

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech in HEATING VENTILATION AND AIR CONDITIONING
Effective from Academic Year 2017- 18 admitted batch
COURSE STRUCTURE AND SYLLABUS
I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Advanced Thermodynamics	25	75	4	0	0	4
PC-2	Refrigeration	25	75	4	0	0	4
PC-3	Air-Conditioning	25	75	4	0	0	4
PE-1	1. Renewable Energy Sources 2. Cryogenic Engineering 3. Computational Fluid Dynamics	25	75	3	0	0	3
PE-2	1. Equipment Design for Thermal Systems 2. Alternative Refrigerants 3. Cold Storage Technology & Systems	25	75	3	0	0	3
OE-1	*Open Elective - I	25	75	3	0	0	3
Laboratory I	Refrigeration & Air Conditioning Lab	25	75	0	0	3	2
Seminar I	Seminar - I	100	0	0	0	3	2
Total		275	525	21	0	6	25

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	Advanced Heat Transfer	25	75	4	0	0	4
PC-5	Ventilation Systems	25	75	4	0	0	4
PC-6	Heating Systems	25	75	4	0	0	4
PE-3	1. Refrigeration Air Condition Equipment & Control Systems 2. Ducting And Air-Conditioning Supply Systems 3. Energy Storage Systems	25	75	3	0	0	3
PE4	1. Energy Conversion and Management 2. Automotive Air Conditioning 3. Maintenance of Refrigeration & Air Conditioning Equipment	25	75	3	0	0	3
OE-2	*Open Elective - II	25	75	3	0	0	3
Laboratory II	Refrigeration & Air Conditioning Simulation Lab	25	75	0	0	3	2
Seminar II	Seminar-II	100	0	0	0	3	2
Total		275	525	21	0	6	25

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	200	100	0	3	22	14

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	100	100	0	0	24	24

*Open Elective subjects must be chosen from the list of open electives offered by **OTHER** departments.

For Project review I, please refer 7.10 in R17 Academic Regulations.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year –II Sem. (HV & AC)

ADVANCED HEAT TRANSFER (Professional Core - 4)

UNIT - I:

Brief Introduction to Different Modes of Heat Transfer: Conduction: General heat Conduction equation-initial and boundary conditions.

1D Steady State Heat Conduction – Composite Systems – Systems with Heat Generation – Fins

2D Steady State Heat Conduction – Analytical solution for simple boundary conditions – Product Solution

UNIT - II:

Transient heat conduction: Lumped system analysis-1D Transient Heat Conduction - Heisler charts-semi infinite solid-use of shape factors in conduction.

Finite Difference Methods for Conduction: 1D & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

UNIT - III:

Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.

External Flows: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.

UNIT - IV:

Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions-hydrodynamic & thermal entry lengths; use of empirical correlations.

Free Convection: Boussinesque approximation-different geometries-combined free and forced convection.

UNIT - V:

Boiling and condensation: Boiling curve-correlations for different regimes -- Condensation: Film and Dropwise condensation - Nusselts theory of film condensation on a vertical plate - assumptions & correlations of film condensation for different geometries.

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces.

REFERENCES:

1. Heat Transfer - A basic approach- Necati Ozisik -TMH
2. Fundamentals of Heat & Mass transfer- Incropera, Dewitt, Bergman, Lavime - wiley Publication
3. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
4. Heat Transfer-S. P. Sukhatme - Univeristies Press
5. Fundamentals of Engineering Heat Transfer-R.C. Sachdeva-New age Science.
6. Heat Transfer/ P. K. Nag /TMH
7. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai
8. Introduction to Heat Transfer/SK Som/PHI
9. Principals of Heat Transfer/Frank Kreith/Cengage Learning

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
I Year - II Sem. M. Tech (HV & AC)

VENTILATION SYSTEMS (Professional Core - 5)

UNIT - I:

Introduction- Fundamentals of good indoor air quality Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth, Psychometric performance of contact volume system. Types of ventilation system. Supply system, Exhaust system.

UNIT - II:

Devices Used in Supply Systems: Air Inlet system. Filters heating & cooling equipment, Fans, Duct, Grills, Diffusers, For distribution of air in the work place.

UNIT - III:

Exhaust Systems: General exhaust systems. Local exhaust system, Removal of pollutants and contaminated air. Air cleaning devices, Fans.

UNIT - IV:

Ventilation in Kitchen: Cooking, Exhaust flow, IMC (International Mechanical Code) Calculation of appliances area, contaminated air, free foot area. Total air flow volume with example. Types of hood, Design of hood. Design factors, integrated air curtains, Combination hood.

UNIT-V:

Ventilation OF Commercial Building: Design of commercial, Residential ventilation system.

REFERENCES:

1. Ventilation Systems: Design and Performance/ Hazim B. Awbi. / Routledge / 2007.
2. Portable Ventilation Systems Hand Book / Neil McManus / CRC Press / 2000.
3. Design of Industrial Ventilation Systems / John L Alden / Industrial Press / 5th Edition.
4. Industrial Ventilation Applications / ISHRAE Hand Book / 2009.
5. Engineering bulletin / TRANE Company.
6. HVAC Hand book / ISHRAE.
7. Industrial Ventilation Applications / ASHRAE Hand Book / 2009.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
I Year -II Sem. M. Tech (HV & AC)

HEATING SYSTEMS (Professional Core - 6)

UNIT - I:

Building Survey-location of equipment. Heat gain through glass-calculation of solar heat gain through ordinary glass tables-shading devices-effect of shading devices. Thermal resistance of various building materials.

UNIT - II:

Heat Transfer Through Building Structures: Periodic heat transfer through walls and roofs. Empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag method. Equivalent temperature difference method. Infiltration-tack effect-wind effect.

UNIT - III:

Heating Load Calculations: Winter heating load calculation-heat losses through structure-heat losses due to infiltration. Effects of solar radiation and internal heat sources on heating loads. Methods for estimating energy requirements for heating.

UNIT - IV:

Air Heating System: Classification - gravity warm heating system, forced warm air heating system-balancing a warm air heating system, warm air furnaces, air cleaners, humidifiers & De-humidifiers, advantages & Disadvantages of warm air heating system. Common problems and remedies of warm air heating system.

UNIT - V:

Hot Water Heating System or Hydraulic Heating System: Classification-based on water circulation, piping arrangement i.e. one pipe system, two pipe direct return system, gravity hot water system. One pipe & two pipe gravity hot water heating. Forced hot water heating system, gas boilers, circulating pump, radiation

REFERENCES:

1. HVAC Fundamentals Volume-I / James E. Brumbou / Audel / 4th Edition
2. Fundamentals of HVAC Systems / Robert Mcdowall / Academic Press / 2007
3. Home Heating & Air Conditioning systems / James Kittle / MGH
4. HVAC Fundamentals / Samuel C. Sugarman / Fairmont Press / 2005.
5. Principles of Refrigeration – Dossat, Pearson
6. R&AC Hand Book by ISHRAE

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
I Year -II Sem. M. Tech (HV & AC)

REFRIGERATION AIR CONDITION EQUIPMENT AND CONTROL SYSTEMS
(Professional Elective - 3)

UNIT - I:

Compressors-Types : constructional details of reciprocating compressors - volumetric efficiency-factors affecting volumetric efficiency-effects of evaporator and condenser pressures- centrifugal compressor - constructional details, applications : Comparison with reciprocating compressors - screw compressors, working principle, single screw and double screw compressor, lubricating oils-rotary compressor-single vane and multi vane compressor surging-Electric motors and control circuits.

UNIT - II:

Condensers: types-water cooled & air cooled condensers-evaporative type, thermal design of compressor-temperature distribution and heat flow in a condenser, pressure drop, fouling factor-LMTD correction factor. (No problems)

Cooling Towers: 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 & dry evaporators-natural & forced convection type-shell & tube, shell & coil, plate type-secondary evaporators-temperature distribution and heat flow in evaporators-pressure drop, fouling correction factor, (no problems)

UNIT - IV:

Expansion Devices - Capillary tube, thermostatic expansion valve, float valve, automatic expansion valve, solenoid control valve— pipe design-general-water piping, refrigerant piping & steam piping-water treatment-corrosion control, scale formation control-Refrigerant flow controls.

UNIT - V:

Installation of Vapor Compression Refrigeration System: evaluation & dehydration-testing for leakages-charging-adding oil defrosting-methods-material, automatic, periodic defrosting-solid & liquid adsorbents; water defrosting - defrosting by reversing the cycle, automatic hot gas defrosting-thermo balance defrosting, electric control defrosting (no problems)

REFERENCES:

1. Principles of Refrigeration/Roy J. Dossat
2. Refrigeration & Air-Conditioning / C. P. Arora/
3. Refrigeration & Air-Conditioning / Stoecker/ TMGH 1982
4. Refrigeration & Air-Conditioning / Domkundwar/Danapath Rai
5. ASHRAE guide & data book application

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
I Year -II Sem. M. Tech (HV & AC)

DUCTING AND AIR-CONDITIONING SUPPLY SYSTEMS (Professional Elective - 3)

UNIT- I :

Air Conditioning Systems: All water, All air, air water system. Unitary System, window air conditioner, split and central air conditioning system, cooling load calculations - occupancy load, lighting load, appliance load, product load, difference between summer & winter load calculations.

UNIT- II :

Air Distribution: Room Air distribution - types of supply air outlets, mechanism of flow through outlets, selection and location of outlets, general considerations. Distribution patterns of outlets - ducts- Definition and types - materials for ducts and its specification, friction loss in ducts - grills, diffusers, registers, rectangular equivalent of circular duct. Air duct designs, duct construction, Duct design procedure.

UNIT- III:

Thermal Insulation for A/C System: 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 building and cold storage - pipe insulation.

UNIT- IV:

Air Conditioning Apparatus: Fans and blowers - types of fans- fan characteristic- centrifugal fans, axial fans -- fan arrangements, filters, sources of noise and control, static pressure calculation for selection of motor and fan. Water supply pipe sizing calculations - piping network for supply and return water line - pipe fittings - lining and insulation - piping system as per ASHRAE standards

UNIT- V:

Applications: Air conditioning systems for automobiles (cars, buses etc) - Air conditioning systems for (trains, ships, aircraft) - Special applications - Computers, hospitals, cold storages, printing, textiles and leather industries.

REFERENCES:

1. Refrigeration & Air-Conditioning by Domkundwar
2. Refrigeration & Air-Conditioning by V.K. Jain
3. Refrigeration & Air-Conditioning by C.P. Arora
4. ASHRAE Hand Book
5. Hand Book of Air Conditioning System design by Carrier

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (HV & AC)

ENERGY STORAGE SYSTEMS (Professional Elective - 3)

UNIT - I

Mechanical: Compressed air energy storage (CAES), Fire less locomotive, Flywheel energy storage, Gravitational potential Energy (device), hydraulic accumulator, Pumped-storage, hydro electricity (pumped) hydroelectric storage, PHS, or Pumped storage hydropower, PSH.

UNIT- II

Electrical, Electromagnetic: Capacitor, Super Capacitor, Super Conducting magnetic energy storage (SMES), also super conducting storage coil.

UNIT- III

Biological: Glycogen, Starch.

Electrochemical (Battery Energy Storage Systems): Flow battery Rechargeable battery, Ultra Battery.

UNIT- IV

Thermal: Brick storage heater Cryogenic energy storage, Liquid nitrogen Engine, Eutectic system, Ice storage air conditioning, Molten salt storage phase change Material, Seasonal thermal energy storage, Solar ponds, Steam accumulator, Thermal energy storage (general)

UNIT- V

Chemical: Biofuels, Hydrated salts, Hydrogen storage, Hydrogen peroxide, Power to gas, Vanadium pent oxide.

REFERENCE:

1. Energy storage Systems & Engineering Technologies- Prof. Anjaneyulu Yerramilli - BS Publications

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
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ENERGY CONVERSION AND MANAGEMENT (Professional Elective - 4)

UNIT - I

Introduction: Principles of energy management. Managerial organization, Functional areas for i) manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs

UNIT - II

Energy Audit: Definition and concepts. Types of energy audits, Basic energy concepts, Resources for plant energy studies. Data gathering, Analytical techniques. Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constraints, Synthesis of alternative options and technical analysis of options. Process integration.

UNIT - III

Economic Analysis: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis.

UNIT- IV

Methods of Evaluation of Projects: Payback, Annualized costs, Investor's rate of return, Present worth, Internal rate of return, Pros and cons of the common method of analysis, Replacement analysis.

UNIT - V

Alternative Energy Sources: Solar Energy: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

REFERENCES:

1. Energy Management Hand Book / W. C. Turner (Ed)
2. Energy Management Principles / CB Smith/ Pergamon Press
3. Energy Management / W. R. Murthy and G. Mc. Kay / BS Publication
4. Management / H. Koontz and Cyrill Donnel / McGraw Hill
5. Financial Management / S. C. Kuchhal / Chaitanya Publishing House

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (HVAC)

AUTOMOTIVE AIR CONDITIONING (Professional Elective - 4)

UNIT - I

AIR CONDITIONING FUNDAMENTALS: Basic air conditioning system - location of air conditioning components in a car, schematic layout of a refrigeration system, compressor components, condenser and high pressure service ports, thermostatic expansion valve, expansion valve calibration, controlling evaporator temperature, evaporator pressure regulator, evaporator temperature regulator.

UNIT - II

AIR CONDITIONER – HEATING SYSTEM: Automotive heaters, manually controlled air conditioner, heater system, automatically controlled air conditioner and heater systems, automatic temperature control, air conditioning protection, engine protection.

UNIT - III

REFRIGERANT: Containers handling refrigerants, tapping into the refrigerant container, refrigeration system diagnosis, diagnostic procedure, ambient conditions affecting system pressures.

UNIT - IV

AIR ROUTING AND TEMPERATURE CONTROL: Objectives, evaporator airflow through the recirculating unit, automatic temperature control, duct system, controlling flow, vacuum reserve, testing the air control and handling systems.

UNIT - V

AIR CONDITIONING SERVICE: Air conditioner maintenance and service, servicing heater system removing and replacing components, trouble shooting of air controlling system, compressor service.

REFERENCES:

1. William H. Crouse and Donald I. Anglin - "Automotive Air conditioning" - McGraw Hill Inc. - 1990.
2. Mitchell information Services, Inc - "Mitchell Automatic Heating and Air Conditioning Systems" - Prentice Hall Ind. - 1989.
3. Paul Weiser - "Automotive Air Conditioning" - Reston Publishing Co., Inc., - 1990.
4. MacDonald, K.I., - "Automotive Air Conditioning" - Theodore Audel series – 1978
5. Goings. L.F. – "Automotive Air Conditioning" - American Technical services - 1974.
6. Boyce H. Dwigins - "Automotive Air Conditioning" - Delmar – 2002.
7. "Principles of Refrigeration", Roy J Dossat: Pearson Education Inc.
8. "Refrigeration and Air Conditioning"; Arora and Damkondwar: Dhanpat Rai and Company.
9. "Refrigeration and Air Conditioning", C. P. Arora: Tata McGraw Hills Pub.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
I Year -II Sem. M. Tech (HV & AC)

MAINTENANCE OF REFRIGERATION AND AIR CONDITIONING EQUIPMENT
(Professional Elective - 4)

UNIT - I

Refrigeration Equipment & Application

Elementary knowledge of refrigeration & air conditioning equipments e.g compressors, condensers, evaporators & expansion devices, Air washers, Cooling towers & humidifying efficiency, Food preservation, cold storage, Refrigerate Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning.

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.

REFERENCES:

1. Robert C. Rosciler, HVAC Maintenance, and operations Hand Book, McGraw. Hill, 1997.
2. Althouse A.D. and Turnquist C. H., Modern Refrigeration and Air conditioning, Good Heart-Wilcoz Co Inc., 2004.
3. ISHRAE Hand book on Refrigeration & Air conditioning, ISHRAE Bangalore, 1998.
4. Nelson C. W., Commercial and Industrial Refrigeration, McGraw-Hill, 1982.
5. Reed G. H., Refrigeration, A Practical Manual, Applied Science Publishers Ltd., London, 1982.
6. Russel E. Smithy, Electricity for Refrigeration, Heating and Air-conditioning, Duxbury Press, Massachusetts, 1980.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
I Year - II Sem. M. Tech (HV & AC)

REFRIGERATION & AIR CONDITIONING SIMULATION LAB

1. Simulation of Refrigeration loops
2. Simulation of Air conditioning loop
3. Simulation of heat pump system
4. Simulation of refrigerant loop using alternate refrigerants
5. Simulation of air conditioning loop using alternate refrigerant
6. Sizing and optimization of components in refrigerant loop
7. Simulation of controls in refrigeration & Air conditioning loop
8. Cooling load evaluation for different applications, viz., 100% fresh air, recirculated and by pass air
9. The equipment may be conducted using refrigerant & air-conditioning simulation software.

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