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**Note:** All End Examinations (Theory and Practical) are of Three Hours Duration.

T – Tutorial  L – Theory  P- Practical / Drawing  C - Credits
JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech. HEAT POWER (REFRIGERATION & AIR-CONDITIONING)

(4 SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2015-16

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M.Tech. HEAT POWER (REFRIGERATION & AIR-CONDITIONING)

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REFRIGERATION (15D31101)

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.

UNIT-II


UNIT-III

Simple vapor Absorption systems- actual vapor absorption cycle- 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-IV

Aircraft Air refrigeration – working principle and types.
Steam jet refrigeration system - thermoelectric refrigeration systems - vortex refrigeration system - pulse tube refrigeration.

UNIT-V

Refrigerants:
Desirable properties- thermo dynamic-chemical and transport properties - designation of refrigerants - inorganic, halo carbon refrigerants - secondary refrigerants - Properties of mixtures of refrigerants.
Ozone depletion potential and global warming potential – effect of refrigerants- alternative refrigerants.

REFERENCE BOOKS:
UNIT-I
THERMODYNAMIC 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 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:

UNIT-V
VAPOUR POWER CYCLES:
Introduction-the carnot vapor cycle-rankine cycle-effecfects of operation condition on efficiency-principles of increasing the thermal efficiency- method of increasing thermal efficiency.
DIRECT ENERGY CONVERSION:

REFERENCE BOOKS:
1. Advanced Thermodynamics:Van Wyllan, TMGH
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, Conduction through spherical shells.

UNIT-II
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 analytical and graphical solutions -simple problems.

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, and absorbing medium.
Solar radiation: Radiation properties of environment, effect of radiation on temperature measurement.

REFERENCE BOOKS :
2) Conduction Heat Transfer- -Schneder  Addition Wieslthy
4) Heat transfer -J.P. Holman, International student edition
6). Heat Transfer by R. K. Rajput
UNIT-I
Psychrometry: Properties of Moist air - Psychrometric relations - Psychrometric chart - Psychrometric processes - 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.

REFERENCE BOOKS:
1. Hand Book of Air conditioning system design -Carrier
5 Refrigeration & Air-conditioning --Stoecker.
7. ASHRE - Guide and data book
M.TECH. HEAT POWER (REFRIGERATION & AIR-CONDITIONING)

I SEMESTER

OPTIMIZATION OF DESIGN (ELECTIVE-I)
(15D31105)

UNIT I

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION:

UNIT II


UNIT III

GEOMETRIC PROGRAMMING:

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.


UNIT V

STOCHASTIC PROGRAMMING:

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

REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
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.
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:

UNIT-III
WASTE HEAT RECOVERY SYSTEMS:

HEAT RECOVERY SYSTEMS & HEAT EXCHANGER NETWORKS:

UNIT-IV
ENGINEERING ECONOMICS:

ENERGY AUDITING:
UNIT-V
PROJECT MANAGEMENT:

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.

REFERENCE BOOKS:
1. Waste heat recovery systems  -D.A. Reay/Pergmon Press
2. Hand book of energy audits  -Albert Thumann
8. The rols of Energy Manger  -EEO., U.K.
10. ‘PERT – CPM’  -L.S. Srinath
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

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.

TEXT BOOK:

REFERENCES:
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M.Tech. HEAT POWER (REFRIGERATION & AIR-CONDITIONING)
I- SEMESTER
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DESIGN OF HEAT EXCHANGERS (ELECTIVE – I)
(15D31108)

UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9

UNIT II FLOW AND STRESS ANALYSIS 9

UNIT III DESIGN ASPECTS 9

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9

UNIT V CONDENSERS AND COOLING TOWERS 9
Design of surface and evaporative condensers – cooling tower – performance characteristics.

TEXT BOOK:

REFERENCES
UNIT I
INTRODUCTION

UNIT II
CONGENERATION TECHNOLOGIES

UNIT III
ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES

UNIT IV
WASTE HEAT RECOVERY SYSTEMS

UNIT V
ECONOMIC ANALYSIS

TEXT BOOKS:

REFERENCES:
UNIT – I
UNIT – II
UNIT – III
UNIT – IV
UNIT – V
Value Improvement Elements – Value Improvement Assault – Supplier Teaming; Business Process Reengineering & Elements of Supply Chain Management. Six Sigma Approach – Application of Six Sigma Approach to various Industrial Situations.

TEXT BOOKS:

REFERENCE BOOKS:
1. Quality management, Howard Giltow-TMH
2. Quality management, Evans.
3. Quality management, Bedi
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I SEMESTER

RENEWABLE ENERGY SOURCES (ELECTIVE-II)
(15D32103)

UNIT – I
SOLAR ENERGY:

UNIT – II
WIND ENERGY:
Wind mills and wind turbine systems, Classification of wind machines: Horizontal & Vertical axis configuration. High and low solidity rotors, Elements of wind mills and wind turbine systems, Aerodynamic models, Rankine Froud Actuator disc model, Betz limit, angular momentum wake rotation theory, Aerofoil sections and their characteristics, Estimation of power output and energy production.

UNIT – III
OCEAN THERMAL ENERGY:
Ocean thermal energy sources, Ocean thermal energy power plant development, Closed and open cycles. Advantages and operating difficulties.
TIDAL & WAVE ENERGY
Tidal power sources, Conventional and latest design of tidal power system, The ocean wave, Oscillating water column (Japanese) and the Dam, Atol design.

UNIT – IV
GEOTHERMAL ENERGY :
Earth as source of heat energy, stored heat and renewability of earth’s heat, Nature and occurrence of geo thermal field, Classification of thermal fields, Model of Hyper thermal fields & Semi thermal fields, drilling hot water measurements.

UNIT – V
FUEL CELL ENERGY:
Description, properties and operation of fuel cells, Major components & general characteristics of fuel cells, Indirect methanol fuel cell systems. Phosphoric acid fuel cell systems and molten carbonate fuel cell systems.
BIOMASS ENERGY:
Types of conversion techniques for the production of solid, liquid and gaseous fuels by chemical and biochemical methods, and Biomass gasifiers- Selection of a model and size, Technical, Climatic, geographical and economic issues.

BOOKS:
3. Non-conventional Energy Sources: G.D. Rai
4. Energy Technology: S. Rao & B.B. Parulekar
11. Energy technology Hand Book: EdD.M.Considine
12. Principles of energy conversion AW. Culp
UNIT - I

UNIT - II

UNIT - III

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

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

REFERENCE BOOKS:
1. A course in Refrigeration & Air-conditioning, S.Domakundwar & S.C.Aroma
4. Entrepreneurship Development in New & Renewable Energy Technologies APPC & IREDA
1. Determination of C.O.P. and time taken for ICE making in the Domestic Vapor Compression Refrigeration.
2. Study on Compressor unit.
3. Determination of the pull-down characteristics of V.C.R.S.
4. Study of Condenser unit
5. Determination of the C.O.P of vapor Absorption Refrigeration system
7. Determination of the cooling capacity and C.O.P. of evaporative condensing test rig.
8. Study of evaporators and condensers device.
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II- SEMESTER

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DESIGN OF AIR-CONDITIONING SYSTEMS
(15D31201)

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- solair 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:

UNIT-V
APPLICATIONS OF AIR-CONDITIONING: -
Industrial, Commercial, transport Air conditioning-Special applications-Computer, Hospital Cold storages, Printing, Textile & Leather industries.
REFERENCES BOOKS:
1. Hand Book of Air conditioning system design -Carrier
6. ASHRAE - Guide and Data Book
CONVECTIVE HEAT & MASS TRANSFER
(Common to R&A/C & Advanced I.C. Engines)
(15D31202)

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

UNIT-III

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.

REFERENCES BOOKS:
1. Heat transfer - J. P. Holman.
2. Heat and Mass transfer- R.C. Sachdeva
JNTU COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.TECH. HEAT POWER (REFRIGERATION & AIR-CONDITIONING)

II- SEMESTER

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REFRIGERATION EQUIPMENT & CONTROLS
(15D31203)

UNIT-I

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).

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)

REFERENCES:

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAM
DEPARTMENT OF MECHANICAL ENGINEERING
M.TECH. HEAT POWER (REFRIGERATION & AIR-CONDITIONING)

II SEMESTER

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ADVANCED FLUID MECHANICS
(Common to R&A/C & Advanced I.C. Engines)
(15D31204)

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 boundary layer: Boundary layer concept, Prandtl's approximations, Blasius 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.


UNIT - IV


UNIT - V

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

REFERENCE:

UNIT-I
Introduction necessity of low temperature - Multistage Refrigeration system -Cascade system
- Manufacture of dry ice-Joule Thompson coefficient.
Liquification of air - Linde 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.

REFERENCE BOOKS:
2. Cryogenic Engineering by Timmerhaus
UNIT - I
DESIGN OF HEAT EXCHANGERS:

DESIGN OF CONDENSERS:

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:

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

REFERENCE BOOKS:
1.  Heat and mass transfer by Arora & Domkundwar.
4.  Refrigeration & Air-Conditioning by Stoecker
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 design static 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.

REFERENCES
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


UNIT III AIR FILTRATION


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.

UNIT V IAQ MEASUREMENTS & CONTROL


TEXT BOOKS:


REFERENCES:

UNIT-I

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
REFERENCES:
1. ASHRAE Handbooks
2. ISHRAE Handbook.
4. Trane air conditioning manual,
5. Refrigeration and Air conditioning, ARI Prentice Hall, New Delhi.
6. Norman C. Harris, Modern air conditioning
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:

REFERENCE BOOKS:
UNIT-I

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 evaporation.

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.

REFERENCE BOOKS:
1. ASHRE - Guide and data book
2. Refrigeration & Air-conditioning- C.P.Arora
3. Hand Book of Air conditioning system design –Carrier
UNIT-I
MATERIAL BEHAVIOR:
Deformation process in pure, impure metals and alloys–effect of low temperature transformation, plastic deformation at constant stress-creep, Role of dislocations, Tensile, Shear strength of perfect and real crystals, Strengthening mechanisms, Work hardening, strain and strain rate on plastic behavior–super plasticity, Ductile and Brittle Failure, Crack Propagation-Fracture, Toughness–fracture toughness, Griffith’s theory, stress intensity factor and fracture toughness Toughening mechanisms–Ductile, brittle transition in steel

UNIT-II
MATERIALS SELECTION
Compatibility with liquid oxygen and other process fluids-external environment, Toughness pressure vessel codes, Motivation for selection-cost basis and service requirements–Selection for surface durability, corrosion and wear resistance–Relationship between materials selection and processing–Case studies in materials selection.

UNIT-III
NON METALLIC MATERIALS
Polymeric materials for Cryogenic Application, Ceramics and Glasses, Cryogenic properties of Composites, Polymeric materials–Formation of polymer structure–Production techniques of fibres, foams, adhesives and coatings–Structure, properties and applications of engineering polymers–Advanced structural ceramics, WC, TiC, TaC, Al2O3, Sic, Si3N4, CBN and diamond–properties, processing and applications.

UNIT-IV
TESTING METHODS AND TECHNIQUES
Basic types of Cryostat and cooling system, Modification, Variations, and special purpose attachments–multiple specimen testing, compression testing, Flexural, torsional, fatigue and impact testing, Extensometry-Resistive strain gauges, Displacement Transducers, Capacitance gauges.

UNIT V
MODERN METALLIC MATERIALS
Dual phase steels, micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel-intermetallics, Ni and Ti aluminides–smart materials, shape memory alloys–Metallic glass–Quasi crystal and nano crystalline materials.
TEXT BOOKS:

REFERENCES:
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 Central Air conditioning system.