JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

Course Structure and syllabi for
M.Tech-ME-Refrigeration & Air-Conditioning
for affiliated Engineering Colleges 2017-18

I YEAR I- SEMESTER:

S.No.	Subject code	SUBJECT	L	T	P	C
1	17D17101	Refrigeration	4	-	-	4
2	17D17111	Advanced Thermodynamics	4	-	-	4
3	17D17102	Conduction and Radiation Heat Transfer	4	-	-	4
4	17D17103	Principles of Air -Conditioning	4	-	-	4
5	 17D17104 17D17105 17D17106	ELECTIVE-I Optimization of Engineering Design Food Preservation Techniques Air Handling Systems Design	4	-	-	4
6	 17D17107 17D17108 17D17109	ELECTIVE-II Cryogenic Engineering Solar refrigeration and Air-Conditioning Erection and Maintenance of Refrigeration and Air- Conditioning Equipments	4	-	-	4
7	17D17110	Refrigeration Laboratory	-	-	4	2
TOTAL			**24**	**-**	**4**	**26**

I YEAR II - SEMESTER:

S.No.	Subject Code	SUBJECT	L	T	P	C
1	17D11105	Design of Air-Conditioning Systems	4	-	-	4
2	17D17201	Convective Heat & Mass Transfer	4	-	-	4
3	17D17202	Refrigeration Equipment & Controls	4	-	-	4
4	17D17203	Advanced Fluid Mechanics	4	-	-	4
5	 17D11208 17D17204 17D17205	ELECTIVE-III Design of Heat Transfer Equipment Advanced Thermal Storage Technologies Indoor air quality control	4	-	-	4
6	 17D17206 17D17207 17D17208	ELECTIVE-IV HVAC System Design Energy Conservation and management Cogeneration and Waste Heat Recovery Systems	4	-	-	4
7	17D17209	Air-conditioning Laboratory	-	-	4	2
TOTAL			**24**	**-**	**4**	**26**

III SEMESTER

S.No	Subject Code	Subject	L	T	P	C
1.	17D20301 17D20302 17D20303	Elective V a) Research Methodology b) Human Values and Professional Ethics c) Intellectual Property Rights	4	-	-	4
2.	17D17301	Elective VI (MOOCS)	-	-	-	-
3.	17D17302	Comprehensive Viva – Voice	-	-	-	2
4.	17D17303	Seminar	-	-	-	2
5.	17D17304	Teaching Assignment	-	-	-	2
6.	17D17305	Project work phase – I	-	-	-	4

IV SEMESTER

S.No	Subject Code	Subject	L	T	P	C
1.	17D17401	Project work Phase – II	-	-	-	12

Project Viva Voce Grades:

A: Satisfactory

B: Not Satisfactory

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M. Tech – I year I Sem. (R&AC)

L	T	P	C
4	0	0	4

(17D17101) REFRIGERATION

Course Objectives:

1.To understand the principles of refrigeration.
2.To understand different vapor Absorption systems.
3.To know Aircraft Air refrigeration systems.
4.To gain knowledge about refrigerants.
5. Ozone depletion potential and global warming potential.

UNIT-I

Vapor Compression Refrigeration:

Analysis of vapor compression refrigeration cycle - reversed Carnot cycle for vapour - effect of suction temperature and condensing temperature on cycle performance – Practical refrigeration cycle – sub-cooled liquid and super heated vapor refrigeration cycles their effect on performance. Multi Pressure Systems- removal of flash gas- intercooling –compound compression (conversion)-multi vapor systems- cascade systems- dual compression- system practices.

UNIT-II

Simple vapor Absorption systems- actual vapor absorption cycle- representation of the cycle on H-C diagram- common refrigerant- (Absorbent)Adsorbent) systems.

Practical single effect Water- Lithium Bromide Absorption system- double effect system- Electrolux refrigerator- newer mixtures for absorption systems.

UNIT-III

Aircraft Air refrigeration – Functions – working conditions – types.

Steam jet water vapor systems- thermoelectric refrigeration systems - vortex refrigeration system - pulse tube refrigeration.

UNIT-IV

Refrigerants:

Desirable properties- thermo dynamic-chemical and transport properties - designation of refrigerants - inorganic, halo carbon refrigerants - secondary refrigerants - Properties of mixtures of refrigerants

UNIT-V

Ozone depletion potential and global warming potential – effect of refrigerants- alternative refrigerants- newer refrigerants.

Course Outcomes:

On successful completion of the course, the student will be able to,
1.Illustrate the basic concepts of refrigeration system.
2.Analyze the vapour compression cycle and interpret the usage of refrigerants.
3.Explainthe components of vapour absorption system.
4.Demonstrate the use of refrigerants.
5.Discuss the theory Ozone depletion potential and global warming potential.

REFERENCE BOOKS:

1. R & A/C by F.Stoecker & Jerold. W.Jones-MGH Intrl.,1982.

2. R & A/C by C.P.Arora, TMGH-2000.
3. R & A/C by Manohar Prasad.
4. Principles of Refrigeration by Roy.J.Dossat, 1997.
5. Refrigeration by Gosney- Oxford University Press-1980.

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M. Tech – I year I Sem. (R&AC)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D17111) ADVANCED THERMODYNAMICS

Course Objectives:

1.To understand thermodynamic relations.
2.To understand exergy and irreversibility.
3.To know nonreactive gas mixtures.
4.To gain knowledge about gas spower cycles.
5. vapour power cycles.

UNIT-I

THERMODYNAMIC RELATIONS:

Introduction-Helmhotz free energy function-Gibbs free energy function-coeffficient of volumetric expansion-isothermal compressibility-differential relation for U,H,G&F-Masxwell relations.

GENERALIZED RELATIONS:

Generalized relation for Cp,Cv,K,B-relations for internal energy and enthalpy-the various Tds equation-clapeyron equation-gas tables-enthalpy and internal energy- pressure ratio-volume ratio-change of entropy-Introduction to third law of thermodynamics.

UNIT-II

EXERGY:

Introduction-availability of heat –availability of a closed system-availability function of the closed system-availability of steady flow system- availability function of open system.

IRREVERSIBILITY:

Introduction-irreversibility for closed and open system-steady flow process effectiveness-second law analysis of the power plant.

UNIT-III

NONREACTIVE GAS MIXTURES:

Introduction-basic definitions for gas mixtures-PVT relations ship for mixtures of ideal gases-properties of mixtures of ideal gases-entropy change due to mixing – mixtures of perfect gases at different initial pressure and temperatures.

UNIT-IV

GAS SPOWER CYCLES:

Introduction-air standard cycles-carnot cycle-ottocycle –disel cycle-dual cycles-comparison between Otto,Diesel, dual cycles-variations between the air standard Otto cycle and actual cycle-Sterlling cycle-Erickson cycle-Atkinson cycle-Brayton cycle- Lenoir cycle.

UNIT-V

VAPOUR POWER CYCLES:

Introduction-the carnot vapor cycle-rankine cycle-effects of operation condition on efficiency-principles of increasing the thermal efficiency- method of increasing thermal efficiency.

DIRECT ENERGY CONVERSION:

Introduction-thermoelectric converters-thermo-ionic converters magneto hydrodynamics generators-solar power cells plant –fuel cell hydrogen –hydrogen fuel cells-direct and indirect oxidation fuel cells-biochemeical fuel cells.(no problems)

Course Outcomes:

1. To be able to state the First Law and to define heat, work, thermal efficiency and the difference between various forms of energy.

2. To be able to identify and describe energy exchange processes in aerospace systems.
3. To be able to explain at a level understandable by a non-technical person how various heat engines work

4. To be able to apply the steady-flow energy equation or the First Law of Thermodynamics to a system of thermodynamic components
5. To be able to apply ideal cycle analysis to simple heat engine cycles to estimate thermal efficiency and work as a function of pressures and temperatures at arious points in the cycles.

REFERENCE BOOKS:

1. Advanced Thermodynamics:Van Wyllan, TMGH
2. Engineering Thermodynamics:P.K.Nag,TMGH Advanced Thermodynamics:Ray & Sarao,Central Publishers.

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(17D17102) CONDUCTION AND RADIATION HEAT TRANSFER

Course Objectives:

1.To understand three modes of heat transfer.
2.To understand Conduction through spherical shells.
3.To know Heating and cooling of bodies with negligible internal resistance.
4.To gain knowledge about thermal radiation.
5. To understand Radiation network for an absorbing and transmitting medium.

CONDUCTION :

UNIT-I

Introduction of three modes of heat transfer, steady, unsteady state heat transfer process, governing equations and boundary conditions

Two dimensional steady state conduction, semi-infinite and finite flat plate; temperature field in infinite and finite cylinders.

UNIT-II

Conduction through spherical shells, numerical methods, relaxation method and finite difference methods - simple problems.

UNIT-III

Heating and cooling of bodies with negligible internal resistance, sudden changes in the surface temperature of infinite plates, cylinders and semi-infinite bodies-simple problems.

RADIATION :

UNIT-IV

Review of the thermal radiation - gas radiation, mean beam length exchange between gas volume and black enclosure, heat exchange between gas volume and gray enclosure, problems.

UNIT-V

Radiation network for an absorbing and transmitting medium, radiation exchange with specular surfaces, radiation exchange with transmissivity and reflecting absorbing medium. Formulation for numerical solution.
Solar radiation: Radiation properties of environment, effect of radiation on temperature measurement, the radiation heat transfer coefficient, problems.

Course Outcomes:

1. Determine these resistances for conduction, radiation, and convection heat transfer, using the fundamental relationships and correlations
2. Learn to solve problems using solvers (multimode systems and design parameter sweep)
3. Compare the various resistances, along with thermal energy conversion and storage, in the thermal systems and identifying the dominant resistance
4. Learn to design modern, innovative thermal systems for various applications

REFERENCE BOOKS :

1) Heat Transfer -Gibhart - Mc. Graw Hill.
2) Conduction Heat Transfer- -Schneder Addition Wieslthy
3) Conduction of Heat in Solids -Carslaw & Jaeger.
4) Heat transfer -J.P. Holman, International student edition
5) Fundamentals of heat and mass transfer -R.C. Sachdev New Age International
6). Heat Transfer by R. K. Rajput Publishers

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(17D17103) PRINCIPLES OF AIR-CONDITIONING

Course Objectives:

1.Will understand well, the importance of maintaining the thermal environment for human comfort which ultimately enhances the working efficiency.
2.Will be in a position to understand the necessity of maintaining the temperature and humidity for various processes in process and pharmaceutical industries.
3.Will become fully aware of the techniques for controlling the contamination of environment which is a must for modern A C systems.

UNIT-I

Psychrometry: Properties of Moist air- Psychrometric relations - Psychrometric chart - Psychrometric processes in air-conditioning equipment - Bypass factor - Sensible heat factor

APPLIED PSYCHROMETRY: Effective and grand sensible heat factors- Selection of Air- Conditioning apparatus for cooling and dehumidification-High latent cooling load applications- All outdoor air application.

UNIT-II

Air-conditioning Processes –Mixing process- Summer, Winter and Year-round air conditioning systems - hot and dry out door condition, Hot and humid outdoor condition - winter air conditioning system - year round air-conditioning system.

UNIT-III

Process of Cooling, Heating and Dehumidifying coils - air washers - Cooling by dry and wet coils - use of hygroscopic solution in air washers - Adiabatic dehumidifier – Humidifier-water injection - steam injection. Heat pump - Different heat pump circuits air, ground water, earth - The linked air cycle heat pump - solar energy collections - Drying of materials.

UNIT-IV

Requirements of Comfort Air-conditions - Thermodynamics of human body - Body regulation process against heat or cold - comfort and comfort chart - Effective temperature - Factors governing optimum effective temperature -Design considerations- Selection of outside and Inside design conditions.

UNIT-V

Ventilation systems: Natural ventilation system - Mechanical - Extraction system - Supply system - Combined supply and extraction system - Air-cleaning - Equipment used for odour suppression and air sterilization. Air-conditioning controls systems - basic elements of the control systems - temperature, humidity and pressure controls and refrigeration flow controls - room thermostat.

Course Outcomes:

1.Define the need and importance of HVAC, handling of different HVAC systems.

2.Describe thermal comfort, its principles and practices, clothing and activities and their impact on comfort and productivity

3.Interpret ventilation impact on human comfort, productivity and health.

4.Propose psychrometry application to HVAC engineering and design different HVAC systems.

5.Explain air and water/refrigerant flow in ducts and pipes, duct and piping design, air distribution in rooms.

6.Paraphrase control of HVAC systems- automatic and manual, different control systems used.

REFERENCE BOOKS:

1.Hand Book of Air conditioning system design -Carrier
2.Refrigeration & Air-conditioning -C.P.ARORA, TMGH,2000.
3 Refrigeration & Air-conditioning --Domkundwar and Arora,DanpatRai& Sons,2000.
5 Refrigeration & Air-conditioning --Stoecker.
6 Refrigeration & Air-conditioning -V.K.Jain.
7. ASHRE - Guide and data book

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(17D17104) OPTIMIZATION OF ENGINEERING DESIGN (ELECTIVE-I)

Course Objectives:

1. Understand the various optimization techniques such as classified optimization, linear programming. One dimensional minimization methods, unconstrained optimization techniques, constrained optimization techniques and dynamic programming.
2. Understand the necessary sufficient conditions for finding the solution of the problems in classical optimization.
3. Comprehend the numerical methods for finding approximate solution of complicated problems.
4. Apply methods like North West corner rule, least count method etc. to solve the transportation problem.

UNIT I

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION:

One dimensional Optimization methods:- Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

UNIT II

Multi variable non-linear unconstrained optimization: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. **Variable** metric method.

UNIT III

GEOMETRIC PROGRAMMING:

Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P

DYNAMIC PROGRAMMING:

Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

UNIT IV

Linear programming – formulation – Sensivity analysis. Change in the constrints, cost coefficients , coefficients of the constraints, addition and deletion of variable, constraints.

Simulation – Introduction – Types – Steps – application – inventory – queuing – thermal system.

UNIT V

Integer Programming – introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

STOCHASTIC PROGRAMMING:

Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

Course Outcomes:

1.Design of mechanical systems and interdisciplinary engineering applications and business solutions using suitable optimization technique.
2. Apply numerical or iterative techniques in power systems for optimal power flow solutions.
3. Optimize the parameters in control systems for desired steady state or transient response.
4. Optimize the cost function in deciding economic factors of power systems.
5. Design of electrical systems optimally using suitable techniques like univariate method,steepest descent method etc.

REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. S.D Sharma/Operations Research
5. Operation Research/H.A. Taha/TMH
6. Optimization in operations research/R.L Rardin
7. Optimization Techniques/Benugundu & Chandraputla/Person Asia.

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(17D17105) FOOD PRESERVATION TECHNIQUES
(ELECTIVE – I)

Course Objectives:

1.Locate and appraise legislative requirements or authoritative guidelines relevant to shelf life extension in fresh, minimally processed and processed foods.
2. Recognise the elements of the Hazard Analysis Critical Control Point (HACCP) system
3.Identify the principles of preservation processes
Operate or observe equipment used in preservation processes with an understanding of the mechanism of preservation employed and the effects of the individual unit operations.
3. Apply principles of food preservation to pilot scale production of processed food and evaluate variation in processing parameters or product formulation on product properties
4. Prepare for practical exercises, organise team work and reflect on issues arising from practical exercise(s) and or production simulation(s) utilising the communication tools
5. Identify and examine the method of packaging, packaging materials and storage practices employed in shelf life extension of fresh, minimally processed and processed foods.
6.Recognise and analyse spoilage symptoms in fresh, minimally processed and processed foods and relate same to the causes of food spoilage.

UNIT-I

Theories and method of chilling, freezing and free de-humidification – preparation for freezing, freezing methods: commercial freezing methods – sharp, quick and air blast freezing, freeze-drying. Methods of pre-cooling fruits and vegetables – hydro cooling, forced air cooling and vacuum cooling.

UNIT-II

Processing of meat products: Refrigeration systems for carcass chilling and holding – chilled brine spray, sprayed coil – dry coil systems, chilling and freezing variety meats – overnight chilling, quick chilling, effect of freezing temp on qualify of meat product
Fishery products: icing of fish – saltwater icing, freezing methods – slow freezing, blast freezing, plate freezing and immersion freezing of fish.

UNIT-III

Dairy products: Milk processing, handling, dairy plant procedure, standardizing, pasteurization, homogenizing, and container filling.

UNIT-IV

Fruit juice concentrations: Processing and quality control – selection, grading and handling of fresh fruit, washing, juice extraction, heat treatment, flavor fortification, packaging storage and distribution- convection methods- freezing and mechanical separation, low temperature vacuum evaporation, direct refrigerant contact method, indirect refrigerant contact methods, high temperature short time evaporations.

UNIT-V

Refrigerated warehouse: factors affecting ware house design- building location, design reduction, shipping and receiving plant forms, utility space, controlled atmospheric storage rooms, jacketed storages, automated ware house – insulation, cold storage doors. Refrigerated

trucks, trailers & containers: temperature control methods, body design & construction, auxiliary equipment, types of refrigeration systems- railway refrigeration cars.

Course Outcomes:

1.Participation in practical sessions in the pilot plant and laboratory culminating with the submission of a scientific report with feedback on your prac performance and reporting.

2. Submission of a literature review assignment on a topic of significance and relevance to the area of study with feedback on your selection, review and critical appraisal of literature.

3. A two hour closed book final examination at the end of the semester that will address specific learning outcomes.

REFERENCE BOOKS:

1. ASHRE - Guide and data book
2. Refrigeration & Air-conditioning- C.P.Arora
3. Hand Book of Air conditioning system design –Carrier

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L	T	P	C
4	0	0	4

(17D17106)AIR HANDLING SYSTEMS DESIGN
(ELECTIVE – I)

Course Objectives:

1.To understand basis concepts air-handling units

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2.To understand constant and variable volume systems.

3.To know air system: components.

4.To gain knowledge about ventilation for control of work environment.

5. To acquire knowledge on Air controls.

UNIT I

BASIS CONCEPTS

Psychrometric, Classifications of Air-Handling Units, Main components, Selection of Air-Handling units, economizer cycle, single zone system, multi zone system-Design Consideration, duct designstatic Regain-equal friction-T method.

UNIT II

CONSTANT AND VARIABLE VOLUME SYSTEMS

Terminals reheat system, Double-Duct systems, Sub zone heating, Draw-through cooling, Triple-Duct system, Fan Coil Unit, Induction system. Various System Configurations - Hydronic heat pump, Heat recovery and Economizer, Indirect evaporative cooling, Energy conservation and system retrofit.

UNIT III

AIR SYSTEM: COMPONENTS

Fan-types, Construction, Arrangement, and Selection, Coil Characteristics and Accessories, Condensate control and Freeze-up protection

UNIT IV

VENTILATION FOR CONTROL OF WORK ENVIRONMENT

Ventilation, Measurements control and exhaust, Air cleaning devices, Rating and Assessments, Test method for air filters, and replacement-Air system, evaluation and control of the thermal Environment, Indoor Air Quality and Outside Air Requirements

UNIT V

AIR CONTROLS

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

Course Outcomes:

1. To be able to duct designstatic Regain-equal friction-T method.

2. To be able to identify and describe Energy conservation and system retrofit.
3. To be able to explain at a level understandable by a non-technical person how various Indoor Air Quality and Outside Air Requirements.

4. To be able to justify Condensate control and Freeze-up protection

5. To be able to apply various Demand control ventilations.

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. Shan K.Wang, Handbook of Air-conditioning and Refrigeration, McGraw -Hill, 2001.
5. SMACNA, HVAC System Duct Design, SMACNA Virginia - 1990.

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L	T	P	C
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(17D17107) CRYOGENIC ENGINEERING
ELECTIVE-II

Course Objectives:

1.Examine basic principles of cryogenics
2.Apply the knowledge of cryogenics in different applications of cryogenics like space technology, gas industry, electronics
3.Design low temperature system by considering properties and principles of mixtures
4.Identify theoretical and mathematical methods of liquefaction systems
5.Construction of liquefaction system for different gases

UNIT-I

Introduction necessity of low temperature - Multistage Refrigeration system -Cascade system - Manufacture of dry ice-Joule Thompson coefficient.
Liquification of air - Lindae system-Analysis-Dual pressure cycle analysis-Liquefaction of Hydrogen and Helium-problems.

UNIT-II

Application of Lower temperature-Effects on the properties of metals-strength-Thermal properties-super conductivity-super fluidity.
Applications like expansion fitting - cryobiology-cryosurgery - space research-computers under ground power lines.

UNIT-III

Low temperature insulation-Reflective insulation-Evacuated powders-Rigid foams-Super insulation.

UNIT-IV

Cooling by adiabatic de-magnetization - Gas separation and cryogenic systems-separation of gases- Rectifying columns-Air separating- single and double columns Air separation plant.

UNIT-V

Storage and handling of cryogenic liquids - Dewars and other types of containers.

Course Outcomes:

1.Acquire knowledge about cryogenics and properties of cryogenic fluids
2.To recognize the liquefaction systems for different gases
3.Apply theoretical and mathematical methods of liquefaction system
4.Design low temperature system by considering properties and principles of mixtures
5.Understand and demonstrate the insulation required for fluid storage and transfer
6.Apply the knowledge of cryogenic fluid storage and transfer systems

REFERENCE BOOKS:

1. Cryogenics by Barron. Oxford University Press 1980.
2. Cryogenic Engineering by Timmerhaus
3. Cryogenic Engineering by Huston: McGraw Hill
4. Refrigeration and Air-conditioning by S.Domkundwar.

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L	T	P	C
4	0	0	4

(17D17108) SOLAR REFRIGERATION AND AIR- CONDITIONING
ELECTIVE-II

Course Objectives:

1.To understand thermodynamic relations.
2.To understand exergy and irreversibility.
3. To understand different types of solar cooling systems

4.To understand the thermodynamic modeling

5.To understand the Economics of different cooling systems

UNIT - I

Review of Psychometric and (Air-conditioning) cooling load calculations-outline of Vapour Compression Refrigeration Systems – Cycle on p-h and T-o charts – C.O.P – Simple problems using property tables.

UNIT - II

Principle of working of working of vapour Absorption Refrigeration, steam jet refrigeration, thermoelectric refrigeration – classification of refrigerants – Desirable properties of ideal refrigerant - Properties of solvent - Solvent refrigerant combination properties.

UNIT - III

Solar cooling systems: vapour compression systems, Rankine cycle, Striling cycle, using P.V.Modules. Solar operated vapour absorption systems – vapour jet refrigeration systems.

UNIT - IV

Solar thermal energy storage - Active and passive systems TROMBE wall – equivalent thermal circuit - Solar green houses.

Solar cooling and dehumidification: Desiccant cooling - Solid and liquid desiccants - improving desiccant cycles - hybrid systems.

UNIT - V

Non –mechanical systems - Australian Rock system – Solar assisted Heat Pump – Economics of solar cooling systems.

Simulation of solar thermal systems - Salient features of DYNSYS, TRNSYS – model formulation – flow diagram of cooling systems.

Course Outcomes:

1. To be able to state the Psychometric and (Air-conditioning) cooling load calculations-outline of Vapour Compression Refrigeration Systems.

2. To be able to identify and describe energy Principle of working of working of vapour Absorption Refrigeration, steam jet refrigeration, thermoelectric refrigeration.

3. To be able to explain at a level understandable by a non-technical person how various P.V.Modules. Solar operated vapour absorption systems.

4. To be able to apply the Solar thermal energy storage.
5. To be able to perform Simulation of solar thermal systems - Salient features of DYNSYS, TRNSYS.

REFERENCE BOOKS:

1. A course in Refrigeration & Air –conditioning, S.Domakundwar & S.C.Arora
2. Principles of Solar engineering, F.Kreith &J.F.Kreider, Mc Graw Hill Book company
3. Solar Cooling & Heating Volumes, I,II,III., T.Negat Vezirogulu
4. Entrepreneurship Development in New & Renewable Energy Technologies APPC & IREDA

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(17D17109) ERECTION AND MAINTENANCE OF REFRIGERATION AND AIR-CONDITIONING EQUIPMENTS

ELECTIVE-II

Course Objectives:

1.To understand Refrigeration and air-conditioning plant layout , parameters affecting the location.
2.To understand erection of r&ac systems. Erection methodology , foundation , padding.
3.To know testing of equipments.
4.To gain knowledge about preventive maintenance.
5. To study maintenance aspects.

UNIT I INTRODUCTION

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

UNIT II ERECTION OF R&AC SYSTEMS

Erection methodology , foundation , padding , network analysis , critical path , interconnections ; safety precautions , air handling equipments , locations in the systems , corrosion , noise , vibration monitoring and control.

UNIT III TESTING OF EQUIPMENTS

Testings/ISI standards, testing of compressors, condensers, evaporators, and cooling towers. Testing of control systems, circuitry and trouble shoot, condition monitoring.

UNIT IV PREVENTIVE MAINTENANCE

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

UNIT V MAINTENANCE ASPECTS

Maintenance procedures, leak detection, vacuumising , charging , trial run , prevention , lubrication , different methods. Studies on different maintenance schedules followed by various industries.

TEXT BOOKS:

1.Robert C.Rosciler, HVAC Maintenance and operations Hand Book,Mc Graw.Hill,1997.
2.Althouse A.D. and Turnquist C.H., Modern Refrigeration and Airconditioning, Good Heart-Wilcoz Co Inc., 2004.

Course Outcomes:

1. To be able to state the Refrigeration and air-conditioning plant layout , parameters affecting the location , organisational approach.
2. To be able to identify and describe Erection methodology , foundation , padding , network analysis.
3. To be able to Test ISI standards, testing of compressors, condensers, evaporators, and cooling towers.
4. To be able to apply the TPM Principles , Corrective and preventive measures.
5. To be able to apply Maintenance procedures, leak detection, vacuumising , charging , trial run ,prevention , lubrication.

REFERENCE BOOKS:

1.ISHRAE Hand book on Refrigeration & Air conditioning, ISHRAE Bangalore, 1998.
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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(17D17110) REFRIGERATION LABORATORY

Course Objectives:

1.To make student understand working of various machines related to refrigeration and their energy efficiency related performance

2.To explain student working of various components of refrigeration systems

1. Find out the Cop. and time taken for ICE making in the Domestic Vapor Compression Refrigeration.
2. Study on Compressor unit.
3. Find out the pull-down characteristics of V.C.R.S.
4. Study of Condenser unit
5. Find our the c.o.p. of vapor Absorption Refrigeration system
6. Study on Expansion devices.
7. Find our the cooling capacity and cop. of evaporative condensing test rig.
8. Study on Evaporating device.

Course Outcomes:

1.Analyze the performance Domestic Vapor Compression Refrigeration system

2.Evaluate the performance of the Vapor compression and Air conditioning units

3.Analyze the Expansion devices

4.Evaluate the performance of capacity and cop. of evaporative condensing test rig.

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(17D11105) DESIGN OF AIR-CONDITIONING SYSTEMS

Course Objectives:

1. Understand the environmental and social impact of old and alternative refrigerants.
2. Ability to design and select the various components of refrigeration systems.
3. Ability to carry out thermodynamic analysis of multi pressure, cryogenic and other non-conventional
refrigeration systems.
4. Ability to carry out heat load calculations and design air conditioning systems.
5. Ability to design air handling system.

UNIT-I

AIR-DISTRIBUTION

Room air distribution - types of supply air outlets - Mechanism of flow through outlets – Considerations for selection and location of outlets - Distribution patterns of outlets friction loss in ducts- grills, diffusers - registers - location of outlets and return air opening - friction loss in ducts - Rectangular equivalents of circular ducts - Air ducts design: duct construction - Duct design procedures- Equal Friction, Static Regain, Velocity Reduction methods.

UNIT-I

BUILDING SURVEY & COOLING LOAD ESTIMATION:

Location of equipment and- Heat gain through glass-Shading from reveals, overhangs and fins-Effect of shading device-Calculation of Solar heat gain through ordinary glass using tables, Fabric heat gain, overall heat transfer coefficient, periodic heat transfer through walls and roofs- solar temperature-Empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag-Equivalent temperature difference method-Infiltration-Stack effect-wind action- load due to infiltration.

COOLING LOAD ESTIMATION:

Occupancy load, lighting load, appliance load-Product load-system heat gains-cooling and heating load estimates-Heat storage, diversity and stratification.

UNIT-III

AIR CONDITIONING SYSTEMS:-

Central station Air conditioning system- All water, all air, air water - unitary, Split, district Air conditioning systems.

UNIT-IV

THERMAL INSULATION & AIR HANDLING APPARATUS:

Method of Heat transfer, desired properties of ideal insulating materials, types of insulating materials, Heat transfer through insulation, economic thickness of insulation, insulation of heated Buildings, insulation for cooling Buildings and cold storage, pipe insulation. Fans and Blowers-types of Fans-Fan characteristics-Centrifugal Fans-Axial Fans-Fan arrangements-Filters- general service – Noise - sources &control

UNIT-V

APPLICATIONS OF AIR-CONDITIONING: -

Industrial, Commercial, transport Air conditioning-Special applications-Computer, Hospital Cold storages, Printing, Textile & Leather industries.

Course Outcomes:

1. Analyze and understand the design of the air-distribution Room air distribution - types of supply air outlets plants.
2. Thorough knowledge of the basic design principles of building survey & cooling load estimation.Location of equipment power plants.
3. Understand the economic, environmental, and regulatory issues related to central station air conditioning system.
4. Understand applications of air-conditioning Industrial, commercial, transport air conditioning.

REFERENCES BOOKS:

1. Hand Book of Air conditioning system design -Carrier
2. Refrigeration & Air-conditioning -C.P.ARORA, TMGH,2000.
3. Refrigeration & Air-conditioning --Domkundwar and Arora, DanpatRai & Sons, 2000.
4. Refrigeration & Air-conditioning -Stoecker.
5. Refrigeration & Air-conditioning -V.K.Jain.
6. ASHRAE - Guide and Data Book

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(17D17201) CONVECTIVE HEAT &MASS TRANSFER

Course Objectives:

1. Understand the convective heat transfer.
2. Ability to forced convection heat transfer in laminar tube flow.
3. To understand boiling and condensation
4. To understand mass transfer.
5. To familiarize Convective mass transfer - governing equations.

CONVECTIVE HEAT TRANSFER:

UNIT-I

Introduction to convection, review of conservation equations - Forced convection in laminar flow - Exact and approximate solutions of Boundary layer energy equation for plane isothermal plate in longitudinal flow - problems.

UNIT-II

Forced convection heat transfer in laminar tube flow - forced convection in turbulent flow – Internal Flows-Correlations-Problems. Approximate analysis of laminar free convective heat transfer on a vertical plate-external flows-correlations-problems.

UNIT-III

Boiling and condensation: Analysis of film condensation on a vertical surface – pool boiling - forced convection boiling inside tubes - problems.

MASS TRANSFER:

UNIT-IV

Definitions of concentration and velocities relevant to mass transfer, Fick's law, species conservation equation in different forms. Steady state diffusion in dilute solutions in stationary media, transient diffusion in dilute solutions in stationary media, one dimensional non dilute diffusion in gases with one component stationary.

UNIT-V

Convective mass transfer - governing equations-forced diffusion from flat plate- Dimension less correlation’s for mass transfer. Simultaneous heat and mass transfer - analogy between heat, mass and momentum transfer.

Course Outcomes

1. Understand the hydrodynamic, thermal boundary layer concept and the relationship between fluid
friction and heat transfer.
2. Understand the concept and mechanism of forced and natural convection.
3. Understand the mass transfer theories.
4. Ability to apply the various empirical correlations used in different fluid flow situations.
5. Ability to analyze and solve complex heat transfer phenomenon.
6. Ability to design the heat exchangers for various industrial applications.

REFERENCES BOOKS:

1. Heat transfer - J. P. Holman.
2. Heat and Mass transfer- R.C. Sachdeva
3. Convective Heat and Mass transfer-Kays.
4. Heat and Mass transfer - V.Gupta and I.Srinivasan - Tata Mc.Graw Hill

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(17D17202) REFRIGERATION EQUIPMENT & CONTROLS

Course Objectives:

1.To understand the principles of Compressors - types - equivalent shaft work .
2.To understand different Condensers.
3.To know Evaporator systems.
4.To gain knowledge about Expansion devices.
5. To know Performance of complete Vapour compression system.

UNIT-I

Compressors - types - equivalent shaft work - Volumetric efficiency - factors affecting total volumetric efficiency - compound compression with inters cooling - rotary compressors - surging - screw compressors - lubricating oils.

UNIT-II

Condensers - types -Water cooled Condensers-Air cooled, Evaporative types - Economic water rate - Economic water velocity - over all heat transfer co-efficient - design - temperature distribution and heat flow in a condenser - pressure drop - fouling factor - LMTD correction factor (no problems).

Cooling towers and spray ponds - classification - performance of cooling towers - analysis of counter flow cooling towers - enthalpy - temperature diagram of air and water - cooling ponds - types - cross flow cooling towers - procedure for calibration of outlet conditions.

UNIT-III

Evaporators - types - Flooded and dry Evaporators, natural and forced convection type - shell and tube - shell and coil, plate type - secondary Evaporators - temperature distribution and heat flow in evaporator - pressure drop - fouling correction factor (no problems).

Defrosting - necessity - methods - manual, automatic, periodic defrosting, solid and liquid adsorbents, water defrosting, defrosting by reversing the cycle, automatic hot gas defrosting, thermo balance defrosting, electric control defrosting. (no problems)

UNIT-IV

Expansion devices - Capillary tube, thermostatic expansion valve - float valves, externally equalized valves - automatic expansion valves - solenoid control valve - location of piping and pump design consideration.(no problems)

UNIT-V

Performance of complete Vapour compression system-Performance of condensing unit-compressor -Evaporator-balancing of load in two stage compression.(no problems)

Installation of vapour compression refrigeration system - evaluation and dehydration testing for leakages - charging - adding oil.(no problems)

Course Outcomes:

1. To be able to state principles of Compressors - types - equivalent shaft work.

2. To be able to identify and describe Condensers , types, Water cooled Condensers-Air cooled, Evaporative types.
3. To be able to explain at a level understandable by a non-technical person how various Evaporators work.

4. To be able to apply the Expansion devices with in the system.
5. To be able to apply evaluation and dehydration testing for leakages, charging, adding oil.

REFERENCES:

1. 'Refrigeration and Air Conditioning'- by Stoecker – TMGH– International Edition,1982
2. 'Refrigeration and Air Conditioning' - by Domkundwar – Dhanpat Rai & Co., - 2000
3. 'Refrigeration and Air Conditioning' - by - C.P.Arora – TMGH - 2000
4. ASHRAE Guide and Data book applications.

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(17D17203) ADVANCED FLUID MECHANICS

Course Objectives:

1.Establish an understanding of the fundamental concepts of fluid mechanics.
2.Understand and apply the potential flow equations to basic flows.
3.Understand and apply the differential equations of fluid mechanics including the ability to applyand understand the impact of assumptions made in the analysis.
4.Understand the boundary layer concepts with respect to fluid flow
5.Understand and apply the compressible flow equations.

UNIT - I

Basic concepts: Continuum hypothesis – Eulerian and Lagrangian descriptions. Derivation of general differential equations – continuity momentum and energy of incompressible flow-Navier Stokes equation for Viscous Fluids (Rectangular Co-Ordinate Systems)-Euler's equations for ideal fluids-Bernoulli's equations (one dimensional) – applications

UNIT - II

Laminar Flow Viscous Incompressible Fluids: Flow similarity – Reynolds number, flow between parallel flat plates, couette-flow, plane poiseuille flow, Hagen – poiseuille flow.

Laminar boundary layer: Boundary layer concept, Prandtl's approximations, Blassius solution for a flat plate without pressure gradient – momentum integral equation – Von-Kerman integral relation – Pohlhausen method of obtaining approximate solutions. Displacement thickness,momentum thickness and energy thickness.Boundary layer separation and control, Kerman's integral equation.

UNIT - III

Introduction to turbulence: Origin of turbulence, nature of turbulent flow – Reynolds equations and Reynolds stresses, velocity profile.

Compressible Fluid Flow Basics: Mach number, Flow pattern in compressible flow, classification of compressible flow, isentropic flow, stagnation properties.

UNIT - IV

Gas Dynamics: Compressible flow through ducts and nozzles – area velocity relations. Flow through convergent and convergent divergent nozzles. Real nozzles flow at design conditions. Introduction to normal compression shock – normal shock relations. Introduction to Fanno Raleigh equations.

UNIT - V

Flow in ducts with friction: Fanno line, adiabatic constant area- Flow of perfect gas, chocking due to friction in constant area flow- Introduction to constant area flow with heat transfer (Raleigh line)

Course Outcomes:

1.Apply knowledge of mathematics, science and engineering.
2.Derive the governing equations of fluid flow and applying them to simple flow problems.
3.Emphasizing the mathematical formulation of various flow problems.
4.Apply the boundary layer concept to the fluid flow problems.

REFERENCE:

1. Yuan S.W. "Foundations of Fluid Mechanics", Prentice Hall – Eastern economy edition 1983
2. Zucrwo M.J. and Hoffman J.D. "Gas Dynamics", Vol-I & Vol-II, John Wiley and Sons Inc. 1977
3. Yahya S.M. "Fundamentals of Compressible Flow", - Wiley Eastern
4. Young, Munsen and Okiisyi, " A Brief Introduction to Fluid Mechanics" 2nd Edition, John Wiley 2000.
5. Frank.M.White, " Fluid Mechanics 5th Edn – McGraw Hill 2005.

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(17D11208) DESIGN OF HEAT TRANSFER EQUIPMENT (ELECTIVE - III)

Course Objectives:

1.To understand the design of heat exchangers.
2 To understand design of evaporators and compressors.
3.To know design of cooling towers and spray ponds.
4. To gain knowledge about design of ducts and fans
5. To know piping system.

UNIT - I

DESIGN OF HEAT EXCHANGERS:

Exchangers-mean temperature differences for parallel and counter flow- effectiveness method(N.T.U)-keys and London charts.

DESIGN OF CONDENSERS:

Types overall heat transfer coefficients- temperature distribution and heat flow in a condenser-pressure drop in a condenser –extended fin surfaces-consideration of fouling factor-L.M.T.D. correction factor.

UNIT - II

DESIGN OF EVAPORATORS:

Temperature distribution and heat flow in an evaporator-pressure drop- factor to be consider in the design of heat transfer equipment-types of heat consideration of fouling factor – correction factor

DESIGN OF COMPRESSORS:

Types-equivalent shaft work-volumetric efficiency-factors affecting total volumetric efficiency –compound compression with inter cooling- rotary compressors-surging.

UNIT - III

DESIGN OF COOLING TOWERS AND SPRAY PONDS:

Classification-performance of cooling towers – analysis of counter flow cooling towers-enthalpy-temperature diagram of air and water- cooling ponds- types of cooling ponds –cross flow cooling towers- procedure for calculation of outlet conditions.

UNIT - IV

DESIGN OF DUCTS:

Continuity equation-Bernoulli’s equation-pressure losses-frictional charts- coefficient of resistance for fillings- duct sizing methods.

DESIGN OF FANS:

Standard air-fan horsepower-fan efficiency-similarity laws-fan laws-performance coefficients- theoretical expression for total pressure drop by a fan-centrifugal fan- axial flow fan-system resistance.

UNIT - V

PIPING SYSTEM:

Requirements of a good piping system-pressure drop in pipes-moody chart-refrigerant piping-discharge line-liquid line-suction line-piping arrangement

Course Outcomes:

1. To be able to state the Exchangers-mean temperature differences for parallel and counter flow- effectiveness method.

2. To be able to identify Temperature distribution and heat flow in an evaporator-pressure drop- factor to be consider in the design of heat transfer equipment.
3. To be able to explain Classification-performance of cooling towers – analysis of counter flow cooling towers- enthalpy-temperature diagram of air and water.
4. To be able to explain design of cooling towers and spray ponds
5. To be able to explain Requirements of a good piping system-pressure drop in pipes-moody chart-refrigerant piping.

REFERENCE BOOKS:

1. Heat and mass transfer by Arora & Domkundwar.
2. Refrigeration & Air-Conditioning by P.L.Ballaney
3. .Refrigeration & Air-Conditioning by C.P.Arora.
4. .Refrigeration & Air-Conditioning by Stoecker

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(17D17204) ADVANCED THERMAL STORAGE TECHNOLOGIES
(ELECTIVE - III)

Course Objectives:

1.To Understand The Necessity Of Thermal Storage – Types-Energy Storage Devices
2.To Understand Sensible Heat Storage System.
3.To Know Parallel Flow And Counter Flow Regenerators.
4.To Gain Knowledge About Specific Areas Of Application Of Energy Storage.
5. Latent Heat Storage Systems.

UNIT I

INTRODUCTION
Necessity of thermal storage – types-energy storage devices – comparison of energy storage technologies - seasonal thermal energy storage - storage materials.

UNIT II

SENSIBLE HEAT STORAGE SYSTEM
Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storage system – use of TRNSYS – pressurized water storage system for power plant applications – packed beds.

UNIT III

REGENERATORS
Parallel flow and counter flow regenerators – finite conductivity model – non – linear model – transient performance – step changes in inlet gas temperature – step changes in gas flow rate – parameterization of transient response – heat storage exchangers.

UNIT IV

LATENT HEAT STORAGE SYSTEMS
Modeling of phase change problems – temperature based model - enthalpy model - porous medium approach - conduction dominated phase change – convection dominated phase change.

UNIT V

APPLICATIONS
Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

Course Outcomes:

1. To be able to state the types-energy storage devices – comparison of energy storage technologies.

2. To be able to identify and describe Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storage system.
3. To be able to explain at a level understandable by a non-technical person how various Parallel flow and counter flow regenerators.

4. To be able to calculate Modeling of phase change problems
5. To be able to explain green house heating – power plant applications – drying and heating for process industries.

TEXT BOOK:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.

REFERENCES:

1. Schmidt.F.W and Willmott.A.J, Thermal Storage and Regeneration, Hemisphere Publishing Corporation, 1981.
2. Lunardini.V.J, Heat Transfer in Cold Climates, John Wiley and Sons 1981.

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(17D17205) INDOOR AIR QUALITY CONTROL
(ELECTIVE - III)

Course Objectives:

1. To impart knowledge on the principles and design of control of indoor/particulate/gaseous air pollutant and its emerging trends.

2. To understand air filtration.

3. To know air pollution–indoor, outdoor; statistics in india.
4. To gain knowledge about design of cleanrooms.
5. IAQ measurements & control.

UNIT I
AIR QUALITY

Air Pollution–Indoor, Outdoor; statistics in India-Contaminants-sources-effects of air quality on health and productivity-IAQ-ASHRAE standards.

UNIT II INDOOR
AIR QUALITY & SICK BUILDING SYNDROME

Effect of temperature , Velocity , Pressure , Humidity on IAQ-Noise-Source-damping methods-Air distribution-diffuser design-location-air charge calculations-age of air-SBS- psycho social effects-Parameters causing SBS-Bio contaminants-diagonising Building problems-NIOSH standards.

UNIT III
AIR FILTRATION

Principles of air filtration-impingement filters, HEPA & ULPA filters, Electronic air cleaners, filters-Filter Standards-filter efficiency-filter testing methods-NAFA certification.

UNIT IV
DESIGN OF CLEANROOMS

History of clean rooms-classification-clean room standards-different contaminants-ISO classification-interiors-Recommended practices-Design of clean rooms for Hospitals, Pharmaceutical, micro electronic, Bio technology food industries and manufacture industries-International standards

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UNIT V
IAQ MEASUREMENTS & CONTROL

Contaminants measurement-sampling sampling methods-Quality assurancecalibration-data interpretation-instruments-specifications-source control–prevention-Dilution Ventilation- demand control volume method.

Course Outcomes:

1. Apply sampling techniques

2.Apply modeling techniques

3.Suggest suitable air pollution prevention equipments and techniques for various gaseous and particulate pollutants to Industries. Discuss the emission standards

TEXT BOOKS:

1. Whyte W. Clean Room Design II Edition, John Wiley & Sons (NY)–1999.

REFERENCES:

1. American Institutes of Architects (AIA) , Guidelines for Design & Construction of Hospital & Health care facilities , AIA, Washington–2001.
2. Thad Godish , Sick Buildings , Lecois Publishers , Ann Arbor , 1994.
3. National Air Filtration Association, NAFA guide to Air Filtration-III edition-NAFA Washington DC-2001.
5. ASHRAE Hand Book, HVAC Systems and Equipment, I-P Edition 1996.

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(17D17206) HVAC SYSTEM DESIGN
(ELECTIVE - IV)

Course Objectives:

1.To understand the principles of Applied Psychrometry, Psychrometric processes using chart Load Estimation.
2.To understand Air Distribution.
3.To know Ventilation and Infiltration.
4.To gain knowledge about Direct and Indirect Evaporative Cooling.
5. To impart knowledge on Air conditioning systems.

UNIT-I

Applied Psychrometry, Psychrometric processes using chart Load Estimation: solar heat gain, study of various sources of the internal and external heat gains, heat losses, etc. Methods of heat load calculations: Equivalent temperature Difference Method, Cooling Load Temperature Difference, and Radiance Method, RSHF, GSHF, ESHF, etc. Inside and outside design conditions.

UNIT-II

Air Distribution: Fundamentals of air flow in ducts, pressure drop calculations, design ducts by velocity reduction method, equal friction method and static regain method, duct materials and properties, insulating materials, types of grills, diffusers, wall registers.

UNIT-III

Ventilation and Infiltration: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load. Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure.

UNIT-IV

Direct and Indirect Evaporative Cooling: Basic psychometric of evaporative cooling, types of evaporative coolers, design calculations, Air Conditioning Equipments and Controls: Chillers, Condensing units, Cooling coils, bypass factors, humidifiers, dehumidifiers, various types of filters, air washers, thermostat, humidistat, cycling and sequence controls, modern control of parity, odour and bacteria, Air filtration- Study of different types of filters, Cooling Towers

UNIT-V

Air conditioning systems: Classification, design of central and unitary systems, typical air conditioning systems such as automobile, air plane, ships, railway coach air-conditioning, warm air system, hot water systems, heat pump, clean rooms (descriptive treatments only). Standards and Codes: ASHRAE/ARI, BIS standards study and interpretation, ECBC, NBC codes

Course Outcomes:

1. To be able to state the Applied Psychrometry, Psychrometric processes using chart Load Estimation.

2. To be able to identify and describe Fundamentals of air flow in ducts, pressure drop calculations, design ducts by velocity reduction method.
3. To be able to explain at a level understandable by a non-technical person how Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load.

4. To be able to apply the Basic psychometric of evaporative cooling, types of evaporative coolers, design calculations.
5. To be able to apply Classification, design of central and unitary systems, typical air conditioning systems such as automobile, air plane, ships.

REFERENCES:

1. ASHRAE Handbooks
2. ISHRAE Handbook.
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Trane air conditioning manual,
5. Refrigeration and Air conditioning, ARI Prentice Hall, New Delhi.
6. Norman C. Harris, Modern air conditioning
7. Jones W. P., Air conditioning Engineering, Edward Arnold Publishers Ltd, London, 1984.
8. Jones W. P., Air conditioning Engineering - Applications, Edward Arnold Publishers Ltd, London, 1984
9. Hainer R. W., Control System for Heating, Ventilation and Air conditioning, Van Nastrand Reinhold Co., New York, 1984.
10. Refrigeration and Air conditioning- C P Arora, Tata McGraw Hill Publication, New Delhi.
11. McQuiston, Faye; Parker, Jerald; Spitler, Jeffrey 2000, Heating, Ventilating and Air Conditioning-Analysis and Design, 5th ed. John Wiley & Sons.

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(17D17207) ENERGY CONSERVATION AND MANAGEMENT
(ELECTIVE - IV)

Course Objectives:

1. To understand the principles of energy conservation.
2. To understand thermal insulation & refractors.
3. To know waste heat recovery systems.
4. To gain knowledge about engineering economics.
5. To impart knowledge Energy management programs.

UNIT-I

ENERGY CONSERVATION:

Rules for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternate energy sources, and energy storage.

UNIT-II

THERMAL INSULATION & REFRACTORS:

Heat loss through un-insulated surfaces, effects of insulation on current carrying wires – economic thickness of insulation – critical radius of insulation – properties of thermal insulators – classification of insulation materials – classification of refractors – properties of refractors – criteria for good refractory material – applications of insulating & refractory materials.

UNIT-III

WASTE HEAT RECOVERY SYSTEMS:

Guideline to identify waste heat – feasibility study of waste heat – shell and tube heat exchanger – thermal wheel – heat pipe heat exchanger – heat pump – waste heat boilers – incinerators.

HEAT RECOVERY SYSTEMS & HEAT EXCHANGER NETWORKS:

Liquid to liquid heat exchangers – gas to liquid heat recovery systems, regenerators, recuperators, rotating regenerators – miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger, U-tube heat exchanger, tube heat exchanger, fluidized bed heat exchanger – economizer.

UNIT-IV

ENGINEERING ECONOMICS:

Managerial objectives, steps in planning – efficiency of organization- capital budgeting – classification of costs – interest – types – nominal and effective interest rates – discrete and continuous compounding – discounting - time value of money – cash flow diagrams – present worth factor, capital recovery factor, equal annual payments – equivalent between cash flows.

ENERGY AUDITING:

A definition – objectives – level of responsibility – control of energy – uses of energy – check lists – energy conservation schemes – energy index – cost index – pie charts –

sankey diagrams – load profiles – types of energy audits – questionnaire – energy audit of industries – general energy audit – detailed energy audit – energy saving potential.

UNIT-V

PROJECT MANAGEMENT:

Method of investment appraisal – rate of return method, pay back method, net present value method (NPV) – adoption of the methods in energy conservation campaign – types of projects — propose of project management – classification – role and qualities of project manager – types of budgets - budget committee – budgeting.

ENERGY MANAGEMENT PROGRAMS:

Necessary steps of energy management programme – concepts of energy management – general principles of energy management – energy management in manufacturing and process industries – qualities and functions of energy managers – duties of energy manager - language of energy manager – checklist for top management.

Course Outcomes:

1. Ability to understand the basic concept of energy conservation and its role in energy management.
2. Learn the purpose and detailed methodology of energy audit.
3. Ability to analyze the energy conservation opportunities in the energy intensive industries.
4. Ability to analyze the quantum of electrical energy that can be saved by the use of energy efficient lighting
systems.
5. Learn the concept of cogeneration, tri generation and waste heat recovery in detail.

REFERENCE BOOKS:

1. Waste heat recovery systems -D.A. Reay/Pergmon Press
2. Hand book of energy audits -Albert Thumann
3. Energy Management -W.R. Murphy & G.Mickay, Butterworths
4. Energy Conservation -P.W.O' Callaghan, Pargamon Press 1981
5. Engineering Heat Audits -C.P. Gupta & Rajendra Prakash, Nechand & Bros.
6. Hand book of energy audits -Albert Thumann, The F.Airmont Press Inc., Atlanta Georgia, 1979.
7. Energy Management Principles -Craig B. Smithm, Pergarmon Press
8. The rols of Energy Manger -EEO., U.K.
9. Industrial Engineering & Management -Dr. O.P.Khanna, Dhanapat Rai & Sons, 1992
10. 'PERT – CPM' -L.S. Srinath

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(17D17208) COGENERATION AND WASTE HEAT RECOVERY SYSTEMS (ELECTIVE - IV)

Course Objectives:

To impart knowledge on

1.The basic energy generation cycles
2.The concept of cogeneration, its types and probable areas of applications
3.Significance of waste heat recovery systems and carryout its economic analysis

UNIT I INTRODUCTION

Introduction – principles of thermodynamics – cycles – topping – bottoming – combined cycle – organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

UNIT II CONGENERATION TECHNOLOGIES

Configuration and thermodynamic performance – steam turbine congeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

UNIT III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment.

UNIT IV WASTE HEAT RECOVERY SYSTEMS

Selection criteria for waste heat recovery technologies – recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems.

UNIT V ECONOMIC ANALYSIS

Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves – sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

Course Outcomes:

Ability to

1.Analyse the basic energy generation cycles
2.Do the economic analysis of waste heat recovery systems

TEXT BOOKS:

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.11
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001

REFERENCES:

1. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers,London, 1963.
3. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
4. De Nevers, Noel., Air Pollution Control Engineering, McGrawHill, New York,1995

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M. Tech – I year II Sem. (R&AC)	**L**	**T**	**P**	**C**
	0	**0**	**4**	**2**

(17D17209 AIR-CONDITIONING LABORATORY

Course Objectives:

1.To understand Humidification and Dehumidification process.
2.To understand Gas charging unit.
3.To know various process and by-pass factor by using Air conditioning test Rig.
4.To gain knowledge on Air-condition system. Split – Air conditioning system and Central Air conditioning system.
5. To understand over-all efficiency of cooling Tower.

1. Study the Humidification and Dehumidification process.
2. Find out the Efficiency of the Air-washer test rig.
3. Study on Gas charging unit
4. Find our over-all efficiency of cooling Tower.
5. Find out the capacity and by-pass factor of the window air conditioning.
6. Study the various process and by-pass factor by using Air conditioning test Rig.
7. Study on Heat pump
8. Study on Air-condition system. Split – Air conditioning system and Cnetral Air conditioning system.

Course Outcomes:

1. Ability to apply the theoretical knowledge to solve problems in Heat Power Engineering.
2. Hands on experience through actual experimentation or simulation.
3. Ability to formulate and analyze practical problems.
4. Ability to prepare mathematical/geometrical model and solve it using appropriate software.
5. Ability to analyze data obtained through experimentation/simulation and drawing suitable technical
conclusion
6.Ability to prepare technical report for the given case study.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech III semester (R&AC)

L	T	P	C
4	0	0	4

(17D20301) RESEARCH METHODOLOGY

(Elective V-OPEN ELECTIVE)

UNIT I

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II

Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.

Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.

Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III

Correlation and Regression Analysis – Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

UNIT IV

Statistical Inference: Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V

Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text Books:

1. Research Methodology:Methods And Techniques – C.R.Kothari, 2nd Edition,New Age International Publishers.
2. Research Methodology: A Step By Step Guide For Beginners- Ranjit Kumar, Sage Publications (Available As Pdf On Internet)
3. Research Methodology And Statistical Tools – P.Narayana Reddy And G.V.R.K.Acharyulu, 1st Edition,Excel Books,New Delhi.

REFERENCES:

1. Scientists Must Write - Robert Barrass (Available As Pdf On Internet)

2. Crafting Your Research Future –Charles X. Ling And Quiang Yang (Available As Pdf On Internet)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech III semester (R&AC)

L	T	P	C
4	0	0	4

(17D20302) HUMAN VALUES AND PROFESSIONAL ETHICS

(Elective V-OPEN ELECTIVE)

Unit I:

HUMAN VALUES:Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

Unit II:

ENGINEERING ETHICS: Senses of Engineering Ethics- Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg‟s theory- Gilligan‟s theory- Consensus and controversy – Models of professional roles- Theories about right action- Self interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

Unit III :

ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

UNIT IV:

ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK: Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing riskSafety and the Engineer- Designing for the safety- Intellectual Property rights(IPR).

UINIT V:

GLOBAL ISSUES: Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of

Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics .

Text Books :

1. “Engineering Ethics includes Human Values” by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009.

2. “Engineering Ethics” by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.

3. “Ethics in Engineering” by Mike W. Martin and Roland Schinzinger – Tata McGrawHill– 2003.

4. “Professional Ethics and Morals” by Prof.A.R.Aryasri, Dharanikota Suyodhana-Maruthi Publications.

5. “Professional Ethics and Human Values” by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran , Laxmi Publications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech III semester (R&AC)

L	T	P	C
4	0	0	4

(17D20303) INTELLECTUAL PROPERTY RIGHTS

(Elective V-OPEN ELECTIVE)

UNIT – I

Introduction To Intellectual Property: Introduction, Types Of Intellectual Property, International Organizations, Agencies And Treaties, Importance Of Intellectual Property Rights.

UNIT – II

Trade Marks : Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes.

UNIT – III

Law Of Copy Rights : Fundamental Of Copy Right Law, Originality Of Material, Rights Of Reproduction, Rights To Perform The Work Publicly, Copy Right Ownership Issues, Copy Right Registration, Notice Of Copy Right, International Copy Right Law.

Law Of Patents : Foundation Of Patent Law, Patent Searching Process, Ownership Rights And Transfer

UNIT – IV

Trade Secrets : Trade Secrete Law, Determination Of Trade Secrete Status, Liability For Misappropriations Of Trade Secrets, Protection For Submission, Trade Secrete Litigation.

Unfair Competition : Misappropriation Right Of Publicity, False Advertising.

UNIT – V

New Development Of Intellectual Property: New Developments In Trade Mark Law ; Copy Right Law, Patent Law, Intellectual Property Audits.

International Overview On Intellectual Property, International – Trade Mark Law, Copy Right Law, International Patent Law, International Development In Trade Secrets Law.

TEXT BOOKS & REFERENCES:

1. Intellectual Property Right, Deborah. E. Bouchoux, Cengage Learing.

2. Intellectual Property Right – Nleashmy The Knowledge Economy, Prabuddha Ganguli, Tate Mc Graw Hill Publishing Company Ltd.,