UNIVERSITY OF KERALA

REGULATIONS, SCHEME AND SYLLABUS

For

M.Tech. Degree Programme

In

MECHANICAL ENGINEERING

(2013 Scheme)

Stream: THERMAL SCIENCE

M.TechProgramme
Mechanical Engineering- Thermal science
Curriculam and scheme of Examinations

SEMESTER I

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal \ Continuous Assessment	End Semester Exam	Total	
MMA 1001	Applied mathematics	3	3	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the university
MTC 1001	Advanced thermodynamics	3	3	3	40	60	100	do
MPT 1002	Turbomachinery	3	3	3	40	60	100	do
MTC 1002	Advanced heat transfer	3	3	3	40	60	100	do
MTC 1003	Incompressible and compressible flows	3	3	3	40	60	100	do
MTC 1004	IC engines combustion and pollution	3	3	3	40	60	100	do
MTC 1101	Thermal Engineering Lab – I	1	2	-	100	-	100	No End Sem Examinations
MTC 1102	Seminar	2	2	-	100	-	100	do
	TOTAL	21	22		440	360	800	Seven hours departmental assistance

SEMESTER II

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal \ Continuous Assessment	End Semester Exam	Total	
MTC 2001	Convection and Two Phase Flow	3	3	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the university
MTC 2002	Measurements in Thermal Science	3	3	3	40	60	100	do
*	Stream Elective	3	3	3	40	60	100	do
*	Stream Elective	3	3	3	40	60	100	do
*	Departmental Elective	3	3	3	40	60	100	do
MCC2000	Research Methodology	2	2	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the individual institutions
MTC 2101	Thermal Engg. Lab-II	1	2	-	100	-	100	No End Sem Examinations
MTC 2102	Thesis preliminary part I	2	2	-	100		100	do
MTC 2103	Seminar	2	2	-	100	-	100	do
	TOTAL	22	23	---	540	360	900	Six hours departmental assistance

* Students can select a subject from the subjects listed under stream/department electives for the second semester as advised by the course coordinator

STREAM ELECTIVES OFFERED IN THERMAL SCIENCE FOR SEMESTER II

Stream Elective I		Stream Elective II	
MTE 2001	Energy conservation and heat recovery systems	MTE 2006	Nuclear engineering
MTE 2002	Combustion science	MTE 2007	Solar thermal engineering
MTE 2003	Modern energy conversion systems	MTE 2008	Steam turbines
MTE 2004	Refrigeration engineering	MTE 2009	Gas turbines
MTE 2005	Industrial hydraulics		

SEMESTER III

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal \ Continuous Assessment	End Semester Exam	Total	
*	Stream Elective III	3	3	3	40	60	100	Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the individual institutions
*	Stream Elective IV	3	3	3	40	60	100	do
**	Non-Dept. (Interdisciplinary) Elective	3	3	3	40	60	100	do
MTC 3101	Thesis – Preliminary - PartII	5	14	-	200		200	No End Sem Examinations
	TOTAL	14	23		320	180	500	Six hours departmental assistance

* Students can select a subject from the subjects listed under stream electives for the third semester as advised by the course coordinator.

** Student can select a subject from the subjects listed under Interdisciplinary electives for the third semester as advised by the course coordinator.

STREAM ELECTIVES OFFERED IN THERMAL SCIENCE FOR SEMESTER III

Stream Elective III	Stream Elective IV
MTE 3001 Design of Heat Transfer Equipment MTE 3002 Air Conditioning and Ventilation	MTE 3003 Fluidized Bed Combustion MTE 3004 Multiphase Flow

SEMESTER IV

Code No.	Name of Subject	Credits	Hrs / week	Marks					
				Continuous Assessment		University Exam		Total	Remark
				Guide	Evaluation Committe	Thesis Evaluation	Viva Voce		
MTC 4101	Thesis Final	12	21	150	150	200	100	600	*5 % of the evaluation mark is earmarked for publication in journal/conference
	TOTAL	12	21	150	150	200	100	600	8 hours departmental assistance

DEPARTMENTAL ELECTIVES FOR SEMESTER II

1. MID 2001 Reliability Engineering
2. MID 2002 Modern Information System
3. MDD 2001 Computational Plasticity
4. MDD 2002 Bio Mechanics
5. MDD 2003 Introduction to Signal Processing
6. MPD 2001 Finite volume method for fluid flow and heat transfer
7. MPD 2002 Transport Phenomena
8. MTD 2001 Finite Element Analysis for Heat Transfer.
9. MTD 2002 Cryogenics Engineering

M.TECH – THERMAL SCIENCE
SYLLABUS

FIRST SEMESTER

MMA 1001: APPLIED MATHEMATICS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits :3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:

- To introduce to the students some of the advanced tools in numerical methods, classical partial differential equations, optimization techniques, sampling theory and transform methods and their importance in modeling may engineering phenomena and applications to solving such problems. Knowledge of these methods are essential for higher studies and research.

Learning Outcomes:

- At the end of the course students will have become familiar with the use of some advanced classical and modern Mathematical tools in the areas of numerical methods, classical partial differential equations, optimization techniques, sampling theory and transform methods which are basic problem solving tools of an engineer.

Module I

Ordinary Differential equations, Series Solution,Singularity, Regular Singularity, Forbenius method, Bessel's equation, Legendre Equation, Hermiteequation (solution only),LaguerreEquation (solution only),Tschebyschevs' equation (solution only), Bessel functions of first and second kind, Recurrence relation for $J_n(x)$, Value of $J_{½}(x)$, ,Generating function for $J_n(x)$, Equations reducible to Bessels equations,
Orthogonality of Bessel functions, Legendre polynomial, Rodrigues formula, generating function for $P_n(x)$, recurrence relation for $P_n(x)$, orthogonality of Legendre polynomials
PartialDifferential Equation:-Classification of PDE,Solution of Boundary Value Problems in partial differential equations using Laplace Transform Method.

Module II

Calculus of variations: Functionals,Euler Equations and its alternative forms,solution of Euler equation, isoperimetric problem,problem of several independent variables, functional involving higher order derivatives,problem with variable end conditions.
Integral equations: Standard forms of integral equations- Fredholm equation, Voltera equation, reduction of an integral equation to differential equation, solutions for integral equation, integral equations of the convolution type, solution of Fredholm integral equation by the method of successive approximations,
Fourier transforms:-Descrete Fourier transforms, Linearity and periodicity, The inverse N-pointDFT, The DFT approximations of fourier coefficients ,Approximation of Fourier transform by an N point DFT , The Fast Fourier Transform.

Module III

Linear algebra: **(More weightage should be given to applications of results and problems)**

Vector space, subspace, linear combinations, linear spans, row space, null space, column space, basis and dimensions, coordinates, rank

Linear transformations-linear operators , algebra of linear transformations-operators, representation of linear transformation / linear operators by matrices, change of basis, invertible operators, Linear functionals and the dual space, Transpose of a linear transformation.

Inner product, Inner product space, orthogonalsets, Gram-Schmidtorthogonalizationprocess, Linear functionalsandadjoint operators.

Text Books:

1. Mathematical methods for Engineers and Physicists-A K Mukhopadhayay –Wheeler publishing
2. Advanced Engineering Mathematics-Peter V O ’Neil –Thomson
3. Higher Engineering Mathematics-Dr. B S Grewal-Khanna publications
4. Linear Algebra and its applications-David C Lay-Pearson
5. Theory and Applications of Linear algebra-Schaum’s outline series-McGraw Hill
6. Higher engineering Mathematics –B V Ramana-TataMcGraw Hill
7. Introduction to Partial differential equations-K SankarRao-Prentice Hall of India

References:

1. Differential equations with applications and Historical notes-George F Simmons-Tata McGraw Hill
2. Elements of Partial Differential Equations, Ian Sneddon, Dover Books on Mathematics Series
3. Introduction to Wavelets through Linear Algebra-Michael W Frazier,Springer
4. Linear Algebra- Kenneth Hoff mann and Ray Kunze- PHI

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTC 1001: ADVANCED THERMODYNAMICS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart an awareness regarding the basic laws of thermodynamics and their applications, kinetic theory of gases, transport phenomena, energy analysis and high temperature thermodynamics.

Learning Outcomes

After undergoing the course, the students will be in a position to understand various thermodynamic processes that are involved in the given system and they will be able to design systems that will be better efficient and less entropy generating.

Module I

Review of the fundamentals of classical thermodynamics- Application of first and second law to unsteady flow systems. Energy analysis.Properties of gas mixtures. Thermodynamic potentials, Stable and unstable equilibrium, Chemical Potential and Phase equilibrium, Third law of thermodynamics, Irreversible thermodynamics – coupled and uncoupled effects-examples.

Microscopic approach to thermodynamics: The molecular model – requirement – properties of simple gas - extension to gas mixtures – real gas effects Kinetic theory of gases- equipartition of energy - Molecular flux - Survival equation- Collision theory – Collision cross-sections – collision dynamics

Module II

Transport Phenomena – Viscosity, Thermal conductivity and diffusion. Fundamentals of Statistical Thermodynamics - Micro and Macro States - Thermodynamic Probability. Degeneration of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Partition function, Calculation of the Macroscopic properties from partition functions.

Module III

Combustion-Gravimetric and molal analysis. Equations of combustion – stoichiometry, Introduction to thermochemistry – Heat of reaction and it's effect on temperature and pressure. Enthalpy of formation, heating value, first and second law analysis of reacting systems. Adiabatic flame temperature Properties of high temperature gases - Evaluation of thermodynamic properties for a single species, Chemical equilibrium – Equilibrium constant – Equilibrium gas mixture properties, Introduction to nonequilibrium systems, chemical reaction rates, reaction kinetics.

References:

1. Holman, J.P., Thermodynamics, 4th Edition,McGraw-Hill Inc., 1998.
2. Sears, F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd Edition, Narosa Publishing House, New Delhi, 1993.
3. Anderson, J.D., Modern Compressible Flow , 3rd Edition, McGraw-Hill Inc.,2004
4. Bird, G.A., Molecular Gas Dynamics and the Direct Simulation of Gas Flows, Clarendon Press – Oxford , 1994
5. Cengel,Y.A., & Boles, M.A., Thermodynamics – An Engineering Approach, Tata McGraw-Hill

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MPT 1002 : TURBOMACHINERY 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart knowledge on various types of turbo machines and their operation, flow mechanism through the impeller, methods of their performance evaluation under various operation conditions.

Learning Outcomes

By undergoing the course, one will be able to understand the working of various turbomachines under different operating conditions and will be able to design a system for the required output at the given conditions.

Module I

Definition and Classification of Turbomachines, Principles of operation, Specific work-representations on enthalpy entropy diagram. Fundamental equation of energy transfer, flow mechanism through the impeller, vane congruent flow, velocity triangles, ideal and actual flows, slip and its estimation, losses and efficiencies, degree of reaction, shape number and specific speed.
Two dimensional cascades: cascade nomenclature, lift and drag, circulation and lift, losses and efficiency, compressor and turbine cascade performance, cascade test results, cascade correlations, fluid deviation, off –design performance, optimum space-chord ratio of turbine blades.

Module II

Axial flow turbines: Two dimensional theory Velocity diagram, Thermodynamics, stage losses and efficiency, Soderberg's correlation, stage reaction, diffusion within blade rows, efficiencies and characteristics.

Axial flow compressors: Two dimensional analysis Velocity diagram, Thermodynamics, Stage losses and efficiency, reaction ratio stage loading, stage pressure rise, stability of compressors.

Three-dimensional flows in axial turbines: Theory of radial equilibrium, indirect and direct problems, compressible flow through a fixed blade row, constant specific mass flow rate, free vortex, off-design performance, blade row interaction effects.

Module III

Centrifugal compressors: Theoretical analysis of centrifugal compressor, inlet casing, impeller, diffuser, inlet velocity limitations, optimum design of compressor inlet, prewhirl, slip factor, pressure ratio, choking in a compressor stage, Mach number at exit.

Radial Flow Turbines: Types of inlet flow radial turbines (IFR), thermodynamics of 90^{o}IFR turbine. Efficiency, Mach number relations, loss coefficient, off-design operating conditions, losses, pressure ratio limits.

References:

1. S L Dixon: Fluid Mechanics and Thermodynamics of Turbo machinery, 1998
2. H I H Saravanamuttoo, G F C Rogers, H Cohen: Gas Turbine Theory,2001
3. P G Hill, C R Peterson: Mechanics and Thermodynamics of Propulsion
4. S M Yahya: Turbines, Compressors and Fans
5. V Kadambi and Manohar Prasad: An Introduction to Energy Conversion Vol III Turbo machinery
6. G F Wislicunes: Fluid Mechanics of Turbomachinery
7. G T Csandy: Theory of Turbo machines

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTC1002 : Advanced Heat Transfer 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart the basic and an advanced level of understanding of the various modes of heat transfer and different kinds of mechanisms that influence heat transfer.

Learning Outcomes

The students will be able to analyses a real life situation involving heat transfer and would be able to design a thermal system. They will be in a position to trouble shoot the problems in a thermal system and able to suggest methods to improve the performance of the system.

Module I

Conduction: Multidimensional steady heat conduction-Analytical and Numerical solution (finite difference method), transient heat conduction-lumped and distributed system, Heating and cooling of finite and semi-finite slabs with negligible surface resistance for different boundary conditions- Solution of heating or cooling of regular solid with comparable internal and external resistance by simple analytical methods and use of charts, Heisler and Grober charts.

Module II

Convection: forced and free convection – velocity and thermal boundary layer, laminar and turbulent flows – General equation for momentum and energy transport Laminar flow heat transfer: Exact slutions of the 2D boundary layer momentum and energy equations. Approximate calculations of the boundary layer by the momentum and energy integral equations. Turbulent flow heat transfer: Time averaged equations of continuity, momentum and energy. Analog methods – Reynolds, Prandtl and Von Karman. Free convection: Solutions of the boundary layer equations for a vertical plate – Free convection with a turbulent boundary layer – Empericalcorelation for free convection from vertical, horizontal inclined surfaces and enclosures

Mixed Convection – Introduction to mixed convection-concepts

Module III

Radiation: Electromagnetic wave and quantum theory,radiative properties of materials-Spectral,directional and total – problems, view factor calculations, radiation exchange between two black, diffuse grey surfaces, radiosityirradation formulation, electrical network, radiation in participating medium, optical thickness-absorbing and emitting medium Mass Transfer: Modes of mass transfer-convective and diffusive mass transfer, Ficks law, analog between heat, mass and momentum transfer-dimensionless numbers

References:

1. Fundamentals of Heat and Mass Transfer - IncroperaF.P and Dewitt D. P
2. Heat Transfer – Yunus A Cengal
3. Heat Transfer – S.P.Venketeshan
4. Heat Transfer – P.K.Nag
5. Heat Conduction – M. NecatiOzisik
6. An introduction to Convective Heat Transfer Analysis – Patrick H. Oosthuizen and David Naylor
7. Thermal Radiation Heat Transfer – John R. Howell

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTC 1003 : INCOMPRESSIBLE AND COMPRESSIBLE FLOW 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Objective

Fluid mechanics is one of the main fundamental subjects of thermal engineering. The objective of this course to teach the students this subject in an advanced level with the use of mathematics of vector calculus. Formulation different problems and solution to some of the simple cases is included to make the students capable of analyzing practical problems involving incompressible as well as compressible flow.

Outcome

The students will be able to analyse a flow situation and capable of using these theories in a real life situation and take appropriate decisions with regard to design and manufacture of various fluid handling devices

Module I

Incompressible flow

Review: (Fluid properties, surface tension, viscosity, Newton's law of viscosity, Rheological properties, fluid statics, manometry), Rate of strain and Stress tensors, Reynolds transport theorem, Navier-Stokes equations in Cartesian and polar coordinates, Vorticity and Vorticity transport equations in two and three dimensions.

Potential flow theory-complex flow potential and velocity for source, sink, simple vortex and doublet. Flow past stationary and rotating circular cylinders using method superposition and Joukowsky transformation. Flow past a vertical flat plate.

Module II

Hagen Poiseuille, Plane and Taylor couette flow, Boundary layer theory, Blasius solution for flat plate, Momentum Integral equation for zero and non-zero pressure gradient, flow separation and vortex shedding, Turbulent flow, characteristics, eddy viscosity, mixing length and Boussinesq's hypothesis, velocity measurements using multi-hole probes, hot-wire and PIV.

Module III

Compressible flow: Review of the 1D flows, such as, Isentropic flow, Fanno flow, Raleigh Flow. Generalised one dimensional flow – Governing equations – Influence coefficients – Flows with and without sonic point. 2D compressible flow – Governing Equations – Linearised solutions to subsonic and supersonic flows. Method of characteristics. Introduction to Hypersonic flows.

Note: Use of approved Gas Tables will be permitted in the examinations.

References:

1. Advanced Engineering Fluid Mechanics – K Muralidhar and G Biswas
2 Mechanics of Fluids- Shames I H
3 Viscous Fluid Flow- White F M
4 Foundations of Fluid Mechanics- Yuan S W
5 Elementary Fluid mechanics- Schlichting H and Gersten K
6 Elementary Fluid Mechanics- Duncan, Thom and Young.
7 The Dynamics and Thermodynamics of Compressible Fluid Flow Vol.I- A H Shapiro
8 Gas Dynamics- E Rathakrishnan

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTC 1004 : IC ENGINE COMBUSTION AND POLLUTION 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart an awareness regarding the chemistry of fuel air mixtures and their combustion, how the combustion mechanism takes place in the engine cylinder of an IC engine. Also to convey informations regarding various alternate fuels, their performances and engine emission and their control.

Learning Outcomes

The students will be able to understand the basic concepts of fuel air mixing and combustion. They will be able to explore alternate fuels that are sustainable and emission free.

Module I

Engine design and operating parameters, Thermo chemistry of fuel-air mixtures. Properties of working fluids- unburned mixture composition, burned and unburned mixture charts, Exhaust gas composition.

Module II

Ideal models of engine cycles, availability analysis of engine processes Combustion in SI engines- Thermodynamic analysis, Flame structure and speed, Cyclic variations in combustion, partial burning and misfire, abnormal combustion Combustion in CI engines- Phenomenological model of CI engine combustion, Analysis of cylinder pressure data, fuel spray behavior

Module III

Utilization of alternate fuels like biodiesel, hydrogen, LPG and natural gas in IC engines- Advantages and disadvantages.HCCI combustion. Engine emissions and air pollution - Genesis and formation of pollutants, SI engine emission control technology, CI engine emission control technology, fuels quality and emissions

References:

1. Heywood J.B. , IC Engine fundamentals, McGraw hill book Co, 1989
2. B.P.Pundir,Engine emissions, Narosa publishing house,2007
3. ObertE.F, IC Engine and air pollution, Harper and row publication, 1973
4. Chambell AS, Thermodynamic analysis of combustion engines, John Wiley and sons, 1986

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTC – 1101 THERMAL ENGINEERING LAB – I 0-0-2-1

1. Experiment on Transient Heat Conduction using data acquisition system.
2. Experiment on Boiling and Condensation.
3. Experiment on Heat Pipe.
4. Experiment on Variable Compression Engine.
5. Experiment on Steam Turbine.
6. Study of FLUENT software (grid generation and preparation of simple models)
7. Analysis of Turbulent flow and heat transfer over a flat plate.
   Evaluation of C_D, Nusselts number
8. Experiment on Wind Tunnel

MTC 1102 SEMINAR 0-0-2-2

The student has to present a seminar in one of the current topics in the stream of specialisation. The student will under take a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation: 25
Seminar Presentation: 25

SECOND SEMESTER

MTC 2001: CONVECTION AND TWO PHASE FLOW 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The course aims at imparting theoretical knowledge about the physics of forced convection in wall bounded flows and two phase flow, and thereby, enable them to tackle two phase flow and forced convection heat transfer problems.

Learning Outcomes

1. By the end of this course, students should be able to:
2. Apply the principles of thermodynamics, fluid mechanics and heat transfer to analyze forced convective heat transfer and two phase flow problems.
3. Develop analytical models and solution methods to solve practical engineering problems. Develop confidence to undertake challenging research problems and
4. Make them to work with practiced professional or researcher groups confidently.

Module I

Forced convective heat transfer in closed conduits – heat transfer in laminar flow - governing equations - heat transfer in laminar flow through circular ducts - hydrodynamic and thermal entry lengths - hydro dynamically developed and thermally developing problems-analytical solution-simultaneously developing flow - laminar fully developed flow and heat transfer- fully developed velocity and temperature profiles-constant heat flux and constant temperature wall boundary conditions- effect of axial variation of surface temperature and heat flux - heat transfer to and from non circular cross sections- empirical correlations.

Module II

Forced convection in turbulent flow – RANS and energy equations – turbulent modeling – Eddy viscosity models- introduction to LES and DNS – thermal entry length in circular ducts- heat transfer in fully developed turbulent flow – universal velocity profile - Kay's temperature profile- heat transfer enhancement in turbulent flow through pipes - Analogy between momentum and heat transfer: Reynold's, Prandtl-Taylor and von Karman analogy – influence of surface roughness - empirical correlations
Multi phase flow:- basic flow models: homogeneous, separated and two fluid models- definition of multiphase flow parameters- flow pattern - identification and classification - flow maps and transition - flow pattern in vertical and horizontal tubes - steady one dimensional continuity, momentum and energy equations – pressure gradient components: frictional, acceleration and gravitational – void fraction and slip ratio correlation - two phase friction factor for laminar and turbulent flow - empirical correlations.

Module III

Boiling heat transfer: - pool boiling and forced convective boiling - sub-cooled and saturated boiling - pool boiling regimes – pool boiling curve – pool boiling correlations - bubble dynamic in pool boiling – regimes of convective boiling - critical heat flux.
Heat transfer in condensation - film condensation and drop wise condensation – liquid formation – droplet growth – crude theory and its modification – Nusselt theory on film condensation – condensation on horizontal tube – condensation within vertical tube – pressure gradient in condensing systems - methods of improving condensation heat transfer coefficient.

References:

1. John G. Collier and John R. Thome: Convective boiling and condensation.
2. C. Kleinstreuer: Two Phase Flow- Theory and Applications.
3. G B Wallis: One dimensional two phase flow
4. L S Tong and Y S Tang: Boiling heat transfer and two phase flow
5. W M Kays and M E Crawford: Convective heat and mass transfer
6. Bejan: Convective heat transfer

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTC 2002: MEASUREMENTS IN THERMAL SCIENCE 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

Measurements are a valuable tool for practicing engineering students. The objective of the course is to feature and study extensive background materials in system response, measurement uncertainty, signal analysis, optics, fluid mechanical apparatus, the use of instruments and techniques for practical measurements required, automatic data acquisition, reduction and analysis as well as their incorporation for control purposes, wind tunnel studies, turbulence, the theory and application of the laws to measurement techniques, techniques of thermal anemometry, volume flow measurement techniques, and fluid mechanics measurement in non-Newtonian fluids.

Learning Outcomes

After the completion of the course, one should be able to understand the flow properties and basic principles related to measuring systems, measurement uncertainty, signal conditioning and analysis, background for optical experimentation, fluid mechanical apparatus, measurement techniques, measurement of flow pressure, measurement of flow rate, flow visualization techniques, measurement of local flow velocity, measurement of temperature.

Module I

Characteristics of Measurement Systems - Elements of Measuring Instruments Performance characteristics - static and dynamic characteristics - Analysis of experimental data - Causes and types of experimental errors - Error &uncertainity analysis- statistical & graphical methods - probability distributions.

Temperature measurements - Theory, Thermal expansion methods, Thermoelectric sensors, Resistance thermometry, Junction semiconductor sensors, Pyrometry, Temperature measuring problems in flowing fluids, Dynamic Response & Dynamic compensation of Temperature sensors, Heat Flux measurements.

Module II

Pressure Measurements – Mechanical & Electrical types, High pressure & Low pressure measurements, Differential Pressure Transmitters.

Laminar & Turbulent flow measurements - Determination of Reynolds stresses – Flow visualization techniques - Gross Volume Flow measurements - Measurement of Liquid level, Density, Viscosity, Humidity & Moisture, Compressible flow measurements.

Module III

Thermal Analysis Techniques - Measurements in combustion: Species concentration, Reaction rates, Flame visualization, charged species diagnostics, Particulate size measurements.

Data Acquisition and Processing - General Data Acquisition system - Signal conditioning - Data transmission - A/D & D/A conversion - Data storage and Display - Computer aided experimentation.

References:

1. J P Holman : Experimental methods for Engineers
2. S. P. Venkatesan: Mechanical Measurements
3. Ernest O Doeblin : Measurement Systems - Application & Design
4. W.Bolton: Mechatronics.
5. Donald P Eckman : Industrial Instrumentation
6. Willard, Mertt, Dean,Settle : Instrumental Methods of analysis
7. D. Patranabis : Principles of Industrial Instrumentation
8. Beckwith & Buck : Mechanical Measurements
9. Nakra&Chaudary : Industrial Instrumentation
10. Physical Measurements in Gas Dynamics and Combustion : High Speed Aerodynamics and Jet Propulsion Vol.IX

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MCC 2000 RESEARCH METHODOLOGY 2-0-0-2

Structure of the Course

Lecture : 2 hrs/ Week Credits : 2
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objective:
To formulate a viable research question
To distinguish probabilistic from deterministic explanations
To analyze the benefits and drawbacks of different methodologies
To understand how to prepare and execute a feasible research project

Outcome
Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

Module 1

Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods *vs.*Methodology. Type of research: Descriptive *vs.*Analytical, Applied *vs.* Fundamental, Quantitative *vs.* Qualitative, and Conceptual*vs.* Empirical.
Research Formulation - Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem. Literature review: Primary and secondary sources - reviews, treatise, monographs, patents.Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.

Module 2

Research design and methods: Research design - Basic Principles- Need forresearch design — Features of a good design. Important concepts relating to research design: Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction. Development of Models and research plans: Exploration, Description, Diagnosis, Experimentation and sample designs.Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection - Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-Testing -Generalization and Interpretation.

Module 3

Reporting and thesis writing - Structure and components of scientific reports -Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes.Presentation; Oral presentation - Planning - Preparation -Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.

Application of results of research outcome: Environmental impacts –Professional ethics - Ethical issues -ethical committees.Commercialization of the work - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

References:

1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi,1990
2. Panneerselvam, "Research Methodology", Prentice Hall of India, New Delhi, 2012.
3. J.W Bames," Statistical Analysis for Engineers and Scientists", McGraw Hill, New York.
4. Donald Cooper, "Business Research Methods", Tata McGraw Hill, New Delhi.
5. Leedy P D, "Practical Research: Planning and Design", MacMillan Publishing Co.
6. Day R A, *"How to Write and Publish a Scientific Paper"*, Cambridge University Press, 1989.
7. Manna, Chakraborti, "Values and Ethics in Business Profession", Prentice Hall of India, New Delhi, 2012.
8. Sople," Managing Intellectual Property: The Strategic Imperative, Prentice Hall of India, New Delhi, 2012.

MTC 2101 THERMAL ENGINEERING LAB – II 0-0-2-1

1. Generation of correlation for natural convection process by experimental method.
2. Generation of correlation for forced convection by experimental method.
3. Performance evaluation of compact heat exchangers.
4. Experiment to determine the effect of condenser and evaporator. Pressure on Vapour compression refrigeration system.
5. Analysis of Natural Convection in an enclosure. Evaluation of Nusselts number and comparison with reported results.
6. Analysis of flow and heat transfer through porous media.
7. Flow and heat transfer in a rotating disc.
8. Pressure measurement using probes.
9. Experiment on flow visualization.

MTC 2102 THESIS PRELIMINARY PART-I 0-0-2-2

The main objective of thesis is to provide an opportunity to each student to do original and independent study and research on the area of specialization. The student is required to explore indepth and develop a topic of his/her own choice, which adds significantly to the body of knowledge existing in the relevant field.The thesis has three parts (Part I in semester-2 and Part-2 in semester -3 & Part-3 in semester -4). The thesis can be conveniently divided into three parts as advised by the guide and the first part is to be completed in this semester The student has to present a seminar before the evaluation committee at the end of the semester that would highlight the topic, objectives , methodology and expected results and submit a report of the work completed in soft bounded form .

MTC 2103 SEMINAR 0-0-2-2

The student is expected to present a seminar in one of the current topics in the stream of specialisation. The student will under take a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation : 25
Seminar Presentation : 25

STREAM ELECTIVES OFFERED FOR SEMESTER II.

MTE 2001: ENERGY CONSERVATION & HEAT RECOVERY SYSTEMS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To make the awareness about the need of conserving energy an minimization of wastage of energy
- To impart knowledge of various energy recovery, storage and transfer techniques
- To make the students understand about various energy conversion systems

Learning Outcomes

The students will be able to design energy efficient systems. They will be capable of employing the right kind of device to cater the given needs.

Module I

Energy consumption and potential for energy conservation in industry-thermodynamics of energy conservation-energy flows-energy auditing-technologies for energy conservation-thermal insulation.

Module II

Waste heat recovery systems, thermal energy storage, heat exchanger, heat pumps, heat pipes.

Module III

Waste heat to mechanical energy conversion systems-design for conversion of energy, simulation and modeling. Applications and case studies.

References:

1. Kenney W F- Energy conservation in the Process industries
2. Chiogioji M H- Industrial energy conservation
3. Bernhardt G A. Sjritsju&Vopat W A – Power station engineering & economy
4. Thumann, Albert PE- Plant Engineers and Managers Guide Energy Conservation
5. Dubin F B-Energy conservation standard

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2002: COMBUSTION SCIENCE 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart knowledge about thermodynamics of reacting mixtures, ignition and flammability, flame propogation and stabilization and different kinds of burners.

Learning Outcomes

The students will be capable of design optimum combustion chambers for the given requirements. They will be able to select the required type of burners for various applications

Module I

Thermodynamics of reacting mixtures – bond energy, heat of formation, heat of reaction, adiabatic flame temperature – entropy changes for reacting mixtures – chemical equilibrium – equilibrium criteria – evaluation of equilibrium constants and equilibrium composition.
Elements of chemical kinetics – Law of mass action – order and molecularity of reaction – rate equation – Arrhenius Law – activation energy – collision theory of reaction rates – transition state theory – general theory of chain reactions – combustion of CO and hydrogen, Analysis of chemical equilibrium product concentrations using CEA.

Module II

Ignition and flammability – methods of ignition – self ignition – thermal theory of ignition – determination of self ignition temperature and experimental results – energy required for ignition- limits of inflammability – factors affecting flammability limits – flame quenching – effects of variables on flame quenching.
Flame propagation – factors affecting flame speed – premixed and diffusion flames, physical structure and comparison – characteristics of laminar and turbulent flames – theory of laminar flame propagation – empirical equations for laminar and turbulent flame velocities.
Flame stabilization – stability diagrams for open flames – mechanisms of flame stabilization, critical boundary velocity gradient – stabilization by eddies – bluff body stabilization – effects of variables on stability limits.

Module III

Gaseous Burner flames.Droplet Combustion.Boundary layer combustion. Combustion of coal – burning of pulverised coal-fluidised bed combustion-gasification of coal. Combustion applications-coal burning equipment, oil burners, gas burners, stoves. Combustion in rocket

motors – solid and liquid propellant combustion, shock tubes, combustion instability, supersonic combustion.
Free burning fires-flame spread over fuel beds-forest fires-fires in buildings-liquid fuel pool fires-fire suppression and prevention Combustion generated air pollution. Clean combustion systems.

References:

1. Combustion Flame and Explosion of Gases- Lewis and von Elbe
2. Some fundamentals of combustion-D B Spalding
3. Fundamentals of combustion-Strehlow R A
4. Elementary Reaction Kinetics-J L Lathan
5. Flames-Gaydon A G &Wolfhard H G
6. Combustion-Jerzy Chomiak

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2003: MODERN ENERGY CONVERSION SYSTEMS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart an awareness regarding various energy conversion systems, fuel cells, concepts of MHD, energy generation from nuclear systems and renewable energy sources

Learning Outcomes

The students will be capable of taking appropriate decision on type of energy conversion system to cater the need. They will be capable of design various energy generators and systems using renewable energy sources.

Module I

Direct Energy conversion systems: Basic principles of Thermoelectric generation and Thermionic generation-Seebeck effect, Peltier effect and Thomson effect. The Diode-selection of materials-elementary principles of design.Principles of Fuel cells-Thermodynamics of the Fuel cells-Selection of fuel and operating conditions-constructional features-practical problems-state of the art and prospects.Photoelectric conversion-conceptual description of photo-voltaic effect-the solar cell-the state of art of solar cells-materials and prospects.

Module II

Principle of MHD generation-the Faraday and Hall generators-choice of generator parameters-Magnetic field requirements-conductivity and ionization-effect of seeding-Recent developments in MHD power systems. Nuclear energy: Fission Reactors:- Classification and basic principles-fuels, moderators and reactor materials-constructional features, safety and waste disposal. Nuclear Fusion ;-Fuels and Reactions-sustained fusion reaction-practical aspects-containment-production of plasma-state of the art of fusion power.

Module III

Renewable Energy sources: Solar energy:-Installation data-collectors and concentrators-design, fabrication and performance of flat plate collectors-solar thermal devices (stills, water heaters, furnaces, solar cookers, solar refrigerators)-solar thermal power generation systems-thermal storage. Biomass: Methods of beneficiation and utilization – pyrolysis, wood distillation, briquetting, gasifies – energy plantations and fast growing varieties. Bio-Gas: Socio-economic relevance – technical data-recent developments in designs. Ocean power: Principles of ducts and OWC converters-evaluation of the potential in India of wave and tidal power- principle of OTEC system. Wind power: Survey of wind energy conversion systems-the wind map of India- wind turbine- pump coupled systems- wind turbine-generator systems.

References:

1. R.A.Coombe: An introduction to Direct Energy Conversion
2. George Sutton: Direct Energy Conversion
3. Duffie and Beckmann: Solar Energy Thermal Processes
4. Meinel&Meinel: Solar Energy
5. MaheshwarDayal: Energy-Today & Tomorrow

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2004: REFRIGERATION ENGINEERING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart an awareness regarding the concepts of refrigeration process and various equipments to accomplish the required task.

Learning Outcomes

The students after undergoing the course will be in a position to design various refrigeration equipments to cater any specific need.

Module I

Review of thermodynamics of different methods of refrigeration, advanced vapour compression systems, multi pressure systems, Flash gas removal, Two evaporator and one compressor systems, one evaporator and two compressor systems, other combinations of compressors, evaporators and condensers, Various types of expansion devices, Low temperature refrigeration, cascade systems.

Module II

Vapour absorption refrigeration systems, principles of operation, description of components and their constructional features-refrigerant, absorber combinations and criteria for selection-performance characteristics, energy sources in absorption systems. Introduction to Cryogenic systems.

Module III

Refrigerants- selection, designation, properties, environmental effects, global warming effect, greenhouse effect international protocols, alternate refrigerants, mixed refrigerants
Vapour jet refrigeration systems, thermoelectric refrigeration systems-Peltier effect combination of thermoelectric elements, Vortex and pulse tube refrigeration systems, air cycle refrigeration systems

References:

1. W F Stoecker: Refrigeration and Air-conditioning
2. GosueyW.B.: Principles of Refrigeration
3. Transactions of ASHRAE
4. Throlkeld J L: Thermal Environmental Engineering.

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2005: INDUSTRIAL HYDRAULICS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart a basic concept of various types of hydraulic systems
- To make the student capable of designing different types of hydraulic systems

Learning Outcomes

- The student will be able to design, operate and maintain various types of hydraulic systems

Module I

Introduction to hydraulic/pneumatic devices, their applications and characteristics-comparison of electric, hydraulic and pneumatic devices.

Pumps and motors: principles of working, range of displacement and pressures. Fixed and variable discharge pumps, gear pumps, internal gear pump, serotor pump, vane pump/piston pump, axial piston pump, swash plate pump, bent-axis pump. Types of hydraulic motors and their characteristics.
Accessories: Hydraulic accumulators, intensifiers, filters, heater, cooler, tank.

Module II

Hydraulic valves: Stop valve, non-return valve, relief valve, sequence valve, counter balance valve, pressure reducing valve, flow control valves, direction control valves, their principles of operations and applications. JIC symbols of hydraulic/pneumatic components.

Properties of commonly used hydraulic fluids.

Typical hydraulic circuits: Examples of practical circuits like those used in machine tools, riveter, pneumatic hammer, hydraulic pressure, power steering.

Module III

Design of hydraulic/pneumatic equipment/circuit to fulfill a given set of requirements like a sequence of operations, load conditions, speed of operation etc.Specifying the components and their rating.Drawing the circuit using standard symbols.

Fluidics: Introduction to fluidic devices, principle of working of common fluidic devices like wall attachment devices, proportional amplifiers, turbulent amplifiers, fluidic logic devices.

Examples of applications of fluidic devices like edge control of steel plate in rolling mills, tension control.

References:

1. Pippenger , John J &Koff Richard M: Fluid Power Controls
2. Pippenger , John J &Hicks,Tyler G: Industrial Hydraulics
3. Kirshner, Joseph M: Fluid Amplifiers
4. Kirshner, Joseph M & Silas Katz: Design Theory of Fluidic components
5. Dr. Heinz Zoebl, Techn: Fundamentals of Hydraulic circuitry

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2006: NUCLEAR ENGINEERING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To introduce the basic concepts of nuclear energy production, various types of reactors and factors involved in the construction of nuclear reactors and radiation protection.

Learning Outcomes

The students will be able to design a nuclear reactor and will be capable of handling nuclear fuels.

Module I

Review of elementary nuclear physics. Nuclear Reactions and Radiations: Principles of radioactive decay- interaction of α, β & γ rays with matter- neutron cross sections and reactions- the fusion process-chain reaction. Basic principles of controlled fusion. Nuclear reactor principles: Reactor classification-critical size- basic diffusion theory-slowing down of neutrons-neutron flux and power-four factor formula-criticality condition-basic features of reactor control.

Module II

Boiling water reactor: Description of reactor system-main components-control and safety features. Materials of reactor construction: Fuel, moderator, coolant-structural materials-cladding – radiation damage. Nuclear fuels: Metallurgy of uranium-general principles of solvent extraction-reprocessing of irradiated fuel-separation process- Fuel enrichment.

Module III

Reactor Heat Removal: Basic equations of heat transfer as applied to reactor cooling-Reactor heat transfer systems-heat removed in fast reactors. Radiation safety: Reactor shielding-radiation dozes- standards of radiation protection- nuclear waste disposal.

References:

1. Nuclear Reactor Engineering- Gladstone &Sesonske
2. Source book on Atomic Energy- S.Glasstone

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2007: SOLAR THERMAL ENGINEERING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart an awareness regarding collection and utilization of solar energy
- To make the student capable of designing a suitable system to tap the energy in a given situation

Learning Outcomes

- The student will be able to design a system for the given requirement

Module I

Introduction, solar radiation- solar radiation data, solar radiation geometry, empirical equations for predicting solar radiation, solar radiation on tilted surfaces, instruments for measuring solar radiation.

Module II

Methods of collection and thermal conversion-Liquid flat plate collectors, solar air heaters, concentrating collectors.

Thermal energy storage- sensible heat storage, latent heat storage , thermochemical storage.

Module III

Solar pond, solar refrigeration, solar thermal electric conversion, other applications.

Economic analysis of solar thermal conversion.

References:

1. F Kreith and J F Kreider: Principles of Solar thermal Engg.
2. J A Diffie and W A Beckman: Solar Engineering of Thermal processes
3. A B Meinel and F P Meinel: Applied Solar Engineering
4. S P Sukhatme: Solar Energy

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2008: STEAM TURBINES 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart a basic concept of various types of steam turbines
- To make the student capable of designing different types of steam turbines

Learning Outcomes

- The student will be able to design, operate and maintain various types of steam turbines

Module I

Steam turbine types-classification. Steam turbine cycles- Carnot cycle, rankine cycle, Reheat cycle, regenerative cycle-Effect of temperature and pressure on cycle efficiency-Thermal efficiency-Heat rate and Steam rate-Mechanical efficiency-Engine efficiency.

Design of nozzles-nozzle construction-critical pressure ratio-nozzle losses-divergence and position angles-wet steam-super saturated steam-shock waves in nozzles-nozzle discharge coefficients-nozzle calculations.

Module II

Design of Turbine Flow passages-isentropic velocity ratio-energy distribution in turbines-effect of carry over velocity and energy distribution.

Impulse flow turbine passages- Impulse blade profiles- Blade pitch and width. Blade height-blade entrance and exit angles-angle of efflux-geometry of blades. Blade profiles.

Reaction turbine flow passages-reaction blade profiles, blade angles, blade pitch, aidth and height-losses in reaction blade passages.

Flow passages with radial equilibrium-steam turbine control and performance.

Module III

Control: control and supervisory instruments-principles of governing-direct acting speed responsive governors- characteristics of the simple speed responsive governor-speed responsive governors with servomotors- hydraulic speed-responsive governors with servomotors-pressure regulators-speed regulation and parallel operation. Emergency governors.
Performance: Effect of throttle governing , effect of initial pressure and temeprature changes, effect of nozzle governing-Parsons number and quality factor-performance of automatic extraction turbines-performance of mixed pressure turbine AC generator.AIEE-ASME preferred standard turbine.

References:

1. Theory and design of Steam and Gas Turbines-John Flee
2. Steam Turbine Theory and Practice- W J Kearton
3. Steam & Gas Turbines- R Yadav

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 2009: GAS TURBINES 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart a basic concept of various types of gas turbines
- To make the student capable of designing different types of gas turbines

Learning Outcomes

- The student will be able to design, operate and maintain various types of gas turbines

Module I

Gas Turbine Plants-open and closed circuit plants- gas turbine power cycles-improvements in the constant pressure cycle-open gas turbine cycle with inter cooling, reheat and regeneration-effect of regeneration, reheating and intercooling on efficiency-effect of operating variables on thermal efficiency, air rate and work ratio- advantages and disadvantages of closed cycle gas turbine- semi-closed type gas turbine.

Module II

Gas turbine applications in aircrafts, surface vehicles, electric power generation, petro-chemical industries, cryogenics.
Two dimensional cascade –the theory for the design of a turbine stage. Irreversibilities-losses in turbine stage-various efficiency for turbines- off design oerformance.

Three dimensional flows in axial turbomachines. Design.

Module III

Higher temperature turbine stages-effect of high gas temperature-methods of cooloing-high temperature materials-heat exchange in a cooled blade- ideal cooled stage –actual cooled stage.

Salient features of various types of combustion chambers for gas turbine engines. Principles of combustion chamber design.

Compressor turbine matching- general and simplified methods for equilibrium operations.

References:

1. Horlock J H: Axial flow turbines.
2. Shepherd D G : Principles of Turbomachinery.
3. S M Yahya -Turbines, Compressors and Fans
4. Cohen, Rogers and Saravanamuttoo- Gas Turbine Theory.

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

THIRD SEMESTER

MTC 3101 THESIS – PRELIMINARY PART II 0-0-14-5

The student has to continue the thesis work done in the second semester in the same area. The student has to present two seminars.The first seminar shall be conducted in the first half of this semester mainly to highlight the progress of the work for the midterm evaluation and second seminar towards the end of the semester to access the quality and quantum of work done in this semester. The student has to submit a report of the work completed in soft bounded form. The seminars and the report shall be evaluated by the evaluation committee.

Evaluation of marks for the Thesis-Preliminary Part II

Evaluation of the Thesis-Preliminary work by the guide - 100 Marks
Evaluation of the Thesis–Preliminary by the Evaluation Committee-100 Marks

STREAM ELECTIVES OFFERED FOR SEMESTER III.

MTE 3001: DESIGN OF HEAT TRANSFER EQUIPMENT 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart a basic concept of various types of heat transfer equipments
- To make the student capable of designing different types of heat transfer equipments

Learning Outcomes

- The student will be able to design, operate and maintain various types of heat transfer equipments

Module I

Heat Exchangers; Classification and General features- range of application-Overall heat transfer coefficient-the controlling film coefficient- LMTD- Effectiveness-NTU- Calculation of heat transfer area by different methods- caloric or average fluid temperature-the pipe wall temperature.

Flow and pressure drop analysis-computation of total pressure drop of shell side and tube side for both baffled and unbaffled types-pressure drop in pipes and pipe annuli stream analysis method.

Module II

Design of a double pipe exchangers-shell and tube exchangers-the tubular element-tube pitch-Shells-tube sheet-baffles-tube sheet layout and tube counts (tube matrix)-V-bend exchangers-shell side film coefficients-shell side mean velocity-shell side equivalent diameter-the true temperature difference in 1-2 exchanger-shell side and tube side pressure drops- fouling factors- Design of a shell and tube type 1-2 exchanger-Extended surface exchangers- Design of a finned tube double pipe exchanger- longitudinal fins and transverse fin.

Module III

Condensers-Condensation of a single vapour-drop wise and film wise condensation-process application-condensation on a surface-development of equation for calculation- comparison between horizontal and vertical condensers- the allowable pressure drop for a condensing vapour-influence of impurities on condensation-condensation of steam- design of a surface condenser-different types of boiling.

Heat Pipes:Theory , Practical Design Considerations- the working fluid, wick structure, thermal resistance of saturated wicks, the container, compatibility, fluid inventory, priming, starting procedure- special types of Heat pipe- Applications

References:

1. Process Heat Transfer-Kern
2. TEMA Standards
3. A Text Book on Heat Transfer- S P Sukhatme
4. Heat Pipes-P Dunn and D A Reay
5. Heat Exchanger Design- A P Fraas and M N Ozisik

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 3002: AIR CONDITIONING AND VENTILATION 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To have an understanding of air properties and comfort conditions
- To study various types of Ac systems

Learning Outcomes

The student will be able to design an AC system for the required comfort condition and also they will be in a position to minimize the total energy use.

Module I

Properties of moist air-Psychrometry, Psychrometric chart on enthalpy concentration and temperature concentration scales, Analysis of Psychrometric processes; sensible heating and cooling, Humidification and Dehumidification, sensible heat ratio; summer winter cycles. Air Heating and cooling, Air washers-humidification. Air filtering equipments and unitary equipment.

Module II

Air Conditioning systems: DX system,all water systems, all air systems-air water systems, heat pump system, central and unitary systems, fan coil systems.

Air movement in rooms, Air distribution devices, Air curtains.

Module III

Estimation of cooling load, duct design; Special purpose Air Conditioning such as theatres, computer room, school, libraries, rail cars, aircraft and ships.

Automatic controls of air conditioning systems, thermostats, dampers and damper motors, automatic valves.

Noise control and acoustic problems.

References:

1. Harris NC : Air conditioning practice
2. Gunther R C : Air conditioning and cold storage
3. Stoeker W F : Refrigeration and Air conditioning and Ventilation of Buildings
4. ASHRAE guide and Data Book

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 3003: FLUIDIZED BED COMBUSTION 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart a basic concept of FBC
- To make the student capable of designing a fluidized bed system

Learning Outcomes

- The student will be able to design, operate and maintain an FBC system

Module I

Introduction, Principle of fluidization, influence of bed parameters on heat transfer and combustion.

Module II

Bed dynamics, desulfurization, attrirtion and elutriation, models and correlations.

Module III

Techniques in FBC, design principles of FBC sub systems, practical plant problems, advanced concepts.

References:

1. Fludization under pressure by J.R.FGuedas&D.Harrison
2. The fluidized combustion of low grade materials by M.J.Cooke&N.Hodgkinson
3. Factors influencing the fludizied combustion of low grade solid and solid fuels by P.L.Waters
4. Sulphur and particulate Emission control; from pressurized fludized bed combustion system by
5. D.L.Keairms,R.A.Newby,B.W.lanearter&D H Archer.
6. Pressuried fluidized bed combustion of coal by R.C.Hoke&R.R.Bertrand.
7. A course in power plant engineering by Arora and Domkundwar

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MTE 3004: MULTIPHASE FLOW

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart an idea about the flow patterns, basic flow models
- To make aware of basic flow models, various correlations

Learning Outcomes

The student will be capable of assessing flow patterns and come out with solutions for finding heat transfer using appropriate correlations.

Module I

Methods of Analysis-flow patterns- vertical and horizontal channels- flow pattern maps and transitions. Void fraction- definitions of multiphase flow parameters- one dimensional continuity, momentum and energy equation- Pressure gradient components: frictional, acceleration and gravitational.

Basic Flow Models: Homogeneous flow model-Pressure gradient-Two phase friction factor for laminar and turbulent flow-Two phase viscosity-Friction multiplier. Separated flow model-Pressure gradient relationship-Lokhart-Martinelli correlation- Parameter X and its evaluation.

Module II

Empirical Treatments: Drift Flux model- Gravity dominated flow regime- Correlations for void fraction and velocity distribution in different flow regimes-pressure losses due to multiphase flow-velocity and concentration profiles.

Convective boiling: Thermodynamics of vapour/liquid systems-Super heat requirement-homogeneous nucleation- Bubble dynamic in pool boiling- Regimes of Convective boiling heat transfer-Boiling map-DNB-Critical Heat flux in forced convection boiling.

Module III

Condensation: Liquid formation-Droplet growth-crude theory and its modifications – Nusselt theory on film condensation- Influence of turbulence-condensation on horizontal tubes-Condensation within vertical tube-Dropwise condensation-Pressure gradient in condensing systems.

References:

1. J G Collier: Convective Boiling & Condensation
2. G W Wallis: One Dimensional Two-Phase Flow
3. YY Hsu, R W Graham: Transport Processes in Boiling & Two Phase Flow

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

FOURTH SEMESTER

MTC 4101 THESIS – FINAL 0-0-21-12

The student has to continue the thesis work done in the second and third semester. There shall be two seminars (a midterm evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper is to be prepared for possible publication in journals / conferences. The final evaluation of the thesis shall be an external evaluation. The marks for the Thesis-Final may be proportionally distributed between external and internal evaluation as follows.

Distribution of marks allotted for the Thesis

Internal Evaluation of the Thesis work by the guide - 150 Marks
Internal Evaluation of the Thesis by the Evaluation Committee - 150 Marks
Final Evaluation of the Thesis work by the Internal and External Examiners:
(Evaluation of Thesis: 200 marks + Viva Voce: 100 marks) - 300 Marks

DEPARTMENTAL ELECTIVES IN MECHANICAL ENGINEERING FOR SEMESTER II

MID 2001: RELIABILITY ENGINEERING 3-0-0-3

Objective:

The objective of this course is to understand the theories and their practical uses with real-world examples and problems to solve. The course focuses on system reliability estimation for time independent and failure dependent models. It helps the students in assembling necessary components and configuring them to achieve desired reliability objectives, conducting reliability tests on components, and using field data from similar components. Also to provide more complex aspects regarding both the Maintainability, Availability and some fundamental techniques such as FMECA (Failure Mode, Effects, and Criticality Analysis) and FTA (Fault Tree Analysis) with examples.

Outcome

After the completion of the course one should be able to know:

- Reliability and Hazard Functions
- System Reliability Evaluation
- Time- and Failure-Dependent Reliability
- Estimation Methods of the Parameters of Failure-Time Distributions
- Parametric Reliability Models
- Models for Accelerated Life Testing
- Renewal Processes and Expected Number of Failures
- Preventive Maintenance and Inspection

Pre-requisite: Concepts of Probability and Statistics, Probability Distributions, Point Estimation, Interval Estimation, Goodness-of-fit Tests, Statistics of Extremes.

Module I

Introduction to reliability: definition, Reliability and Quality, failure and failure modes

Failure data analysis: Reliability and rates of failure, Reliability function, expected life, failure rate, hazard function, constant and time dependent hazard models, state dependent hazard models, Markov Analysis.

Module II

System Reliability models – Series, parallel, mixed configurations, k-out-of-m models
Redundancy techniques – component vs unit redundancy, mixed redundancy, Standby redundancy, weakest link technique
Reliability improvement, Reliability allocation

Module III

Fault tree analysis, use of Boolean algebra, Load strength analysis. Understanding of FMECA. Maintainability- Definition, relationship between reliability and maintainability
Availability- Definition, relationship between reliability and availability, simple Markov models.

Case studies from industries demonstrating Reliability aspects. Computer softwares in reliability.

References

1) Charles E Eblings – An Introduction to Reliability and Maintainability Engineering, McGraw Hill
2) E. Balagrusamy - Reliability Engineering, Tata-McGraw Hill Publishing Company Limited, New Delhi, 1984.
3) L S Srinath – Reliability Engineering, East West Press
4) Lewis, E.E., Introduction to Reliability Engineering, John Wiley & Sons, New York, 1987.
5) O'Connor Patric D.T., Practical Reliability Engineering, 3/e revised, John Wiley & Sons, 1995.
6) StamatisD.H., Failure Mode and Effect Analysis, Productivity Press India (P) Madras, 1997.

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.

MID 2002: MODERN INFORMATION SYSTEM **3-0-0-3**

Course Objectives

- To learn about different information systems.
- To effectively use and manage information technology in today's network enterprises.
- To study inter connected networks of information systems for end user collaboration.
- To learn systems for making timely decisions based on organized informations.

Learning Outcomes

After the completion of the course the student is expected to

- Widen his knowledge about information technology that will enable him to solve management problems.
- Explore full potential of computer as a problem solving tool.

Module I

Introduction to information systems ,Types and examples of information systems, information technology infrastructure. System concepts, system design, development and analysis

Module II

Decision support systems: Overview, Data Mining and Warehousing, Modeling and. Analysis, Knowledge based DSS. Model management, modeling processes, modeling languages.

Module III

Neural computing, applications, advanced artificial intelligent systems and applications. Intelligent software agents, Impact of Management support systems.

References

1. Kenneth C. Laudon and Jane P. Laudon, Management Information Systems – Managing the digital firm, , Pearson education, 2002.
2. Burch John.GJr and Others , Information Systems theory And Practice, John wiley&Sons
3. James A O'Briean, Management Information Systems, Tata McGraw Hill
4. Decision Support Systems and Intelligent Systems, , Prentice Hall International
5. Marakas, Decision Support System, Pearson Education
6. Robert Levine et al ,"Comprehensive Guide to AI and Expert Systems",McGraw Hill Inc..Henry C. Mishkoff, "Understanding AI", BPB Publication, New Delhi, 1986

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students

MDD 2001: COMPUTATIONAL PLASTICITY **3-0-0-3**

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:

At the end of this course, the students will

- gain insight into the behavior of metals under loading and heating conditions,
- be able to use elementary theory of plasticity to formulate bulk forming processes,
- be able to master the basic formulations and their applications to sheet forming Processes,
- be able to master and apply the basic theory of metal cutting,
- have the basic knowledge about the cutting tools, cutting fluids and the cutting
- parameters and how they affect the cutting performance,
- be able to optimize metal cutting operations for the selected criteria

Learning Outcomes:

At the completion of the course, students will be able to…

- Predict the changes in the mechanical behavior of materials due to thermo-mechanical processing based finite element modeling.
- Interpret and quantitatively determine elastoplastic behavior of metals.

Module I

Elements of continuum mechanics and thermodynamics – Kinematics of deformation - Infinitesimal deformations - Forces. Stress Measures - Fundamental laws of thermodynamics - Constitutive theory - Weak equilibrium. The principle of virtual work - The quasi-static initial boundary value problemThe finite element method in quasi-static nonlinear solid mechanics - Displacement - based finite elements - Path-dependent materials. The incremental finite element procedure – Large strain formulation - Unstable equilibrium. The arc-length method

Module II

Overview of the program structure of FEM for plasticity
The mathematical theory of plasticity – Phenomenological aspects - One-dimensional constitutive model - General elastoplastic constitutive model - Classical yield criteria – Plastic flow rules - Hardening laws

Module III

Finite elements in small-strain plasticity problems – Preliminary implementation aspects - General numerical integration algorithm for elastoplastic constitutive equations - Application: integration algorithm for the isotropically hardening vonMises model - The consistent tangent modulus – Numerical examples with the vonMises model - Further application: the von Mises model with nonlinear mixed hardening

References:

1. Eduardo de Souza Neto, DjordjePeric, David Owens, Computational methods for plasticity : theory and applications - 2008 John Wiley & Sons Ltd
2. A. Anandarajah, Computational Methods in Elasticity and Plasticity – 2010 Springer
3. Han-Chin Wu, Continuum mechanics and plasticity - CRC Press
4. D R J Owen, E Hinton, Finite Elements in Plasticity Theory and Practice – 1980 Peneridge Press Ltd.
5. Jacob Lubliner, Plasticity theory – 2006
6. J. Chakrabarty, Theory of plasticity third edition – 2006 BH
7. D W A Rees, Basic engineering plasticity an introduction with engineering and manufacturing applications - BH

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.

MDD 2002: BIO MECHANICS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Objective:

- To gain knowledge of bio mechanics
- To gain knowledge of designing of artificial implants
- To gain knowledge of viscoelastic material modeling
- Understand various bio materials

Outcome:

- Students will understand how the theory is used in analyzing human body and motions
- At the end of the course students will know the different bio materials

Industrial relevance:

This course is having direct application to industry.
In medical field, implementation of theory of mechanics will help in implementing various designs

Module I

Human Anatomy & physiology: Anatomy & Physiology of major systems of the body Basic Terminology-Major Joints - Major Muscle Groups -Tissue Biomechanics -Hard and Soft - Bones - Bone Cells and Microstructure- Physical Properties of Bone- Bone Failure (Fracture and Osteoporosis)- Muscle Tissue-Cartilage-Ligaments- Scalp, Skull, and Brain -Skin Tissue

Module II

Kinetics of Human Body -Forces Exerted across Articulating Joints -Contact Forces across Joints - Ligament and Tendon Forces- Joint Articulation
Rheology of body material-Viscoelasticity-Definition of Viscoelasticity 1D Linear Viscoelasticity (Differential Form Based on Mechanical Circuit Models- Maxwell Fluid-Kelvin–Voigt Solid- 1-D Linear Viscoelasticity (Integral Formulation)- 3-D Linear Viscoelasticity -Dynamic Behavior of Viscoelastic Materials

Module III

Biomaterials:- Different types of biomaterials - metals, polymers, ceramics, glasses, glass ceramics, composites. Material properties.Reactions to biomaterials - inflammation, wound healing & foreign body response, immunology and compliment system, -, prostheses and orthotics.Artificial bio-implants – Dental implants, heart valves, kidneys, joints.

References:

1. Principles of Biomechanics by Ronald L Huston-CRC Press
2. Introduction to continuum biomechanics by Kyriacos A. Athanasiou and Roman M. Natoli-Morgan & Claypool
3. Duane Knudson Fundamentals of Biomechanics –Springer
4. Text book of Medical Physiology – C., M. D. Guyton..
5. Biomechanics: Motion,Flow stress and Growth, Y.C. Fung- Springer, New
6. York, 1990
7. Leslie Cromwell, Fred J.Weibell and Erich A.Pferffer. Biomedical instrumentation and Measurements -Prentice Hall of India, New Delhi.

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.

MDD 2003: INTRODUCTION TO SIGNAL PROCESSING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- Understand Fundamentals of DSP and its use in Noise and Vibration Enhancement
- Understand how to correctly implement and use the results of an FFT
- Interpretation of common Frequency Domain Measurements
- Understand the fundamentals and applications of Digital Filters
- Application and interpretation of Order Tracking analysis

Learning Outcomes:

As an outcome of completing this course, students will be able to:

- Understand how the combination of A/D conversion, digital filtering, and D/A conversion may be used to filter analog signals such as speech and music (1-D), and images (2-D).
- Understand the time- and frequency-domain concepts related to A/D conversion.
- Understand the time- and frequency-domain concepts related to D/A conversion.
- Understand the role of oversampling in A/D and D/A conversion.
- Understand the roles of downsampling and upsampling in digital processing of analog signals.
- Understand the respective roles of the magnitude and phase response of a digital filter.
- Understand the concepts of phase delay and group delay of a digital filter.
- Understand the relations between the DTFT, the DFT, and the FFT.
- Understand the computational issues in the implementation of digital filters.
- Understand the notion of random signals as an aid to filter design.
- Design FIR filters using the Windowing Method.
- Write reports on filter design and DSP applications projects
- Assess the societal impact of DSP, and the engineer's responsibilities in this regard.

Module I

Introduction to Signal Processing: Descriptions of Physical Data (Signals), Classification of Data. **Deterministic Signals:** Periodic, Almost Periodic and Transient Signals.Periodic Signals and Fourier series, Delta Function, Complex Form of the Fourier Series, Spectra. Fourier Integral, Energy Spectra, Properties of Fourier Transforms, Importance of Phase, Echoes, Continuous-Time Linear Time-Invariant Systems and Convolution, Group Delay (Dispersion), Minimum and Non-Minimum Phase Systems, Hilbert Transform, Effect of Data Truncation (Windowing).

Module II

Fourier Transform of an Ideal Sampled Signal, Aliasing and Anti-Aliasing Filters, Analog-to-Digital Conversion and Dynamic Range, Shannon's Sampling Theorem.Sequences and Linear Filters, Frequency Domain Representation of Discrete Systems and Signals, Discrete Fourier Transform, Properties of DFT, Convolution of Periodic Sequences, Fast Fourier Transform. Basic Probability Theory, Random Variables and Probability Distributions, Expectations of Functions of a Random Variable.

Module III

Stochastic Processes: Probability Distribution Associated with a Stochastic Process, Moments of a Stochastic Process, Stationarity, and the Second Moments of a Stochastic Process, Ergodicity and Time Averages.Single-Input Single-Output Systems,Estimator Errors and Accuracy, Mean Value and Mean Square Value , Correlation and Covariance Functions, Power Spectral Density Function, Cross-spectral Density Function, Coherence Function, Frequency Response Function .Description of Multiple-Input Multiple-Output (MIMO) Systems, Residual Random Variables, Partial and Multiple Coherence Functions, Principal Component Analysis.

Reference:

1. Fundamentals of Signal Processing for Sound and Vibration Engineers, K. Shing and J.K. Hammond, Wiley, 2007
2. Digital Signal Processing for Measurement Systems:Theory and Applications, G. D'Antona and Alessandro Ferrero, Springer
3. Digital Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, Prentice hall

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.

MPD 2001: FINITE VOLUME METHOD FOR FLUID FLOW AND HEAT TRANSFER 3-0-0-3

Structure of the Course

Lecture : 3 hrs/ Week Credits :3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:

- A number of physical problems related to Propulsion Engineering and Thermal Engineering can be modeled as partial differential equation and often non-linear. These equations cab not be solved by analytical methods and suitable numerical techniques are to be applied. The objective this stream elective is to give the students the necessary fundamentals ideas and their applications for real problems. An exposure to open source computational tools is also aimed. Reading and understanding at least two Journal Publications dealing with later developments in solution algorithms for flow and heat transfer.

Learning Outcomes:

- Mathematical formulation of physical problems and their solution.
- Capability to write computer programs based on the techniques learned.
- Development of a directory containing the basic and applied computer programs, tutorials and their document.

Module I

Governing equations of fluid flow and heat transfer-Programming in object oriented C++, Classes, Structures and Union (Portions up to this is for study by students themselves. Questions may be asked for the examinations). Governing equations in primitive variables – general scalar form for incompressible flow-conservative vector form for compressible flow-Linearisation -Jacobian-Mathematical nature of governing equations- Governing equations in terms of stream function and vorticity (2D and 3D).
Finite difference approximations for differential coefficients, order of accuracy, numerical examples-Stability, convergence and consistency of numerical schemes - Von-Neumann analysis for stability-Courant-Friedrich-Lewi criterion.

Module II

Rayleigh-Ritz, Weighted Residual, Galerkin and sub-domain methods, Interpolation and shape functions in FEM, FE discretisation of Laplace, Poissons and convection diffusion equations. Element equations for triangular, quadrilateral, tetrahedral and hexahedral elements.Numerical integration-Newton Cotes and Gauss quadrature.Application of boundary conditions, Solution of system of equations using TDMA and Conjugate gradient methods.

Module III

Finite volume discretisation of Laplace, Poissons and convection diffusion equations. Evaluation of gradients on regular and arbitrary cells, Upwind, Central and Power Law schemes. Structured and unstructured grids.Staggered and collocated grids, Pressure Poisson's equation, SIMPLE, PISO and PROJECTION algorithms for incompressible flow. Flux vector splitting method for compressible flow. Hybrid FE and FV, Semi Lagrangianand Spectral methods, Development of computer programs - Introduction to OpenFOAM. Computer assignments.

References:

1. Applied finite element analysis, Larry J. Segerlind
2. Numerical heat transfer and fluid flow, Suhas V. Patankar
3. Computational fluid dynamics: the basics with applications, John D. Anderson
4. Modern Compressible Flow: with Historical Perspective. John D. Anderson, JR
5. Introduction to Computational Fluid Dynamics, Anil W. Date

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.

MPD 2002:TRANSPORT PHENOMENA 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

1.To develop and detailed understanding of the physics behind transport phenomena in engineering systems.
2. To learn solution techniques in advanced transport phenomana.

Learning Outcomes

1. Student will be capable of applying theoretical knowledge in various industrial and academic situations
2. They will be in a position to develop models for a particular problem involving heat and mass transfer.

Module I

Viscosity and the mechanism of momentum transport-pressure and temperature dependence of viscosity-Theory of viscosity of gases at low density- Theory of viscosity of liquids.

Thermal conductivity and the mechanism of energy transport-temperature and pressure dependence of thermal conductivity in gases and liquids-theory of thermal conductivity of gases at low density – theory of thermal conductivity of liquids- thermal conductivity of solids.

Diffusivity and the mechanism of mass transport- definitions of concentrations, velocities and mass fluxes-Fick's law of diffusion- temperature and pressure dependence of mass diffusivity-theory of ordinary diffusion in gases at low density- theories of ordinary diffusion in liquids.

Module II

Shell balance for momentum, energy and mass, boundary conditions, Adjacent flow of two immiscible fluids- heat conduction with a nuclear heat source-diffusion through a stagnant gas film-diffusion with heterogeneous chemical reaction- diffusion with homogeneous chemical reaction-diffusion into a falling liquid film: Forced convection mass transfer-diffusion and chemical reaction inside a porous catalyst; the "Effectiveness factor'.
The equations of change for isothermal, non isothermal and multi component systems- the equations of continuity of species A in curvilinear co-ordinates-dimensional analysis of the equations of change for a binary isothermal mixture.

Module III

Concentration distributions in turbulent flow- concentration fluctuations and the time smoothed concentration-time smoothing of the equations of continuity of A.

Inter phase transport in multi component systems-definition of binary mass transfer coefficients in one phase – correlations of binary mass transfer coefficients in one phase at low mass transfer rates-definition of binary mass transfer coefficients in two phases at low mass transfer rates- definition of the transfer coefficients for high mass transfer rates.

Macroscopic balances for multi component systems- the macroscopic mass, momentum, energy and mechanical energy balance-use of the macroscopic balances to solve steady state problem.

References:

Text book: Transport Phenomena Bird R B, Stewart W E and Lightfoot F N

Note: Use of approved charts & tables are permitted in the examinations.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students.

MTD2001: FINITE ELEMENT ANALYSIS FOR HEAT TRANSFER 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week   Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart an awareness regarding various types of equations and their methods of solving
To analyse a given situation to find out the temperature profiles and rate of heat transfer

Learning Outcomes

The students will be capable of analyzing theoretically any heat transfer problems by using FEM

Module I

Review of the fundamentals of the three modes of heat transfer. Governing differential equations.Initial and boundary conditions.

Review of the numerical techniques for the solution of matrix equations.
Basic concepts of Finite Element method. Mesh generation-
Types of elements, Node numbering scheme.Interpolation polynomials.Finite element equations and element characteristic matrices.Variational approach, Galerkin approach.Assembly of element matrices.Solution of finite element system of equations.

Module II

Steps involved in a thermal analysis. Analysis of linear and nonlinear conduction problems in steady and transient hea t transfer.1D, 2D and 3D analysis with simple examples.Axisymmetric heat transfer.Finite element solution in the time domain.

Effects of convection in heat transfer- advection-diffusion. Analysis of heat transfer problems with radiation.

Module III

Concepts of adaptive heat transfer analysis. Implementation of the adaptive procedure.

Computer programming and implementation of FEM. Introduction to general purpose FEM packages.

References:

1. R W Lewis, K Morgan, H R Thomas and K Seetharamu: The Finite Element Method in Heat Transfer Analysis
2. H C Huang and A Usmani: Finite Element Analysis for Heat Transfer
3. L J Segerland: Applied Finite Element Analysis
4. C Zeinkewicz: The Finite Element Method

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.

MTD 2002: CRYOGENIC ENGINEERING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To impart a basic concepts of low temperature production and utilization
- To study various systems for low temperature production

Learning Outcomes

- The students will be capable of designing a liquefaction system
- They will be able to produce liquefaction systems with minimum energy consumption

Module I

Introduction: Historical development-present areas involving cryogenic engineering. Low temperature properties of engineering materials-Mechanical properties-Thermal properties-Electric and magnetic properties-Properties of cryogenic fluids.

Module II

Gas liquefaction systems: Introduction-Production of low temperatures-General liquefaction systems-Liquefaction systems for Neon, Hydrogen and Helium-Critical components of liquefaction systems.
Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigerators using liquids and gases as refrigerants-refrigerators using solids as working media.

Module III

Cryogenic fluid storage and transfer systems: Cryogenic fluid storage vessels-Insulation-Cryogenic fluid transfer systems.
Applications of Cryogenics: Super conducting devices-Cryogenics in Space Technology-Cryogenics in biology and medicine.

References:

1. Cryogenic Systems – Randall Barron
2. Cryogenic Engineering- R.B.Scott
3. Cryogenic Engineering – J.H.Bell Jr.

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.