JK Lakshmipat University

Near Mahindra SEZ, P.O. Mahapura, Ajmer Road, Jaipur 302 026

Ph.:+91-141-7107500/504

INSTITUTE OF ENGINEERING AND TECHNOLOGY

2 Year M.Tech. Program

in

Thermal Engineering

(Department: Mechanical Engineering)

Batch 2017-19

Course Structure

&

Scheme of Examination

JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
Department of Mechanical Engineering
(M.Tech. Program in Thermal Engineering)
Course Structure for the Batch 2017-19

Semester	Courses						LTP Credit Hrs/ Week
I	Advanced Thermodynamics	Viscous Fluid Flows	Convective Heat & Mass Transfer	Experimental Methods in Thermal Engineering	Numerical Methods in Engineering		(15 4 2) 20
	TEMTECH101	TEMTECH102	TEMTECH103	TEMTECH104	TEMTECH105		
	(310)4	(310)4	(310)4	(302)4	(310)4		21
II	Thermal Systems Simulation and Design	Energy Management	Program Elective-I	Program Elective-II	Program Elective-III		(15 3 4) 20
	TEMTECH201	TEMTECH202					
	(302)4	(310)4	(310)4	(310)4	(310)4		22
III	Program Elective-IV	PROJECT	SEMINAR	Minor Dissertation			20
		TEMTECH302	TEMTECH303	TEMTECH304			
	(310)4	(6)6	(004)2	(8)8			22
IV	Seminar	Major Dissertation					20
	MTECH401	MTECH402					22
	(004)2	(18)18					

List of Program Elective Courses (Note: There are two groups A&B. Students have to select either group A or group B

	Group A: Energy Engineering	**Group B: Refrigeration and Air-conditioning**
Program Elective-I	Energy System	Advanced Refrigeration and Air conditioning
Program Elective-II	Steam & Gas Turbines	Two Phase Flow and Heat Transfer
Program Elective-II	Renewable Energy Systems	Thermal Environmental Engineering
Program Elective-III	Design of Heat Exchange Equipment	Design of Heat Exchangers
Program Elective-III	Conduction & Radiation	Air-conditioning & Ventilation
Program Elective-IV	Introduction to Transport Phenomena	Cold Preservation of Foods
Program Elective-IV	Computational Methods in Thermal & Fluids Engineering	Refrigeration and Air-conditioning System Design

Total Credits-80

Course Code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH101	Advanced Thermodynamics	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Sylabus(Theory)

Unit–I

Introduction to thermodynamics, Entropy: Clausius theorem- the property of entropy– the Inequality of Clausius– entropy change in an irreversible process–entropy principle– Applications of entropy principle to the processes of transfer of heat through a finite temperature difference, and mixing of two fluids maximum work obtainable from a finite body and a thermal energy reservoir–entropy transfer with heat flow-entropy generation in a closed system–entropy generation in an open system.

UNIT-II

P-V-T Relationships for pure substances: P-V diagram for a pure substance, triple point line, critical point, Properties of Gases: Equations of state– Vander Waal's equation–law of corresponding states – Beatie- Bridgeman equation, Redlich-Kwong equation, Mo**l**ier diagram for a pure substance– drynessfraction– problems using steam tables. Gas Mixtures: Dalton's law of partial pressures– enthalpy and entropy of gas mixtures. Reactive Systems: Degree of reaction– reaction equilibrium– law of mass action– heat of reaction – temperature dependence of the heat of reaction– temperature dependence of the equilibrium constant–change in Gibbs function – Fugacity and activity.

UNIT-III

Thermodynamic Relations: derivation of Maxwe**l**'s equations–TdS equations– difference in Heat capacities– ratio of heat capacities– Joule-Kelvin effect– Clausius- Clapeyron equation.

UNIT-IV

Power Cycles: Brayton cycle– comparison between Brayton cycle and Rankine cycle– effect of regeneration on Brayton cycle efficiency– Brayton- Rankine combined cycle.

UNIT-V

Statistical Thermodynamics: Thermodynamic equilibrium distribution– thermodynamic distribution function– thermodynamic ensemble, micro canonical ensemble, canonical ensemble, grand canonical ensemble.

Text Book(s)

1. Adrian Bejan, Advanced Engineering Thermodynamics, John Wiley & Sons 3rd Edition.
2. M J Moran, H N Shapiro, Advanced Engineering Thermodynamics, John Wiley & Sons 3rd Edition

Reference Book(s)

1. Y. A. Cengel and M. A. Boles, "Thermodynamics– An Engineering Approach", 5th Edition in SI Units, Tata McGrawHi**l** Publishing Company Limited, New Delhi, 2006.

2. C.Borganakke and R. E. Sonntag, “Fundamentals of Thermodynamics”, 7th Edition, Wiley India, Delhi, 2012.
3. Van P. Carey, “Statistical thermodynamics and micro scale thermo physics”, Cambridge University Press,1999.

Course Code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH102	Viscous Fluid Flows	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

Unit-I
Introduction of viscous flow, fluid properties, Velocity and stress fields Continuity, Euler's equation; N-S and vorticity equations and its solutions for viscous flow, with numerical problems.

Unit-II
Exact solutions Stokes' problems, Exact solutions; Poiseuille and Couette flows, more exact solutions; inclined plane, immiscible flows, Creeping flows, with numerical problems.

Unit-III
Viscous particle motion, Similarity; viscous stagnation flows, Boundary layer theory; flow separation, with numerical problems.

Unit-IV
Integral methods; Karman integral relation, Thwaite's method, Transition to turbulence; topics in stability analysis, with numerical problems.

Unit-V
Reynolds' averaging; closure models; mixing length theories, with numerical problems.

Text Book(s)
1. Fluid Mechanics, Franz Durst, Springer 1st Edition

Reference Book(s)
1. Viscous Fluid Flow, Frank White, McGraw-Hill, 3rd Edition

Course Code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH103	Convective Heat & Mass Transfer	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I
Definitions of Heat/ Mass Transfer Coefficient, Main Flow Classifications, Transport Equations of Bulk Mass, Momentum, Energy and Species transfer.

Unit-II
Boundary Layer Theory and its approximations, Laminar and Turbulent External boundary layers with effects of Pressure Gradient, Wall thermal conditions, viscous dissipation, Wall mass transfer. Similarity, Integral and Finite- difference solutions of boundary layer equations

Unit-III
Developing Internal (ducted) flows within boundary layer approximations, fully developed flows and heat transfer in non-circular ducts, use of superposition techniques, Graetz Problem and its solution.

Unit-IV
Turbulent Flow and Heat transfer through a pipe; Chilton Colburn Analogy, Reynolds' Analogy; Convection Correlations Computational Approaches for solving turbulent Flows and k-epsilon model of turbulence. Free Convection: Analytical solution for flow over a heated vertical plate. Free Convective Flows for other important geometries; Mixed Convection; Influence of Richards on number, Archimedes number.

Unit-V
Condensation; Transpiration cooling. Boiling; Nucleation and Bubble Growth; Homogeneous Nucleation; Heterogeneous Nucleation; Bubble Growth Without Heat and Mass Transfer Convective Mass Transfer; The Concentration boundary layer; Heat and Mass Transfer Analogy.

TextBook(s):

1. Kays W M and Crawford M E, "Convective Heat and Mass Transfer", McGraw Hill Int Edition, 3rd edition, 1993.

ReferenceBook(s):

1. Spalding D B, "Introduction to Convective Mass Transfer", McGraw Hill, 1963.

2. Bird R. B., Stewart W. E. and Lightfoot E. N., "Transport Phenomena", John Wiley and Sons, Inc., 1960.
3. Schlichting H., "Boundary Layer Theory", Sixth edition, McGraw Hill, 1968.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH104	Experimental Methods in Thermal Engineering					3	0	2	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	20	50	-	30	100

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

Unit-I

Temperature measurement: Hg- in- glass thermometer, RTD, thermistor, thermocouple, thermopile, liquid- crystal thermography, optical pyrometer, and Thermal conductivity measurement: Guarded hot plate apparatus, heat flux meter.

Unit-II

Pressure Measurement: Manometers, bourdon tube pressure gage, diaphragm gage, bellow gage, McLeod gage, Pirani gage and ionization gage.

Unit-III

Flow measurement: Positive displacement flow meters, venture, orifice, impact tube, flow nozzle, sonic nozzle, rotameter, pitot static tube, hot-wire anemometer, laser Doppler anemometer, flow visualization techniques– shadow graph, Schlieren and interferometer.

Unit-IV

Fundamentals: Importance of measurement and experimentation, calibration, uncertainty analysis, error propagation, Gaussian or Normal distribution, confidence level, regression analysis, correlation coefficient, Chi- Square test, zeroth-, first- and second- order systems.

Unit-V

Data acquisition and processing: Signal conditioning, data transmission, storage, A to D and D to A conversion, Designing experiments.

Text Book(s):

1. J. P. Holman, Experimental Methods for Engineers, 7th edition, Tata McGraw-Hill 2001.

Reference Book(s):

1. T. G. Beckwith, J. H. Lienhard V, R. D. Marngoni, Mechanical Measurements, 5th edition, Pearson Education, 2010.
2. E. O. Doebelin, Measurement systems, Application and Design, 5th edition, Tata McGraw-Hill, 2008.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH105	Numerical Methods in Engineering					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

UNIT-I

System of linear equations: Gauss elimination method, triangularization method, Cholesky method, Partition method, Error Analysis for Direct Methods. Iteration Methods: Jacobi Iteration Method, Gauss Seidel Iteration Method, SOR Method.

UNIT-II

Eigen value and Eigen Vectors, Boundson Eigen values, Jacobi Method for symmetric matrices, givens method for symmetric matrices, house holders method, power method.

UNIT-III

Numerical differentiation: Introduction, methods based on undetermined coefficients, optimum choice of step length, extrapolation methods, partial differentiation. Numerical Integration: Introduction, open type integration rules, methods based on undetermined coefficients: Gauss- Legendre, Gauss Chebyshev, Romberg Integration. Double integration: Trapezoidal method, Simpson's method.

UNIT-IV

Numerical Solutions of ordinary differential equations (boundary value problem): introduction, shooting method: linear and nonlinear second order differential equations.

UNIT-V

Numerical solutions of partial differential equations: introduction, finite difference approximation to derivatives. Laplace equation -Jacobi method, Gauss Seidel Iteration Method, SOR Method, Parabolic Equations, iterative methods for parabolic equations, hyperbolic equations.

Text Book(s):

1. S. S. Sastry, "Introductory Methods of Numerical Analysis", Prentice Hall India Pvt., Limited, 4th Edition.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Limited, Publishers, 4th Edition, 2003.

ReferenceBook(s)

1. Samuel Daniel Conte, Carl W. DeBoor, "Elementary Numerical Analysis: An Algorithmic Approach", 3rd Edition, McGraw-Hill.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH201	Thermal Systems Simulation and Design					3	0	2	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	20	50	-	30	100

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

Unit-I
Modeling of Thermal Systems: types of models, mathematical modeling, curve fitting, linear algebraic systems.

Unit-II
Numerical model for a system, system simulation, methods for numerical simulation, Acceptable Design of a Thermal System: initial design, design strategies, design of Systems from different application areas, additional considerations for large practical Systems.

Unit-III
Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems.

Unit-IV
Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems.

Unit-V
Search methods: single - variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynamic programming and other methods for optimization, knowledge-based design and additional considerations, professional ethics.

Text Book(s):

1. W. F. Stoecker, Design of Thermal Systems- McGraw-Hill, 1971.

Reference Book(s):

1. Y. Jaluria, Design and Optimization of Thermal Systems– CRC Press, 2007.
2. Bejan, G. Tsatsaronis, M. J. Moran, Thermal Design and Optimization-Wiley, 1996.
3. R. F. Boehm, Developments in the Design of Thermal Systems- Cambridge University Press, 1997.
4. N. V. Suryanarayana, Design & Simulation of Thermal Systems- MGH, 2002.

Course Code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH211	Energy Systems	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

Unit-I

Classification of energy sources- Utilization, economics and growth rates- Fossil fuels, nuclear fuels and solar energy- Combustion calculations.

Unit-II

Conventional thermal power plant design and operation- Superheat, reheat and regeneration- Other auxiliaries of thermal plant- High- pressure boilers- Steam generator control.

Unit-III

Gas turbine and combined cycle analysis – Inter - cooling, reheating and regeneration gas turbine cooling - design for high temperature - Combined cycles with heat recovery boiler – Combined cycles with multi-pressure steam – STAG combined cycle power plant – Influence of component efficiencies on cycle performance.

Unit-IV

Energy efficiency – Energy accounting, monitoring and control– Thermal and Electricity audit instruments – Energy consumption models - Specific Energy Consumption – ECO assessment and Evaluation methods.

Unit-V

Transformer loading/ efficiency analysis – Feeder loss evaluation – Lighting – Energy efficient light sources - Domestic/ commercial / industrial lighting – Lighting controls- Energy conservation in lighting schemes- Luminaries- Casestudies.

Text Book(s):

1. El – Wakil M. M., Power Plant Technology, McGraw Hill, 1985.
2. Culp Jr A. W., Principles of Energy Conversion, McGraw Hill, 2001.

Reference Book(s):

1. Sorensen, H. A., Energy Conversion Systems, J. Wiley, 1983.
2. Morse, T. F., Power Plant Engineering, Affiliated East West Press, 1978.
3. Saigh, A. A. M., (Ed): Solar Energy Engineering, Academic Press, 1977.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH202	Energy Management					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Importance of energy management. Energy auditing: methodology, analysis of past trends (plant data), closing the energy balance, laws of thermodynamics, measurements, portable and online instruments.

Unit-II

Steam Systems: Boiler- efficiency testing, excess air control, Steam distribution & use steam traps, condensate recovery, flash steam utilization. Thermal Insulation.

Unit-III

Electrical Systems: Demand control, power factor correction, load scheduling / shifting, Motor drives- motor efficiency testing, energy efficient motors, motor speed control. Lighting levels, efficient options, fixtures, day lighting, timers, Energy efficient windows.

Unit-IV

Energy conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration & air conditioning systems. Waste heat recovery: recuperators, heat wheels, heat pipes, heat pumps.

Unit-V

Cogeneration- concept, options (steam/ gasturbines/ diesel engine based), selection criteria, control strategy. Heat exchanger networking- concept of pinch, target setting, problem table approach, composite curves. Demand side management.

Text Book(s):

1. L. C. Witte, P. S. Schmidt, D. R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988.

Reference Book(s)

1. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
2. I. G. C. Dryden, Butterworths, The Efficient Use of Energy, London, 1982.
3. W. C. Turner, Wiley, Energy Management Handbook, New York, 1982.
4. Technology Menu for Efficient energy use- Motor drive systems, Prepared by National Productivity Council and Center for & Environmental Studies- Princeton Univ, 1993.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH213	Renewable Energy Systems					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Introduction SOLAR RADIATION AND COLLECTING DEVICES: Solar Incident Flux, Extra-terrestrial Radiation, Clear Sky Irradiation, Solar Radiation Measurement, Monthly Average Radiation on Tilted Surfaces. Cover plates, Collector Plate Surfaces, Collector Performance, Collector Improvement, Effect of Incident Angle, and Heat Transfer to Fluids, Heat Transfer Factors, Concentrating Collectors, and Reflectors.
SOLAR SYSTEM DESIGN AND ECONOMIC EVALUATION Hot water heating, heating and hot water systems, pump sand fans, sizing pipe and duct work, fundamentals of economic analysis, systems optimization.

Unit-II

WIND ENERGY SYSTEMS: Orientation systems and Regulating devices, Types of Wind Turbines, Operating Characteristics, Basics of Air-foil Theory, Wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems.

Unit-III

ENERGY FROM WATER: OTEC– Principle of operation, Open and Closed OTEC cycles, Wave energy: Wave energy conversion machines and recent advances Tidal Energy: Single basin and double basin tidal systems Small- Mini- Micro hydro-system: Concepts, Types of turbines, Hydrological analysis.

Unit-IV

GEOTHERMAL ENERGY: Introduction, Classification of Geo-thermal areas, Applications of Geo- thermal energy for power generation, Economics of Geo- thermal energy.

Unit-V

Alternate Technologies: Principles of MHD Power Generation, Ideal MHD– Generator Performance, Practical MHD Generator: Faraday and Hall Configurations, MHD Technology. Fuel Cell– principle and operation, types and recent developments, electrolyser– construction and operation.

Text Book(s):

1. B H Khan, Non-Conventional Energy Resources, Tata McGraw Hill, 2nd Ed.

Reference Book(s):

1. Peter J. Lunde Solar Thermal Engineering, John Wiley & Sons.
2. H. P. Garg, Solar Energy Fundamentals and Applications, TMH.
3. S. Psukhatme, Solar Energy Principles of thermal storage, TMH.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH223	Design of Heat Exchange Equipment					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Heat Exchangers - mean temperature differences for parallel and counter flow effectiveness method (NTU). Classification of heat transfer equipment – Design of shell and tube heat exchanger.

Unit-II

Finned surface heat exchanger – Heat exchangers for special services – Fired heaters Plate and spiral plate heat exchanger – plate heat exchanger for Dairy industry –Heat Pipes.

Unit-III

Overall heat transfer co-efficient – temperature distribution and heat flow in a condenser - pressure drop in a condenser - extended fin surfaces - consideration of fouling factors – LMTD correction factor.

Unit-IV

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 various types of boilers.

Unit-V

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.

Text Book(s):

1. Ganapathy, V., Applied Heat Transfer, Pennwell Books, 1982.

Reference Book(s):

1. Heat and Mass Transfer by – Arora and Domkundwar.
2. Kays, W. M. and London, A. L., Compact Heat Exchangers, McGraw-Hill, 1998.
3. Dunn, P. and Reay, D. A., Heat Pipes, Pergamon, 1994.
4. Kakac, S. and Liu, H., Heat Exchangers, CRC Press, 2002.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH212	Steam and Gas Turbines					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

Unit-I
Classification of steam turbines, combination of turbines, over view of turbines, Flow of steam through impulse turbine blades / impulse and reaction turbines blades, Energy losses in steam turbines, governing and performance of steam turbines.

Unit-II
Steam turbine auxiliary systems: turbine protective devices, tripping devices, unloading gears, lubricating systems, glands and sealing systems, Construction, Operation and Maintenance of Steam Turbines.

Unit-III
Gas Turbine – shaft power cycles, velocity diagram and work done by gas turbine, turbine blade cooling, blade materials, blade manufacture, matching of turbine components.

Unit-IV
Combustion chambers, requirements, types, factor affecting performance of CC, performance of turbines.

Unit-V
GT auxiliary systems, operation and maintenance, starting and ignition systems, lubrication systems, Fuel system and controls, operation, maintenance and troubleshooting.

Text Book(s):

1. R Yadav, Steam and Gas Turbines and Power Plant Engineering, Central Publishing House, Allahabad, 2004.

Reference Book(s):

1. Ganesan, V., Gas Turbines, Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 1999.
2. Lee J F, Theory and Design of Steam and Gas Turbines, McGraw-Hill, New York.
3. Meherwan P Boyce, Gas Turbine Engineering Handbook, Gulf Publishing Company.
4. Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd, 1989.

5. Gordon C, Dates, Aero – thermodynamics of Gas Turbine and Rocket Propulsion AIAAE ducation Series, NY, 1984.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH215	Conduction and Radiation					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Introduction to three modes of heat transfer - conduction, convection and radiation. Importance of radiation, Mechanism of radiation, Electromagnetic spectrum. Concept of black body, derivation of black body radiation laws from first principles – Planck's law, Stefan Boltzmann law, Wien's displacement law. Universal black body function, F function charts.

Unit-II

Spectral directional emissivity, definition of total and hemispherical quantities, hemispherical total emissivity. Spectral directional absorptivity, Kirchhoff law, directional and hemispherical absorptivity, hemispherical total absorptivity. Concept of bi-directional reflectivity, bi-hemispherical spectral reflectivity, hemispherical total reflectivity. Participating media and concept of transmissivity, total transmissivity.

Unit-III

Need for view factors, concept of view factors, mathematical definition. View factor Algebra, Hottel's crossed string method, view factors for 2D surfaces using algebra. View factors from 2D surfaces using charts, Radiosity Irradiation method for gray diffusion closures – Problems for 2 and 3 surface enclosures –parallel plate formula, radiation shields, concept of re-radiating surface.

Unit-IV

Introduction to gas radiation – The equation of transfer – derivation Simple solutions to the equation of transfer. Concept of mean beam length – Calculation of mean beam length for simple geometries from charts and formula. Engineering treatment of gas radiation in enclosures – modified enclosure theory – problems to illustrate the modified enclosure theory.

Unit-V

Introduction to conduction: Derivation of energy equation for conduction in three dimensions – Initial and boundary conditions. Solution of simple problems in steady state conduction with analytical solutions – Concept of electrical analogy –fin heat transfer and concept of fin efficiency and fin effectiveness. Laplace equation – solution by variable separable method –concept of superposition and homogeneous boundary conditions. Phase change problems – The Stefan and Neumann problems –analytical solutions.

Numerical solution of conduction problems: Basic ideas of finite difference method – forward, backward and central differences – Discretization for the unsteady heat equation – simple problems. Basis ideas of the finite volume method –application to Laplace and Poisson equations.

Text Book(s):

1. M. Necati Ozisik, Heat Transfer: A Basic Approach, McGraw-Hill Education, International Edition, May 1, 1985.

Reference Book(s):
Conduction:

1. Conduction Heat Transfer, D. Poulikakos, Prentice Hall, 1994.
2. Heat Conduction, S. Kakac and Y. Yener, Taylor and Francis, 1994.
3. Analytical methods in Conduction Heat Transfer, G. E. Myers, McGraw Hill, 1971.
4. Conduction Heat Transfer, V. S. Arpaci, Addison Wesley, 1996 (A bridged edition Ginn press 1998)
5. Heat Transfer, A. J. Chapman, Macmillan, 1984.

Radiation:

1. Thermal Radiation Heat Transfer, R. Siegel and J. R. Howell, Taylor & Francis, 2002.
2. Radiation Heat Transfer, E. M. Sparrow and R. D. Cess, Wadsworth, 1966.
3. Radiative Transfer, H. C. Hottel and A. F. Saroffim, McGraw Hill, 1967.
4. Radiative Heat Transfer, M. F. Modest, McGraw Hill, 2003.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH311	Introduction to Transport Phenomena					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

Unit-I
Introduction to transport phenomena, Vector and tensor calculus, Mechanisms of momentum transport, Shell momentum balances, 1-D problems on velocity distribution in laminar flow.

Unit-II
Equations of change for isothermal systems, Applications of equations of change to solve1-D problems on velocity distribution in laminar flow, Mechanisms of energy transport, Shell energy balances.

Unit-III
1-D problems on temperature distribution in solids and in laminar flow, Equations of change for non-isothermal systems, Applications of equations of change to solve 1-D problems on temperature distribution in solids and in laminar flow.

Unit-IV
Mechanisms of mass transport, Shell mass balances, Applications of shell mass balances to solve 1-D problems on concentration distributions in solids and in laminar flow.

Unit-V
Equations of change for multi-component systems, 1-D problems on concentration distributions in solids and in laminar flow, Methods of solution of momentum, heat and Mass transfer problems with more than one independent variable.

Text Book(s):

1. Transport Phenomena by Bird, Stewart, and Lightfoot, Revised Second Edition, Wiley, 2007

Reference Book(s)

1. S. Kou, Transport Phenomena in Materials Processing, John Wiley and Sons, New York (1996).

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH221	Advanced Refrigeration and Air conditioning					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Refrigeration cycles–analysis: Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle – conditions for high COP – deviations from ideal vapor compression cycle, Multi pressure Systems, Cascade Systems - Analysis.

Unit-II

Main system components: Compressor- Types, performance, Characteristics of Reciprocating Compressors, Capacity Control, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their behaviour with fluctuating load.

Unit-III

Refrigerants: Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact – Montreal / Kyoto protocols – Eco Friendly Refrigerants. Different Types of Refrigeration Tools, Evacuation and Charging Unit, Recovery and Recycling Unit, Vacuum Pumps.

Unit-IV

Other refrigeration cycles: Vapor Absorption Systems – Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration Thermo Electric Refrigeration, Air Refrigeration cycles.

Unit-V

Psychrometry: Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation.

Text Book(s):

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited.
2. Arora C. P., Refrigeration and Air-conditioning, Tata McGraw–Hill, New Delhi.

Reference Book(s):

1. Stoecker W. F., and Jones J. W., Refrigeration and Air-conditioning, McGraw-Hill, New Delhi.
2. Data Books: Refrigerant and Psychrometric Properties (Tables & Charts) SI Units, Mathur M. L. & Mehta F. S., Jain Brothers.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH222	Two Phase Flow and Heat Transfer					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Phase Transition Boiling – Basic processes – Nucleation – Bubble Growth – Pool Boiling – Convective Boiling, Subcooled Boiling, Saturated Boiling, Critical Heat Flux (CHF)/ Maximum Heat Flux - Onset, mechanisms, correlations - Void fractions and DP – Helmholtz Instability, Film Boiling (Saturated, Subcooled) – Taylor instability.

Unit-II

Condensation – Basic Processes - Nucleation, growth – Kinetic theory, non-condensibles - Film condensation – Dropwise condensation.

Unit-III

Two – Phase Flow Introduction – Variables – Flow Patterns Homogeneous Flow Model – Conservation Equations – Pressure Gradient – Velocity of Sound – Two –Phase Friction Factor, ΔP.

Unit-IV

Separated Flow Model – Pressure Gradient - Maximum Flowrate, choked flow-ΔP, Martinelli & other correlations.

Unit-V

Critical Flow, Drift Flux Model - Flooding, flow reversal Special Applications-Bubbly Flow – Slug Flow – Annular Flow – ΔP for special geometries- Nano-fluids, Boiling Chaos, Fractals.

Text Book(s):

1. Liquid Vapor Phase Change Phenomena: An Introduction to Thermo-physics of Vaporization and Condensation Processes in Heat Transfer Equipment, by Carey V. P., 2nd edition, 2008, Taylor & Francis.
2. Handbook of Phase Change, Boiling and Condensation, by Kandlikar S. G., Shoji M., and Dhir V. K., 1st edition, 1999, Taylor and Francis.

Reference Book(s):

1. Nano fins – Science and Applications, N. Singh and D. Banerjee, 2012, Springer.
2. Transport Phenomena in Multiphase Systems, Faghri A., and Zhang Y., 2006, Elsevier.

3. Mechanistic Modeling of Gas – Liquid Two – Phase Flow in Pipes, Shoham O., 2006, SPE Book Store (http://store.spe.org).
4. Convective Boiling and Condensation by Collier J. G., and Thome J. R., 3rd edition, 1994, Oxford Science Publication.
5. Boiling Heat Transfer and Two Phase Flow by Tong L. S., and Tang Y. S., 2nd edition, 1997, Taylor and Francis.
6. Transport Processes in Boiling and Two Phase Systems, Hsu Y. Y., and Graham R. W., McGraw Hill, 1976.
7. Heat Transfer in Boiling, Hahne, E., and Grigull, U., Academic Press, 1972.
8. Boiling Liquid Metal Heat Transfer, Dwyer, O. E., American Nuclear Society, 1974.
9. Handbook of Heat Transfer, Rosenhow, W. E., and Hartnett, J. P., McGraw Hill, 1974.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH214	Design of Heat Exchangers					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

Unit-I

Basic design methodologies: Classification of heat exchanger, selection of heat exchanger, Thermal –Hydraulic fundamentals, Overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and crossflow heat exchanger, e-NTU method for heat exchanger analysis, Fouling, Rating and sizing problems, heat exchanger design methodology.

Unit-II

Fouling of heat exchangers: Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling

Unit-III

Design of double pipe heat exchangers: Thermal and Hydraulic design of inner tube and annulus, hair pin heat exchanger with bare and finned inner tube, total pressure drop Design of Shell & tube heat exchangers: Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method. Design of compact heat exchangers: Heat transfer enhancement, plate fin heat ex changer, tube fin heat exchanger, heat transfer and pressure drop.

Unit-IV

Condensers and evaporators Condenser: Shell and tube condenser, plate condenser, air Cooled condenser, direct contact condenser, condenser for refrigeration and air-conditioning, thermal design of shell and tube condenser Evaporator: Evaporator for refrigeration and air-conditioning, thermal analysis of evaporator, standards for evaporators and condensers.

Unit-V

Heat transfer enhancement and performance evaluation: Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis.

Text Book(s):

1. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press.

2. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication.

Reference Book(s):

1. Compact Heat Exchangers by Kays, V. A. and London, A. L., McGraw Hill
2. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press
3. Heat Exchanger Design Handbook by Schunder E. U., Hemisphere Pub., Process Heat transfer by Donald Q Kern, McGraw Hill.

Course Code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH224	Thermal Environmental Engineering	3	1	0	4

Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

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-psychosocial effects – Parameters causing SBS – Biocontaminants – 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 CLEAN ROOMS – History of cleanrooms – classification - cleanroom standards different contaminants, ISO classification – interiors – Recommended practices – Design of clean rooms for Hospitals, Pharmaceutical, microelectronic, Biotechnology food industries and manufacture industries – International standards.

UNIT-V
IAQ MEASUREMENTS & CONTROL Contaminants measurement - sampling methods - Quality assurance calibration - data interpretation – instruments – specifications – source control – prevention Dilution Ventilation – demand control volume method.

Text Book(s):

1. Threlkeld, J. L., Thermal Environmental Engineering, Prentice Hall, New Jersey, 1962.
2. Whyte W. Clean Room Design II Edition, John Wiley & Sons (NY) – 1999.

Reference Book(s):

1. American Institutes of Architects (AIA), Guidelines for Design & Construction of Hospital & Healthcare facilities, AIA, Washington – 2001.
2. Thad Goodish, Sick Buildings, Lecois Publishers, Ann Arbor, 1994.

3. National Air Filtration Association, NAFA guide to Air Filtration –III edition NAFA. Washington DC - 2001.
4. ASHRAE Hand Book, HVAC Systems and Equipment, I-P Edition, 1996.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH225	Air-conditioning and Ventilation					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

UNIT-I

Psychometry – Evolution of air properties and psychometric chart- Basic processes i.e. sensible heating/ cooling, humidification/ dehumidification and their combinations, steam and adiabatic humidification, adiabatic mixing, etc.-By pass factor and Sensible heat ratio.

UNIT-II

Human Comfort- Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level- Concept of human comfort-Thermal response- comfort factors- Environmental indices- Indoor air quality. Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP- Precision AC-Winter AC.

UNIT-III

Load Estimation – Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor. Design conditions, outdoor, indoor – External load, wall, roof, glass – Internal load, occupancy, lighting, equipments - Ventilation, air quantity, loads-Load estimation methods. Heating load estimation – Vapour transfer in wall, vapour barrier, load estimation basics.

UNIT-IV

Basics of Ventilation-Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings. Methods of Ventilation-Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined-Displacement ventilation Industrial Ventilation-Steel plants, car parks, plant rooms, mines, etc.

UNIT-V

Air Distribution-Ducts, types, fittings, air flow, friction chart, methods of sizing, balancing. Air Diffusion-Isothermal jet, throw, drop, types of outlets, ADPI, outlet/ inlet selection.

Text Book(s):

1. Threlkeld, J. L., Thermal Environmental Engineering, Prentice Hall, New Jersey, 1962.

Reference Book(s):

1. ASHRAE Handbook-Fundamentals, American Society of Heating, Refrigerating and Air – Conditioning Engineers Inc., Atlanta, USA, 2009.
2. Croome, D. J. and Roberts, B. M., Air conditioning and ventilation of buildings, Pergamon.
3. Stoecker, W. F., and Jones, J. W., Refrigeration and Air Conditioning, 2nd Edition, Tata McGraw Hill, New Delhi, 1982.
4. Arora, C. P., Refrigeration and Air Conditioning, Tata-McGraw Hill, New Delhi, 2003.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH322	Refrigeration and Air-conditioning System Design					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

UNIT-I
REFRIGERATION CYCLES – ANALYSIS, Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle, conditions for high COP- deviations from ideal vapor compression cycle, Multi-pressure Systems, Cascade Systems-Analysis.

UNIT-II
MAIN SYSTEM COMPONENTS Compressor- Types, performance, Characteristics of Reciprocating Compressors, Capacity Control, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behavior with fluctuating load.

UNIT-III
REFRIGERANTS: Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact- Montreal/ Kyoto protocols - Eco Friendly Refrigerants. Different Types of Refrigeration Tools, Evacuation and Charging Unit, Recovery and Recycling Unit, Vacuum Pumps. SYSTEM BALANCING & CONTROLS: System Equilibrium and Cycling Controls, Electric Circuits in-Refrigerators, Window A/C, Types of motors, Relays.

UNIT-IV
LOAD ESTIMATION &AIRCONDITIONING CONTROL: Solar Radiation-Heat Gain through Glasses, Heat Transfer through Walls and Roofs Total Cooling Load Estimation. Controls of Temperature, Humidity and Airflow.

UNIT-V
AIR DISTRIBUTION: Flow through Ducts, Static & Dynamic Losses, Air outlets, Duct Design– Equal Friction Method, Duct Balancing, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units. WATER CIRCUITS: Water piping in Chilled Water Systems, Multiple Fan Coil Units, Condensers Multiple Condensers and Cooling Towers.

Text Book(s):

1. Dossat R. J., Principles of refrigeration, John Wiley, S. I. Version (2001).
2. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, New Delhi - 2000.

Reference Book(s)

1. Carrier Air Conditioning Co., Hand book of Air Conditioning Systems design, McGraw Hill, 1985.
2. Langley, Billy C. Refrigeration and Air Conditioning Ed.3, Enginewood Cliffs (N. J) Prentice Hall 1986.
3. ASHRAE, Fundamentals and equipment, 4 volumes – ASHRAE Inc. 2005.
4. Jordan and Priested, Refrigeration and Air conditioning 1985.
5. Langley, Billy C., 'Solid state electronic controls for HVACR' prentice-Hall, 1986.

Course Code	Course Title					Teaching Scheme				
						L	T	P	Credits	
TEMTECH321	Cold Preservation of Foods					3	1	0	4	
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus(Theory)

UNIT-I

INTRODUCTION – Microbiology of food products, Mechanism of food spoilage, critical microbial growth requirements, Design for control of micro-organisms, Regulations and Standards.

UNIT-II

PROCESSING AND PRESERVATION Thermodynamic Properties, Water Content, Initial Freezing Temperature, Ice Fraction, Transpiration of Fresh Fruits and Vegetables, Food Processing Techniques for Dairy Products, Poultry, Meat, Fruits and Vegetables.

UNIT-III

FREEZING AND DRYING- Precooling, Freeze Drying Principles, Cold Storage and Freezers, Freezing Drying limitations, Irradiation Techniques, Cryo Freezing, Energy Conservation in Food industry, Numerical and Analytical Methods in Estimating Freezing, Thawing Times.

UNIT-IV

COLD STORAGE DESIGN AND INSTRUMENTATION- Initial Building Consideration, Building Design, Specialized Storage Facility, Construction Methods, Refrigeration Systems, Insulation Techniques, Control and Instrumentation, Fire Protection, Inspection and Maintenance.

UNIT-V

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

Text Book(s):

1. Peter Fellows, Food Processing Technology: Principles and Practice, Wood Head, 2000.
2. Romeo T. Toledo, Fundamentals of Food Process Engineering, Springer III Edition, 2007.

Reference Book(s):

1. Frazier W. C., Westhoff D. C., Food Microbiology, 4th Ed., McGraw-Hill, New York 1988.

2. Michael. J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton, Industrial Microbiology,WileyBlackWell,2001.
3. S. Yanniotis, B. Sunden, Heat Transfer in Food Processing, Recent Developments and Applications, WIT Press, Southampton, 2007.
4. C. V. J. Dellino, Cold and Chilled Storage Technology, Springer II Edition, 1997.
5. Andrew D. Althouse, Carl H. Turnquist, Alfred F. Bracciano, Modern Refrigeration and Air Conditioning, Goodheart-Wilcox, 18th Edition, 2003.

Course Code	Course Title					Teaching Scheme				
						L	T	P		Credits
TEMTECH312	Computational Methods in Thermal and Fluid Engineering					3	1	0		4
Evaluation Scheme (Theory)						Evaluation Scheme (Practical)				
Mid Term Test-I	Mid Term Test-II	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks	Mid Term Test-I	End Term Test	Class Participation	Additional Continuous Evaluation *	Total Marks **
20	20	40	10	10	100	-	-	-	-	-

*Additional Continuous Evaluation: Quizzes /Assignments/ Presentations/ Practical Records/ Mock Interviews/ others

Syllabus (Theory)

UNIT-I

GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD- Classification, Initial and Boundary conditions –Initial and Boundary Value problems– Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT-II

CONDUCTION HEAT TRANSFER -Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT-III

INCOMPRESSIBLE FLUID FLOW – Governing Equations, Stream Function– Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

UNIT-IV

CONVECTION HEAT TRANSFER AND FEM –Steady One-Dimensional and Two-Dimensional Convection – diffusion, unsteady one- dimensional convection– diffusion, Unsteady two dimensional convection – diffusion –Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.

UNIT-V

TURBULENCE MODELS – Algebraic Models – One equation model, K–ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Text Book(s):

1. Muralidhar,K.,andSundararajan,T.,“ComputationalFluidFlowandHeatTransfe” , Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar, P. S., “Computer Simulation of flow and heat transfer”, Tata McGraw- Hill Publishing Company Ltd., 1998.
3. Subas, V. Patankar, “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.

Reference Book(s):

1. Taylor, C and Hughes, J. B., “Finite Element Programming of the Navier Stokes Equation”, Pineridge Press Limited, U. K., 1981.
2. Anderson, D. A., Tannehill, J. I., and Pletcher, R. H., “Computational fluid Mechanics and Heat Transfer, “Hemisphere Publishing Corporation, New York, USA, 1984.
3. Fletcher, C. A. J., “Computational Techniques for Fluid Dynamics 1”, Fundamental and General Techniques, Springer–Verlag, 1987.
4. Fletcher, C. A. J., “Computational Techniques for fluid Dynamics 2”, Specific Techniques for Different Flow Categories, Springer–Verlag, 1987.
5. Bose, T. X., “Numerical Fluid Dynamics”, Narosa Publishing House, 1997.

Course code	Course Title	Teaching Scheme				
		L	T	P	S	Credits
TEMTECH302	Project	0	0	0	0	6

Syllabus (Theory)

Students need to carry out a small scale project to develop hands-on experience of working in a project. During the course, the student will also develop a system that can transform some input parametric values into useful parametric output values. The system can be a physical or a software based. The students will learn working as a team and basic collaboration and project management skills. The student will also learn about formulating project documentation.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH303	Seminar	0	0	4	2

S. No.	Evaluation Component	Duration (Hours)	Marks (100)	Nature of Component
1.	Presentation	Weekly	20	Open Book
2.	Report (Soft Copy)	Weekly	20	Open Book
3.	Assignment	Continuous	10	Open Book
4.	Final Presentation		25	Open Book
5.	Final Report(Hard Copy)		25	Open Book

Syllabus (Practical)

Operation Procedure

1. Student has to devote full semester for **TEMTECH303** course.
2. Student has to report to the Supervisor regularly.
3. Seminars' evaluation has to be carried out in the presence of a two-member committee comprising.
4. Experts in the relevant area constituted by the Supervisor.

Final Thesis to be submitted has to be in formal hard bound cover bearing of the Institute emblem.

Reference Books:

Based on literature survey to be done with peer reviewed journals.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
TEMTECH304	Minor Dissertation				8

OPERATION DETAILS:

- Each Student will be assigned by Director, IET to a faculty member who will act as the instructor. Students and faculty members covering a broad area will be grouped in a panel.
- Within 2 weeks of registration, the student should submit the work plan with time line and developmental activities in consultation with his assigned supervisor. Two copies of written outline of the total work should be submitted to the supervisor within 2 weeks.
- Mid semester grading will be done by the supervisor based on the performance of the student in research and development activities. The student should submit the Mid semester report to the supervisor in the 9^{th} week of the semester, which shows the progress of the student till the mid semester.
- The student is also required to submit End-semester report which provides the details of work done by the student in research and development area. End semester report should be submitted to the supervisor in the 15^{th} week of the semester. The end semester report should also contain a research proposal.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MTECH401	Seminar	0	0	4	2

S. No.	Evaluation Component	Duration (Hours)	Marks (100)	Nature of Component
1	Presentation	Weekly	20	Open Book
2	Report (Soft Copy)	Weekly	20	Open Book
3	Assignment	Continuous	10	Open Book
4	Final Presentation		25	Open Book
5	Final Report(Hard Copy)		25	Open Book

Syllabus (Practical)

Operation Procedure

1. Student has to devote full semester for **MTECH401** course.
2. Student has to report to the Supervisor regularly.
3. Seminars' evaluation has to be carried out in the presence of a two-member committee comprising.
4. Experts in the relevant area constituted by the Supervisor.

Final Thesis to be submitted has to be in formal hard bound cover bearing of the Institute emblem.

Reference Books:

Based on literature survey to be done with peer reviewed journals.

Course code	Course Title	Teaching Scheme			
		L	T	P	Credits
MTECH402	Major Dissertation				18

-	-	-	-	-	-	-	-	-	-	-

Operation of the course

a) The student should immediately chalk out a plan of work in Consultation with his supervisor. Current literature (journals, books, etc.) must be methodically reviewed and the status of the work in the field must be considered. The detailed outline of work must reflect a survey of the current literature in the same area and must include topic of research, objective, background of previous work in the area, methodology and a work plan with a time schedule clearly indicating the intermediate milestones and the estimated time to achieve the same along with references and bibliography.
b) Within two weeks of registration, the student should give his Dissertation particulars to the Director-IET office through supervisor in TS-1 Proforma.
c) The student should regularly interact with his supervisor and present seminars and submit reports on the scheduled dates. Proposed examiners and other faculty in relevant area may be requested to attend the presentations.
d) Supervisor will announce the Mid-semester grade to his student and send the MID-SEM Evaluation Form to the Director-IET office.
e) TWO typed copies of Final Dissertation Report and Abstract are to be submitted to the supervisor on or before the last day of class work in each semester. Supervisor will retain his copy and send the remaining ONE copy after the viva voce examination along with the Final Evaluation Form and Dissertation Abstract to the Director-IET Office.
f) The following format for Dissertation Abstract should be used:

Format for submission of Dissertation Abstract

Dissertation Title :

Supervisor :

Semester : First/Second Session :

Name of Student : ID No. :

Abstract

Abstract in the above format should also be included in the bound report.

g) Every student has to sign his attendance regularly with the supervisor or as per the alternative arrangement made by the supervisor. An attendance sheet is being provided for this purpose to the supervisor.
h) The candidate should apply and seek prior permission of his supervisor for going on leave for any genuine needs. If the leave of absence exceeds seven days in the entire semester, the recommended final grade may be revised by the Director-IET in consultation with the supervisor.
i) A separate Dissertation topic has to be assigned to individual students. Wherever the broad area is same, the aspects to be researched by an individual candidate should be clearly focused and spelt out.
j) Utmost care should be taken in the preparation of the FINAL REPORT. A check-list of various items is provided and students should carefully go through these. Supervisors are also requested to examine the draft of the FINAL REPORT keeping in view the items in the check-list.

2. EVALUATION

Evaluation in this course is essentially individual oriented. The various instruments of evaluation along with the weightage of components are given below:

Component	Weightage	Week in which due
Viva –I	15	5th week
Mid. sem. written report	15	10th week
Mid. sem. presentation	15	10th week
Viva –II	15	15th week
Final Dissertation*	25	Last day of class work
Final Viva-voce*	15	Actual date announced by Director-IET

---

*Final Viva-voce examination and evaluation of the Dissertation is to be jointly done by the Supervisor and the examiner appointed by the Director-IET. The other components are to be evaluated by the supervisor and the details are to be

made available to the examiner at the time of final viva. Supervisor will send the copy of Dissertation report to the examiner well in advance. Before sending he should check the contents as per checklist and sign the 'Certificate' page.

The evaluation will recognize the day-to-day work involvement and punctuality of the student in his work. Evaluation in various components shall take into account work progress and achievements, technical/professional competence, documentation and expression, initiative and originality, punctuality and reliability, self-reliance, and acquisition of special skills. The student should extend full cooperation to his supervisor and interact with him in advance about the time, venue and mode of each evaluation. He should be in constant touch with his supervisor. Supervisor may require his student to sign the attendance sheet before a particular time on each working day.

Grading will be done mainly on the basis of the progress made towards attaining the overall objectives of the Dissertation. The supervisor shall evaluate various prescribed components of evaluation before the submission of final Dissertation. The supervisor shall evaluate the various prescribed components of evaluation before the submission of final report. He/she should seek utmost participation of examiner by inviting him to the various seminars. A full time student is normally registered for 18 credits when registered. Supervisor can reduce/increase the prescribed credits subject to a minimum of 14 and maximum of 22 credits depending on the time and effort devoted by the individual student. Supervisor should maintain all pertinent records of his student. Departures in the number of credits to be registered may be decided by the Director-IET. The final report and performance in the final viva are to be jointly evaluated by the Supervisor and examiner appointed by the Director-IET. Evaluation in various components can be done on the basis of marks or grades. However, the recommendations for the final award shall invariably be made in terms of one of the prescribed letter grade. The student will have to defend the work appearing in his/her Dissertation before the panel of examiners. Immediately after the final viva, ONE copy each of the Dissertation Report and Dissertation Abstract along with the completed Final Evaluation Form are to be submitted to the Director-IET office by the supervisor. The student should also ensure with his supervisor so that these reach the Division well before the last

date of comprehensive examination. Supervisor should check that he has signed the 'Certificate Page'.

3. COURSE NOTICES

Notices pertaining to this course will be displayed on Notice Boards by the supervisor.

4. GENERAL

a) It is the responsibility of the student to ensure continuous interaction with his Supervisor.

b) Prescribed formats of the Cover/Title page and certificate from the supervisor should be adhered to in the preparation of final Dissertation Report. Check-list of items for the preparation of the FINAL REPORT should also be consulted. The following sequence may be followed in the preparation of the Dissertation Report:

- Title page (inner cover)
- Acknowledgement
- Certificate from the Supervisor
- List of Symbols & Abbreviations used
- Dissertation Abstract
- Table of contents
- Chapters 1, 2, 3, etc.
- Conclusion
- Appendices
- Bibliography/References
- List of Publications/Conference Presentations, if any.

The registration in Dissertation course is normally after the completion of coursework. 14-18 credits of Dissertation will be assigned at the time of registration. Credits put upto a maximum of 22 may be permitted depending upon the total time and effort put in by an individual student.