.
5. Robert W. Vance, Cryogenic Technology, Johnwiley & Sons, Inc., New York, London.

WEB REFERENCES

1. www.nasa.gov
2. www.cryogenicsociety.org/
3. www.iifiir.org/
4. www.linde.com
5. www.airliquide.com/
6. www.cern.ch
7. www.nist.gov

PRA 702 - FOOD PROCESSING, PRESERVATION AND TRANSPORT

L	T	P	C
4	0	0	4

PRA 702	FOOD PROCESSING, PRESERVATION AND TRANSPORT	4 Credits
Goal	To provide an equivalent depth of knowledge in several food processing techniques, their protection and the transference techniques.	

Objectives	**Outcome**
The course should enable the students to 1. Recognize the basic microbiology of food products. 2. Understand the various food processing techniques. 3. To know about the process of freezing and drying in food processing techniques. 4. To know the basic facts of Energy conservation techniques. 5. To understand the design features of refrigerated transportation.	The students should be able to 1. Analyze the mechanism of food spoilage and acquire additional parameters of food products. 2. Predict the method of food processing technique for energy conservation. 3. Analyse the food preserving techniques related with drying limitations. 4. Evaluate the various energy conservation technique adopted for freezers and cold storages. 5. Explore the feasibilities of design features of refrigerated transport

UNIT – I INTRODUCTION **12**

Microbiology of Food Products, Mechanism of Food Spoilage, Refrigeration Technologies of Food Products, Thermodynamic Properties, Cooling Process and Heat Transfer Parameters of Food Products – Their Effect on Quality, Moisture Losses from Respiration of Food Products, Optimum Cold Storage Conditions.

UNIT - II PROCESSING AND PRESERVATION **12**

Food Processing Techniques, Standard Norms for Processing, Plant Layout, Preservation of Milk, Butter, Fruits, Vegetables, Meat Products, Environment Friendly Food Processing Techniques, Cryofreezing, Energy Conservation in Food Industries.

UNIT - III FREEZING AND DRYING **12**

Precooling, Quick Freezing, Freeze Drying Principles, Techniques and Equipments, Cold Storage and Freezers. Freezing and Drying Limitations. Irradiation Techniques. Food Preserving Techniques for Remote Areas.

UNIT - IV COLD STORAGE DESIGN AND INSTRUMENTATION **12**

Design, Selection, Matching, Installation and Maintenance of Cold Storages & Freezers. Insulation, Instrumentation and Control. Energy Conservation Techniques for Freezers and Cold Storages.

UNIT - V TRANSPORT **12**

Refrigerated Transportation, Refrigerated Containers and Trucks. Design Features, Piping and Role of Cryogenics in Freezing and Transport.

TOTAL : 60

REFERENCES

1. Alan Rodes, Principles of Industrial Microbiology, Pergamon International Pub., 1989.
2. Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub., 1997.
3. Stanley E. Charm, Fundamentals of Food Engineering, III Ed. AVI Pub. Company Inc. 1989.
4. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York, 1991.
5. Arora C.P., Refrigeration and Air conditioning II Ed. McGraw-Hill, Pub.,2nd Edition , 2007.
6. ASHRAE Handbook, Cold Storage Application – Collection of papers from ASHRAE Winter meeting at Delirious and Chicago, Jan 1988 and 1989.

WEB REFERENCES

1. http://microbial.org/vlmicro/vl_food.html
2. http://www.howstuffworks.com/food-preservation.html
3. http://www.fao.org.wfs/final/e/volumed/t//a-e.html
4. http://www.iifiir.org

PRA 703- BUILDING ARCHITECTURE AND HVACR SYSTEMS

L	T	P	C
4	0	0	4

PRA 703	BUILDING ARCHITECTURE AND HVACR SYSTEMS	4 Credits
Goal	The goal of the course is to design a medium to large industrial and office buildings where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors.	

Objectives	**Outcome**
The course should enable the students to: 1. Learn about the factors that determine the climate change along with the effects of geographical location. 2. Learn about the human comfort conditions and effects of climate on metabolic activities of human. 3. To learn about the various building materials for different conditions of climate. 4. To learn about passive and active architecture.	The students should be able to: 1. Decide an architecture which takes into effect of climate changes. 2. Design a condition or device for comfort living. 3. Select a proper material taking into account of heat flow conditions in addition to building aesthetics. 4. Decide about the various alternatives for building architecture.

UNIT - I CLIMATE & ARCHITECTURE 12

Factors that determine climate, Climatic variations – Natural and Man made systems, Climate and vernacular architecture, Natural cooling, Effects of Geographical location.

UNIT - II WEATHER AND COMFORT 12

Climate and its components, Characteristics of Human Metabolic activities with changing climate, the sensation of heat and comfort zone, Design of solar shading devices and Mechanical Ventilation systems.

UNIT - III BUILDING MATERIALS – THERMAL STUDIES 12

Building Aesthetics and Thermal infiltration,Periodic heat flowthrough building elements for weather conditions all round the air, Tropical conditions.

UNIT - IV ENVIRONMENT AIR QUALITY CONTROL 12

Air movement and orientation of buildings, landscaping in the tropics, Design consideration in different climate conditions, Tropical sky scrapers, Effects of Greenery – Natural ventilation.

UNIT - V INTELLIGENT BUILDINGS & HVAC SYSTEMS 12

Energy resources and conservation related to building environment, Building automation and Energy Management – passive and Active systems, Solar energy to substitute room heating systems.

TOTAL: 60

REFERENCES

1. ASHRAE Hand book – HVAC Systems & Equipment 1992, HVAC Applications 1992, ASHRAE Inc. Atlanta.
2. Kenya, A., Design Primer for Hot climates, Architectural Press, London, 1980.
3. A.J. Davis and P.P. Schubert, Alternative Natural Energy Sources in Building Design, II Edition, Nostrant of Reinhold Co. New York, 1981.
4. National Building code of India ‘SP7-1983, Bureau of Indian Standards 1984.
5. Giveni B. Man, Climate & Architecture, Barking Esser Applied Science, 1982.

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1. http://www.egt.bme.hu/ecobuild/vernar.htm
2. http://hern.dis.anl.gov/eehern/96/9603vent.html
3. http://www-air-care.com.sg/hvac.html
4. http://www.pfg.co.za/solutions_building.asp
5. http://www.sardi.sa.gov.au/hort/coolchai/inforkits/ref_sys

PRA 704 - ENERGY CONSERVATION IN HVACR SYSTEMS

L	T	P	C
4	0	0	4

PRA 704	ENERGY CONSERVATION IN HVACR SYSTEMS	4 Credits
Goal	The course is intended to impart knowledge on Efficiency, Exergy and irreversibility applicable to refrigeration and air conditioning cycles. Also to enhance the understanding of energy conversion and energy conservation in HVACR systems.	

Objectives	**Outcome**
The course should enable the students to: 1. Learn about First and Second law of thermodynamics applicable to Refrigeration and Air conditioning Cycles 2. Study about Energy auditing and Energy conservation techniques 3. Understand about heat transformers and heat pumps	The students should be able to: 1. Understand the concept of Energy and Energy 2. Learn about the Conservation modalities in HVACR Systems 3. Analyse different heat transformers and Heat Pumps

UNIT - I FIRST & SECOND LAW ANALYSIS 12

Thermodynamics of Energy conservation – Second law – Exergy – Irreversibility and efficiency – analysis of Refrigeration and Air conditioning cycles, Heat pumps, Thermal insulation.

UNIT - II ENERGY CONSERVATION MODALITIES 12

Energy auditing in Engineering and process Industry, Identifying avenues for Energy conservation, Conservation through periodic maintenance of HVAC systems, Predictive and Preventive maintenance.

UNIT - III REFRIGERATION & AIR CONDITIONING EQUIPMENTS 12

Energy conservation in Air Handling units – Fans, Air conditioning apparatus – Unitary equipments, Refrigeration Equipments – Reciprocating Refrigeration Machine, Centrifugal Refrigeration Machine, Absorption Refrigeration Machine, Heat Rejection Equipments, Energy
Efficient motors.

UNIT - IV HEATING AND VENTILATING SYSTEMS 12

Energy conservation feasibility analysis – conventional ventilating systems, constant volume induction system, Multizone unit system, Variable volume induction system, constant temperature systems. Heat Pipe Applications in Air conditioning systems.

UNIT - V HEAT CONVERSION SYSTEMS 12

Theory of Heat transformers – Two temperature level, Three Temperature level, Heat Pumps – Vapour compression and Absorption units, Heat Transformers.

TOTAL : 60

REFERENCES

1. Carrier Air conditioning Co., Hand Book of Air conditioning System Design, McGraw-Hill, 1985.
2. Plant Engineers and Manager's Guide to Energy Conservation, Fair Mount Press, 1987.
3. Ashrae Hand Book – Equipment, 1989.
4. Georg Alefeld and Reinhard Radermacher, Heat conversion systems, CRC press, 1994.
5. Energy conservation in Heating, Cooling and Ventilating Building, Proceeding Hemisphere publishing corporation, 1988.

6. Edward Hartmann, Maintenance Management, Productivity And Quality Publishing Pvt. Ltd. Madras, 1995.

WEB REFERENCES

1. http://www.tinsleymullen.com
2. http://www.eren.doc.gov
3. http://ecep/usl.edu

PTE 708 - FANS, BLOWERS & COMPRESSORS

L	T	P	C
4	0	0	4

PTE 708	FANS, BLOWERS & COMPRESSORS	4 Credits
Goal	To expose the students in Axial and Centrifugal Flow Thermal Turbomachinery	

Objectives	**Outcome**
The course should enable the students to: 1. Learn the principles and theory behind the Thermal Turbo machinery 2. Learn the theory and details of Centrifugal Fans and Compressors. 3. Learn the theory and details of Axial Fans and Compressors. 4. Understand the details and theory behind testing, control and application of Thermal Turbo machinery	The students should be able to: 1. Understand the velocity triangles and calculate the specific work, various losses involved in the Thermal Turbo machines. 2. Know about principles and theories behind the axial and centrifugal turbomachines. **3.** Exposure to various testing procedures involving Fans, Compressors and Blowers and also exposure on Noise control of Turbomachinery

UNIT - I PRINCIPLES OF TURBO MACHINERY 12

Introduction to turbo machines – Transfer of energy to fluids– Performance characteristics – fan laws – Dimensionless parameters – Specificspeed – selection of centrifugal, axial, mixed flow, Axial flow machines.

NIT - II ANALYSIS OF CENTRIFUGAL BLOWER 12

Centrifugal Blowers: Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficiency,flowthrough impeller casing inlet nozzle volute, diffusers, leakage disc friction mechanical losses multivane impellers of impulse type, crossflow fans.

UNIT - III ANALYSIS OF AXIAL FLOW 12

Axial flow fans: Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

UNIT - IV TESTING AND CONTROL OF FANS 12

Fan testing, noise control, materials and components blower regulation, speed control, Throttling control at discharge and inlet.

UNIT - V DESIGN AND APPLICATIONS OF BLOWERS 12

Special design and applications of blowers, induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

TOTAL : 60

REFERENCES

1. Stepanoff A.J., Turboblowers, John Wiley & Sons, 1970.
2. Brunoeck, Fans, Pergamon Press, 1973.

3. Austin H. Church, Centrifugal pumps and blowers, John Wiley and Sons, 1980.
4. Dixon, Fluid Mechanics, Thermodynamics of turbomachinery Pergamon Press, 2010.
5. Dixon, Worked examples in Turbomachinery, Pergamon Press, 1984.

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1.http://www.petropager.com
2. http://www.erichson.com
3. http://www.apgate.com

PRA 705 - ERECTION AND MAINTENANCE OF REFRIGERATION AND

AIR-CONDITIONING EQUIPMENTS

L	T	P	C
4	0	0	4

PRA 705	**Erection & Maintenance of Refrigeration & Air-conditioning Equipments**	**4Credits**
Goal	The goal of the programme is to expose the student in various parameters such as corrective and preventive measures that has to be considered for erection & maintenance of refrigeration & air-conditioning equipments.	

Objectives	**Outcome**
The course should enable the students to: 1. Learn the plant lay out and its parameters. 2. Learn the erection methodology and various maintenance procedures. 3. Learn the various testing, reliability analysis of equipments.	The students should be able to: 1. Understand the different types of maintenance procedures. 2. Schedule maintenance followed by various industries. 3. Understand the total preventive maintenance principles.

UNIT - I INTRODUCTION 12

Refrigeration and air-conditioning plant layout, parameters affecting the location, organisational approach.

UNIT - II ERECTION OF R&AC SYSTEMS 12

Erection methodology, foundation, padding, network analysis, critical path, interconnections; safety precautions, air handling equipments. Maintenance procedures, vacuumising, changing, trial run, leak detection, prevention, lubrication, different methods and equipments, locations in the systems, corrosion, noise, vibration monitoring and control.

UNIT - III TESTING OF EQUIPMENTS 12

Testing of compressors, condensers, evaporators, cooling towers, motors, controls, test rings, ISI standards. Testing of control systems, circuitry and trouble shooting, condition monitoring.

UNIT - IV TOTAL PREVENTIVE MAINTENANCE 12

TPM Principles, Corrective and preventive measures, Reliability analysis, Signature analysis, Different types of maintenance procedures, Practical hints, Failure Mode and Effect Analysis, Problem Solving Techniques.

UNIT - V MAINTENANCE SCHEDULES 12

Studies on different maintenance schedules followed by various industries

TOTAL: 60

TEXT BOOK

1. ASHRAE Hand book on Refrigeration & Air conditioning, Published by ISHRAE, Bangalore, 1998.
2.

REFERENCES

1. Althouse A.D. and Turnquist C.H., Modern refrigeration and air-conditioning, Good Heart-Wilcoz Co Inc., 1980.

2. Nelson C.W., Commercial and Industrial refrigeration, McGraw-Hill, 1982.
3. Paul F. Goliber, Laboratory Manual, Depuar publishing Inc., 1980.
4. Reed G.H., Refrigeration, A Practical Manual, Applied Science Publishers Ltd., London, 1982.
5. Russel E. Smithy, Electricity for Refrigeration, Heating and Air-conditioning, Duxbury Press, Massachusetts, 1980.

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2. www.psfindustries.com/intro.html-9k
3. www.murrob.com/mrci/default.htm
4. www.asme.org/conf/ijpgcol/ol-cfp.pdf
5. www.tecnoarmit.fx.ro/scop.htm-5k

PTE 709 - QUANTITATIVE AND QUALITATIVE RESEARCH

L	T	P	C
4	0	0	4

PTE 709	Quantitative and Qualitative Research	4 credits
Goal	To make students to Understand and interpret research reports when you read them, indentifying their major elements and underlying methodologies. This module is intended to supplement what you will learn from your coursework and reading. It may also help you get an idea of what research is before you take courses in research methods.	

Objectives	**Outcome**
The course should enable the students to: 1. Identify different research methods and these are compatible with different situations, and therefore it is important to know which method is best suitable for use with a particular hypothesis or question. 2. Give exposure to answer unanswered questions or exploring which currently not exist in a research.	The students should be able to: 1. Identify the major differences between qualitative and quantitative research. 2. Describe the pros and cons of using qualitative data collection techniques. 3. Understand in-depth interviewing and focus groups as questioning techniques. 4. Discuss observation methods and explain how they are used to collect primary data.

UNIT - I RESEARCH METHODOLOGY 12

Types of research- Literature survey- Patent survey- literature review reporting- ethics and interventions of research- planning for research- research tools- seven management tools-graphical representations – Codes – Standards.

UNIT - II QUANTITATIVE METHODS 12

Descriptions-statistics-distribution-sampling-hypothesis testing- regression-ANOVA- reliability-validity- uncertainty - sensitivity analysis- use of SPSS.

UNIT - III QUALITATIVE METHODS 12

Historical analogy-market research- survey-analysis-delphi methodology-determination of index-life cycle analysis - modeling and simulation.

UNIT - IV MEASUREMENT IN RESEARCH 12

Need for measurement- types of measuring instruments- configurationsand functional descriptions of instruments- performance- characteristics- static and dynamic characteristics-manipulation, transmission and recording of data- data acquisition and processing systems-Computer aided experimentation.

UNIT - V RESEARCH REPORT PREPARATION 12

Principles of Written communication- content preparation- synopsis writing- result analysis-discussion section-case studies.

TOTAL : 60

REFERENCES

1. Robert B. Burns, Introduction to Research methods, SAGE Publications London- 2000
2. Herman J. Ader, Gidon J. mellenbergh, Research Methodology, SAGE Publications London-1999
3. Jeremy Miles& Mark Sherlin, Applying Regression and Correlation, A Guide for students and researchers SAGE Publications London- 2008
4. Ernest O. Doebelin, Measurement Systems- Application and Design IV Edition McGraw-Hill International Edition NY-5th Edition 2007.

PRA 706- AIR HANDLING SYSTEMS DESIGN

L	T	P	C
4	0	0	4

PRA 706	AIR HANDLING SYSTEM DESIGN	4 Credits
Goal	To expose the student to air distribution and ventilation systems	

Objectives	**Outcome**
The course should enable the students to: 1. Principles of air handling and air distribution 2. Know about various air handling system configurations 3. To expose the students to ventilation and air controls	The students should be able to: 1. Know the categories of air handling systems and to design air ducts 2. Understand principle of air flow, its measurement, evaluation and control. 3. Know the concepts of indoor air quality and the applications of constant volume and variable volume systems

UNIT - I INTRODUCTION 12

Psychrometric, Heat to return air and fan heat economizer cycle, Single zone system, Categories of central air handling system, Air handling system Design Consideration, Duct design static Regain – Equal friction– T method.

UNIT - II CONSTANT AND VARIABLE VOLUME SYSTEM 12

Terminals reheat system, Double-Duct systems, Double-Duct systems with sub zone heating, Double-Duct systems with Draw-through cooling, Two fan Double-Duct systems, Triple-Duct system, Fan coil Unit system, Induction system.

UNIT - III VARIOUS SYSTEM CONFIGURATIONS 12

Hydronic heat pump systems, Heat recovery and Economizer cycle, Indirect evaporative cooling, Energy conservation and system retrofit.

UNIT - IV VENTILATION FOR CONTROL OF WORK ENVIRONMENT 12

Ventilation for control, Principle of airflow,Airflowmeasurement techniques, General exhausts ventilation, Air cleaning devices, and replacement-Air system, Evaluation and control of the thermal Environment, Indoor air Quality and Outside Air Requirements.

UNIT - V AIR CONTROLS 12

Thermostats, Damper and damper motor, Automatic Valves, Direct digital control, Application of fuzzy logic & neural network-Demand control volume method.

TOTAL : 60

REFERENCES

1. Ysen - Yao Sun, Air handling system design, McGraw–Hill, Inc., NY – 1994
2. William A. Burges, Michael j. Ellen Becker, Robert D. Treitman, Ventilation for control of the work environment, A Wiley – Interscience Publication NY – 1989.
3. John I. Levenhagen, Donald H. Spethmann, HVAC controls and systems, McGraw–Hill international Edition. NY – 1992. Allan T. Kirkpatrick & James S. Elleson, Cold air distribution system design guide, ASHEAC – 1996 USA.
4. SMACNA, HVAC System Duct Design, SMACNA Virginia – 1990.

WEB REFERENCES

1. www.environ.com
2. www.ataiaircon.com
3. www.building.org

PTE 103 - ADVANCED FLUID MECHANICS

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PTE 103	ADVANCED FLUID MECHANICS	4 Credits
Goal	The goal of the programme is to provide advance concepts for ideal and non ideal flows, to impart the knowledge of various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts and to provide the details shock waves.	

Objectives	**Outcome**
The course should enable the students to: 1. To understand advance concepts for ideal and non ideal flows. 2. To understand various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts. 3. To understand the details of shock waves.	The students should be able to: 1. To know advance concepts for ideal and non ideal flows. 2. To get the knowledge of various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts. **3.** To know the details of shock waves.

UNIT – I INTRODUCTION **12**

Ideal and non-ideal flows, general equations of fluid motion, Navier - stokes equations and their exact solutions. Boundary layer theory, wedge flows, laminar flow over plates and through cylinders.

UNIT – II TWO DIMENSIONAL FLOW **12**

Subsonic flow, physical significance of irrotational motion – Kelvin's theorem – Differential equation in terms of velocity Potential and stream function – Flow with small purtubaration – flow past a wave shaped wall – Gothert's rule – Prandtl Glanert rule – Hodograph method

UNIT – III TURBULENT FLOW **12**

Turbulence, models and flow equations: steady and unsteady turbulent boundary layers

UNIT – IV COMPRESSIBLE FLOW THROUGH DUCTS **12**

Introduction to compressible viscous flow, governing equations, flow with friction flow with heat transfer flow though nozzle and diffusers

UNIT – V SHOCK WAVE **12**

Normal and oblique shocks – Prandtl – Meyer expansion – Rankine – Hugnoit relation, Application of method of characteristics applied to two dimensional case – simple supersonic wind tunnel Design of supersonic wind tunnel and nozzle.

TUTORIAL: 15, TOTAL: 60

REFERENCES

1. T Radhakrishnan - Gas Dynamics, Prentice Hall, New Delhi.
2. Mohanty A K- Fluid Mechanics, Prentice Hall of India, 1986
3. Shapiro A F -The Dynamics of Compressible flow Vol 1, The Ronald Press company 1963
4. Shames- Mechanics of Fluids, Megraw-Hill Inc
5. Schlichting H - Boundary layer theory, McGraw Hill-Inc
6. Yahya S.M, "Fundamentals of Compressible flow", New Age International (P) Ltd.New Delhi,1996.