Scheme of Studies

M.Tech in Mechanical Engineering

Specialization: Industrial Refrigeration & Cryogenics

M.Tech. Programme
Mechanical Engineering – Industrial Refrigeration & Cryogenics
Curriculum and Scheme of Examinations (2013 Admission)

SEMESTER I

Code No.	**Name of Subject**	**Credits**	**Hrs / week**	**End Sem Exam hours**	**Marks**			**Remarks**
					Internal Continuous Assessment	**End Semester Exam**	**Total**	
MRM1001	Mathematics	3	3	3	40	60	**100**	Of the 40 marks of internal Assessment, 25marks for test and 15 marks for assignment. End sem exam is Conducted by the University
MRC1002	Measurements in Thermal Engineering	3	3	3	40	60	**100**	do
MRC1003	Adv. Thermodynamics & Fluid Mechanics	3	3	3	40	60	**100**	do
MRC1004	Heat and Mass Transfer	3	3	3	40	60	**100**	do
MRC1005	Refrigeration Systems	3	3	3	40	60	**100**	do
MRC1006	Cryogenic Engineering	3	3	3	40	60	**100**	do
MRC 1101	Industrial Refrigeration Lab	1	2	-	100	-	**100**	No End Sem Examinations
MRC1102	Seminar	2	2	-	100	-	**100**	do
	TOTAL	**21**	**22**		**440**	**360**	**800**	7 hours of Departmental assistance work

SEMESTER II

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
MRC 2000	Research Methodology	2	2	3	40	**60**	**100**	Of the 40 marks of internal Assessment, 25marks for test and 15 marks for assignment.End Sem Exam is conducted by the Individual Institutions
MRC2001	Refrigeration Machinery & Components	3	3	3	40	**60**	**100**	Of the 40 marks of internal Assessment, 25marks for test and 15 marks for assignment. End sem exam is Conducted by the University
MRC2002	Design of cryogenic equipments & systems	3	3	3	40	**60**	**100**	do
***	Stream Elective I	3	3	3	40	**60**	**100**	do
***	Stream Elective II	3	3	3	40	**60**	**100**	do
**	Department Elective	3	3	3	40	**60**	**100**	do
MRC2101	Computational Fluid Dynamics Lab	1	2	-	100	-	**100**	No End Sem Examinations
MRC 2102	Thesis – Preliminary – Part I	2	2	-	100	-	**100**	do
MRC 2103	Seminar	2	2	-	100	-	**100**	do
	TOTAL	**22**	**23**	---	**540**	**360**	**900**	6 hours of Departmental assistance work

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

List of Stream Electives for Second Semester

STREAM ELECTIVE I		STREAM ELECTIVE II	
MRE 2001	Space Cryogenics	MRE 2004	Air-Conditioning Systems And Design
MRE 2002	Utilisation Of Solar Energy	MRE 2005	Design Of Heat Transfer Equipments
MRE 2003	Heat Pump And Energy Recovery Systems	MRE 2006	Computational Fluid Dynamics

List Of Department Electives For Second Semester**

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 2002Transport Phenomena
8. MTD 2001 Finite Element Analysis for Heat Transfer.
9. MTD 2002Cryogenics Engineering

SEMESTER III

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Continuous Assessment	End Semester Exam	Total	
***	Stream Elective III	3	3	3	40	60	**100**	Of the 40 marks of internal Assessment, 25marks 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
MRC 3101	Thesis – Preliminary – Part II	5	14	-	200	-	**200**	No End Sem Examinations
	TOTAL	**14**	**23**	-	**320**	**180**	**500**	6 hours of Departmental assistance work

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

List of Stream Electives for Third Semester

STREAM ELECTIVE III		STREAM ELECTIVE IV	
MRE 3001	**Cryogenic Heat Transfer**	MRE 3003	**Food Processing, Preservation And Transport**
MRE 3002	**Vacuum Technology**	MRE 3004	**Experimental Methods In Engineering**

List of Non- Department Electives** for Third Semester

1. **MRI 3001 E**nergy Conservation In Refrigeration And **Air-Conditioning** Systems
2. **MRI 3002** Energy Conservation In Buildings
3. **MRI 3003** Energy Conservation In Industrial Processes & Equipments

SEMESTER IV

Code No	Subject Name	Credits	Hrs/week	Marks					Remarks
				Continuous Assessment		University Exam		Total	
				Guide	Evaluation Committee	Thesis Evaluation	Viva Voce		
MRC 4101	Thesis	12	21	150	150	200	100	600	8 hours of Departmental assistance work
	Total	**12**	**21**					**600**	

M.Tech in Mechanical Engineering

Specialization: Industrial Refrigeration & Cryogenics

SYLLABUS

SEMESTER I

MRM 1001 MATHEMATICS

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Special functions: Beta and gamma functions Bessel functions. Definition of Jn(x). Bessele equation. Recurrence relations. Generating functions. Legendre polynomials. Legendre's equations. Rodrigue's formula. Orthogonality.

Module 2

Partial differential equations. Parabolic, elliptic and hyperbolic equations. Solution by separation of variables. D' Alembert's method (Cartesian only). Integral equations. Equations of second kind. Relation between differential and integral equations. Solution by successive approximation.

Module 3

Numerical Methods. Numerical integration. Trapezoidal rule. Simpson's 1/3 rule. Simpson's 3/8 rule. Numerical solution of ODE. Taylor's series method.. modified Euler's method. Ruge-Kutta 4th order method. Milne's predictor corrector method. Curve fitting. Method of least square. Fitting a straight line. Fitting a parabola.

References:

1. Sokolnikoff & Redheffer, "Mathematics of Physics and Modern Engineering" TMH 2000
2. Venkitaraman M. K., Higher Mathematics for Engineering and Science TMH 2002
3. Greenberg M. D., Advanced Engineering Mathematics TMH 2006

Structure of the Question paper

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

MRC 1002 MEASUREMENTS IN THERMAL ENGINEERING

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject, To produce knowledgeable users of the subject, To introduce the subject, To recognize the aspect of engineering problems solvable by applying the subject, To make the students aware of the capabilities and limitations of the subject for engineers. Understand the various processes related to the subject. To study advanced features of the subject, To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt, Describe various operations in Mechanical Engineering using the subject, Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Instrument classification, characteristics of instruments- static and dynamic, error analysis , systematic, and gross errors, statistical analysis. Different types of sensors and transducers- resistance, inductance, capacitance, piezoelectric, thermoelectric, photoelectric, strain gauges, indicating recording and integrating instruments

Module 2

Measurement methods of temperature and heat flux, pressure, flow, linear motion, force torque, shaft power vibration, liquid level, viscosity.

Module 3

Measurements in refrigeration and air conditioning practice- different instruments for measuring mass flow, air flow, velocity, temperature, humidity, sound, solar radiation, air purity Data logging and acquisition, elements of microcomputer interfacing, use of intelligent instruments for physical variable

References:

1. Doeblin, Measurement system application and design, Mc Graw Hill 2006

2. Barney, Intelligent instrumentation, Prentice Hall India 2003

3.Holman J P, Experimental Methods for Engineers, Mc Graw Hill 2005

4. Morris A S Principles of Measurements and Instrumentation, Prentice Hall of India 2000

Structure of the Question paper

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

MRC1003 ADVANCED THERMODYNAMICS & FLUID MECHANICS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Review of fundamentals of thermodynamics, Zeroth law of thermodynamics-ITS temperature scale, First law of thermodynamics-steady and unsteady flow, Second law of thermodynamics – statements, equivalence, corollaries, reversible process, factors that render process reversible, thermodynamic temperature scale. Entropy- Clausius inequality, principle of increase of entropy, Concept of lost work, Entropy generation in open and closed system, Tds Equations, Applications of second law of thermodynamics, third law of thermodynamics. Irreversibility and Availability-Available energy and reversible work-Open and closed system. Availability-Flow process and Non flow process, Irreversibility and Gouy-Stodola theorem, Second law efficiency, effectiveness of a process, availability function, Thermodynamic potential function- Helmholtz function, Gibbs function. Thermodynamic relations-Maxwell's relation, Joule Kelvin effect, Clausius-Clapeyron equation.

Module 2

Equation of state for real gases- van der Waal's equation, RKS equation, Peng- Robinson equation- compressibility chart, law of corresponding states. Thermodynamics of gas mixtures, models used for analysis of mixtures, modeling of gas vapour mixture, Ideal solutions-Fugacity, Raoult's law, Vapour liquid equilibria, Phase diagram for binary solutions. Types of motion of fluid element, concept of rotational and irrotational flow. Vorticity and circulation. Stream function velocity potential.

Module3

Dimensional analysis and similitude. Buckingham Pi theorem and its applications. Important dimensionless groups in fluid mechanics and their significance. Geometric, kinematic and similarity, model study. Incompressible viscous flow, concept of laminar and turbulent flows. Stokes viscosity law. Navier stokes equation and its significance. Simplification of Navier stokes equation for steady incompressible flows with negligible body forces. Parallel flow through straight channel and Coutte flow. Hagen-Poiseulli flow.Concepts of hydrodynamic boundary layer, Critical Reynold's number, separation of boundary layers, displacement thickness, momentum thickness and energy thickness. Techniques of boundary layer control.

Concept of thermal boundary layer.

References :

1. Sonntag, Borgnakke & Van Wylen, Fundamentals of thermodynamics, John Wiley & sons 2000
2. Asad M., Thermodynamics for Engineers –, Prentice Hall of India Ltd. 2000
3. Nag P.K., Engineering thermodynamics –, Tata McGraw Hill publishers 2001
4. Cengel Y., Boles M., Thermodynamics: An Engineering Approach. With Student Resources DVD, McGraw Hill. 2000

Structure of the Question paper

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

MRC 1004 HEAT AND MASS TRANSFER

Structure of the Course

Lecture : 3 hrs/ Week   Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Multi-dimensional steady state conduction: Mathematical analysis of two dimensional systems, Numerical method of analysis. Conduction shape factor, Conduction unsteady state. Lumped heat capacity systems, time constant and response of temperature measuring instruments – transient heat flow in semi infinite body, infinite solids - Convection boundary conditions. Applicability of the Heisler charts - Multidimensional transient systems. Introduction to heat pipes.

Module 2

Heat transfer with change of phase, melting and solidification, application in food freezing and ice making - boiling and condensation - Two phase flows - two phase flow pressure drop Cryogenic heat transfer - forced convection boiling. Flow induced vibrations. Stratification in cryogenic vessels- frost formations.

Module 3

Introduction to mass transfer. Molecular diffusion and diffusivity - Ficks law of diffusion. Temperature and pressure dependence of mass diffusivity for a binary liquid mixture, diffusion in binary mixtures - basic definitions. The differential mass balance for single component systems and two component systems. Diffusion of component A through stagnant B. Steady state equimolar counter diffusion- The analogy between momentum, heat and mass transfer. Diffusion into a falling liquid film. The penetration theory: Convection mass transfer- application of dimensional analysis to mass transfer. Mass transfer coefficient. Mass transfer coefficients for flow in pipes in laminar and turbulent flows. Air water operations - basic definitions -simplified method for finding the height of a cooling tower. Drying – types of dryers, critical moisture content and equilibrium moisture content.

References:

1. Holman J. P., “Heat Transfer" McGraw Hill Book Company, New york 2000
2. Myers J. E., "Analytical methods in conduction heat transfer", International text book company. 2000
3. Kreith F., "Principles of heat transfer", International text book company 2000
4. Sachdeva R. C., "Fundamentals of engineering heat and mass transfer'. Wiley Eastern limited.2000

Structure of the Question paper

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

MRC 1005 Refrigeration systems

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Brief history of refrigeration, refrigerants and environmental issues. Reverse Carnot cycle and standard vapor compression refrigeration cycle - analysis, comparison and Ewing's construction. Compressors - reciprocating, centrifugal and screw type, volumetric efficiency and performance. Performance of single stage refrigeration cycle and its limitations. Multistage, multi evaporator and cascade systems.

Module 2

Properties of refrigerants -primary, secondary and mixtures. Ozone friendly refrigerants, ozone depletion and global warming. lubricants. Absorption refrigeration system - LiBr-water and aqua-ammonia systems, calculations by h-x diagrams, Platen-Munter's system and solar energy applications. Steam jet refrigeration, vortex tube, Pulse tube, thermoelectric refrigeration and gas cycle refrigeration.

Module 3

Air liquefaction cycles. Condensers and evaporators: classifications, condensation and boiling heat transfer correlations, design and performance. Expansion values - capillary tube, AEV, TEV and float value. Refrigeration system simulation: balancing of condensing unit and evaporator

References:

1. Gosney W.B. "Principles of refrigeration" Cambridge University Press(1982)

2. Dossat R. J., Principles of Refrigeration" 4th Edition 2002.-Pearson Education, India. 2000

3. Transactions of ASHRAE. 2008

4. ASHRAE guide and Data Books Fundamentals (1977), Transactions (1978), Equipment (1979), Systems (1980)

Structure of the Question paper

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

MRC 1006 CRYOGENIC ENGINEERING

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives:

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module1

Thermodynamics of gas liquefaction- liquefaction cycles- cryogenic refrigeration systems down to milli Kelvin range. Properties of cryogenic liquids, superfluidity, properties of solids at cryogenic temperatures: mechanical, thermal, electrical and magnetic properties, superconductivity. Storage and transfer of cryogenic liquids, liquid level.

Module2

Thermocouples, platinum resistance and semiconductor thermometry. Cool down of cryogenic transfer lines, frost phenomena, cryogenic insulation. Applications of cryogenics in engineering, space technology, liquid fuel rockets, space simulation chambers.

Module3.

Cryogenic heat pipes, nuclear research, bubble chambers, spectroscopy, vacuum technology, cryo pumping, food processing, preservation during transport, biology, medicine and LNG technology, cryocooler and its applications.

References:

1. Haselden C.J. (Ed) Cryogenic Fundamentals, Academic Press (1975)
2. Baily C.A. Advanced cryogenics. Plenum Press (1971)

3. Barron R.F. Cryogenic Systems McGraw Hill (1966)

Structure of the Question paper

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

MRC 1101 INDUSTRIAL REFRIGERATION LAB.

Structure of the Course

Practical : 2 hrs/ Week Credits : 1

Internal Continuous Assessment : 100 Marks

Experiments to illustrate different techniques of measurements of various quantities like temperature, humidity, pressure, velocity, etc. study of components of refrigeration and air conditioning systems and testing their performance, simple heat transfer experiments with condensers and evaporators. Experiments on cooling tower, walk- in coolers. Cooling and Freezing characteristics of food products; Production of liquid argon and liquid oxygen using liquid nitrogen, Measurements of their boiling points at atmospheric pressure. Study of data acquisition system, Simple exercises using Labview.

MCC 1102 Seminar

Structure of the Course

Seminar : 2 hrs/ Week Credits : 2

Internal Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in Mechanical, Refrigeration, Cryogenics and related areas. 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: 50
Seminar Presentation: 50

SEMESTER II

MRC 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.

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.

MRC 2001 REFRIGERATION MACHINERY AND COMPONENTS

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
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To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Refrigeration compressors, different types, performance, capacity control. Criteria for selection of materials and dimensions. Design and lubrication of reciprocating compressors, surging in centrifugal compressors, compressor rating and selection, protection devices. Condensers: types, effect of air and non-condensable gases, purging and recovery in centrifugal chillers, optimum cooling water rate in evaporative condenser. Cooling towers: types range and approach. Air washers, spray ponds. Condenser and tower maintenance.

Module 2

Evaporators: Types, effect of air quantity and surface area on capacity, LMTD, chiller selection, direct and indirect systems, secondary refrigerants, anti freeze solutions, defrosting of evaporators. Expansion devices: capillary tube, thermostatic expansion valve, automatic expansion valve and float valve etc ,design and constructional features. Interdependence of refrigeration systems and overall system performance. Compressor motors.

Module 3

Control systems of temperature, pressure and oil flow. Pneumatic controls, microprocessor based control. Control of system capacity. Motor safety devices and controls. Receivers, accumulators, driers and strainers. Refrigeration piping system. Equipment selection: compressor, chiller, condenser, thermostatic expansion valve. Charging of refrigerant, dehydration, leak testing.Preventive maintenance of different refrigerant components: compressor, condenser, evaporator.

References:

1. Dossat R. J., “Principles of Refrigeration”. John Wiley & Sons. 2000
2. Althouse A. D., Turnquist C. H. “Modern refrigeration and Air-conditioning”, Good Heart Wilcos. CO. Inc. 2000
3. Ananthanarayan P.N., Basic Refrigeration and air condition, Tata Mc Graw Hill Publishing Company. 2004

Structure of the Question paper

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

MRC 2002 DESIGN OF CRYOGENIC EQUIPMENT AND SYSTEMS

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objective:

To provide the students with a foundation in the subject.
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To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Theory of Air separation, design of air separation plants, argon recovery systems; inert gas recovery systems, design and construction of high pressure air compressors, after coolers, turbines and expansion devices, Cryogenic heat exchangers, regenerators. Stirling cycle machines, Helium liquefiers.

Module 2

Design of cryogenic transfer lines, storage systems and pumps, insulation systems. Road transport of bulk cryogenic liquids. Introduction to cryostat design for operations in 4K range. Methods of temperature control. Low temperature fabrication techniques. Vacuum technology, rotary diffusion, absorption and Cryo Pumps. Radiation shielding for cryogenic liquid storage.

Module 3

Recent developments in application of cryogenics: magnetic levitation, super conducting bearings, superconducting generators, Production of very high magnetic fields, cryosurgical probes, material science, purification of industrial gases.

Reference:

1. Guthrie A. Vacuum Technology, John Wiley(1963)
2. Dushman S. Scientific foundations of Vacuum Techniques John Wiley (1962)
3. Timmerhaus K. D. (Ed) Advances in cryogenic Engineering Vol 1 to 24, Plenum Press (l956-80) .
4. White G.K., Experimental Techniques in low temperature Physics, Oxford University Press (1966)
5. Croft A. J. Cryogenic Laboratory Equipment, Plenum Press. 2000

Structure of the Question paper

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

MRC 2101 COMPUTATIONAL FLUID DYNAMICS LAB

Structure of the Course

Practical : 2 hrs/ Week Credits : 1

Internal Continuous Assessment : 100 Marks

The purpose of this course is to acquaint the students with the practical use of CFD tools for investigating fluid flow and heat transfer problems·
Study of commercial CFD packages.

The following exercises are to be done using commercial software packages.

Fluid flow problems (internal and external flows)
Heat conduction problems ,Natural convection & forced convection problems
Conjugate heat transfer problems, Hydrodynamic boundary layer problems
Simulation of flow in turbo machines
Cooling of electronic ,packages

MRC 2102 Thesis – Preliminary – Part 1

Structure of the Course

Thesis: 2 hrs/ Week Credits : 2

Internal Continuous Assessment : 100 Marks

For the thesis- preliminary Part I the student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/ she should broadly identify the area of the thesis work, familiarize with the design and simulation tools required for the thesis work and plan the experimental platform, if any, required for the thesis work. The student should submit a detailed report of these activities at the end of the semester.

Evaluation of marks for the thesis preliminary part I
Evaluation of the thesis – preliminary work by the guide - 50 marks
Evaluation of the thesis – preliminary by the Evaluation Committee - 50 marks

MRC 2103 Seminar

Structure of the Course

Seminar : 2 hrs/ Week Credits : 2

Internal Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in Mechanical, Cryogenics, Industrial Refrigeration and related areas. 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: 50
Seminar Presentation: 50

MRE 2001 SPACE CRYOGENICS

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
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Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module I

Chemical rocket propulsion, Definitions and fundamentals: thrust, total impulse, specific impulse, mixture ratio, bulk density, characteristics velocity, thrust to weight ratio, exhaust velocity, mass ratio, multistaging; Types of chemical propellants: solid, liquid, hybrid, Physical properties of common earth storable propellants, semi-cryo and cryogenic propellants; Pressure fed system – sources of pressurising gas, Pump fed systems - engine operating cycles, pumps and turbines – general configuration, Fluid circuits of various cryogenic engines and semi-cryogenic engines;

Module II

Design of regeneratively cooled combustion chamber, film cooling, dump cooling, transpiration cooling and radiation cooling. Design of expansion nozzle- characteristics, Design of injector–hydraulic characteristics; Engine thrust and mixture ratio control, Igniters, Propellant tanks, Valves: shut off valve, flow control valves, check valve, isolation valve, relief valves, Common materials used in cryogenic propulsion; Problems in storage and handling of cryogenic propellants: safety aspects, Thermal protection systems for stage tanks, Thermal stratification-destratification, Geysering effect, geysering elimination, Zero “g” problems – restart mechanism.

Module III

Cryocoolers for space applications. Passive coolers: Radiators, stored cryogens. Effect of orbit on radiators. Active coolers: Stirling cycle coolers, Pulse tube, Joule-Thompson, Sorption, Reverse Brayton, Adiabatic Demagnetization, 3He coolers, Optical cooling and Peltier effect coolers. Advantages/disadvantages of different types of cooler technology. Existing cooler applications on Herschel, James Webb, Athena and Planck detectors. Static Cryogenic Seals for Launch Vehicle Applications.

References:

1. Moss RJ, Gabriel SB. A critical review of space-cooling techniques. Advances in Space Research, 17(1), 1996, pp 119-122.
2. Collaudin B, Rando N. Cryogenics in space: a review of the missions and of the technologies. Cryogenics, 40. 2000. pp797-819.
3. Lounasmaa OV. Experimental principles and methods below 1K. Academic press. 1974.
4. White GK, Meeson PJ. Experimental techniques in low-temperature physics. Clarendon Press. 2002. 4th edition.

Structure of the Question paper

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

MRE 2002 UTILISATION OF SOLAR ENERGY

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Extraterrestrial radiation, solar constant, spectral distribution of extraterrestrial radiation, solar radiation at earth's surface, beam radiation, diffuse radiation, air mass, variation of extraterrestrial radiation, Data pertaining to solar radiation, estimation of available solar energy based on longitude, latitude, time of year and atmospheric conditions.

Module 2

Solar collectors- Flat plate collectors, general description, the basic flat plate energy balance equation, general characteristics of flat plate solar collectors, collector overall heat transfer coefficient. Focusing collectors, the solar disk and theoretical solar images, concentrators, receivers and orienting systems.

Module 3

Energy storage, process loads and solar collector outputs, energy storage in solar process systems, water storage, packed bed exchanger storage, phase change energy storage capacities of storage media. Solar water heating, water heater systems, collector and storage tanks, loads and sizing of systems. Solar heating, solar heater systems, The Denver solar house, other practical examples. Solar cooling, solar absorption cooling, solar operated absorption cooler. Solar heating/cooling, collector- storage wall systems, collector- radiator heat pump systems, solar energy heat pump system, open cycle cooling systems, solar ponds, green houses. Application of solar energy for drying and farm operations; water pumping. Heating applications of solar energy, thermal power systems.

References:

1. Duffie J.A. and Beckman W. A. "Solar energy thermal processes", John Wiley and Sons(1974)
2. Sayigh A.A.M. "Solar energy engineering" Academic press, (1977)
3. Krieth and Krieder "Principles of solar engineering" McGraw Hill (l978)

Structure of the Question paper

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

MRE 2003 HEAT PUMP AND ENERGY RECOVERY SYSTEMS

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Concept of heat pumps, Types of heat pumps, Advantages and disadvantages of different types of heat pumps. Different heat pump sources and sinks. Vapour compression heat pumps Refrigerants for various compression heat pumps. Thermodynamic and dynamic analysis of vapour compression systems.

Module II

Concept of chemical heat pump. Vapour absorption heat pumps, vapour absorption heat transformers. Compression absorption heat pumps. Working fluids used for absorption heat pumps. Solar assisted heat pumps. Method of heat storage. Different types of heat pumps used in domestic, commercial and industrial sectors. Latest examples.

Module II

Thermodynamic analysis of vapour absorption heat pumps, heat transformers and compression- absorption heat pumps. Concept of heat pipes. Types of heat pipes and working fluids. Heat exchanger. Application of heat pipes in heat recovery systems. Importance of energy conservation. Principles of energy recovery. Role of heat pumps in energy recovery Energy recovery in buildings and air-conditioning systems typical examples.

References:

1) Reay D.A. and Mac Micheal, 'Heat pump' Pergamon press 1988.

2) Reay D. A.' and Mac Micheal "Heat pump design and applications" Pergamon press, 1977.

3) Reay D.A. "Industrial energy conservation , Pergamon press 1977

4) Sherrat A_F.C. "Airconditiing and energy conservation" The Architectural Press, London 1978.

5) Dunn P.D. and Reay D.A. “Heat pipes". Pergamon press1978.

Structure of the Question paper

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

MRE 2004 AIR CONDITIONING SYSTEMS & DESIGN

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Properties of moist air - Psychrometry, Psychrometric Processes, sensible heat ratio; sensible heating and cooling, Humidification and dehumidification devices; Airwashers and evaporative coolers.

Module 2

Air-Conditioning systems; unitary equipments, split unit; packaged systems, central air-conditioning systems- all air, all water and air-water systems, 3 and 4 pipe system, constant volume, variable temperature systems, multi zone, dual duct; dual air, induction fan coil systems.

Module 3

Air movement in rooms, air jets, air distribution devices; Duct design - noise and noise control; Estimation of cooling load (ASHRAE or CARRIER method). Special purpose air-conditioning, schools, hospitals, theatres, computer rooms, automobiles etc. Control systems used in air-conditioning plants.

References:

1. Harris N.C and Cands L. C Modem air-conditoning practice - McGraw Hill (1974)
2. Gunther R.C - Refrigeration, air-conditioing & Cold storage- Chilton Book Co Rador, Pensylvania (1969)
3. Gosling C.T - Applied air-conditioning and refrigeration, Applied science Publishers Ltd, London (1974),
4. Kandembi V and Hutchinson F.N- Refrigeration, Air-conditioning and Environmental Control in India, Prentice Hall of India (1968)

Structure of the Question paper

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

MRE 2005 DESIGN OF HEAT TRANSFER EQUIPMENTS

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

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 annulii stream analysis method.

Module 2

Design of double pipe exchangers -shell and tube exchangers- the tubular element tube pitch- Shells-tube sheet-baff1es 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 3

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 pipes- Applications.

References:

1. TEMA Standards 2000
2. Sukhatme S P, A Text Book on Heat Transfer 2000
3. Dunn P and Reay D A, Heat Pipes 2001
4. Fraas A P and Ozisik M N,Heat Exchanger Design 2002

Structure of the Question paper

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

MRE 2006 COMPUTATIONAL FLUID DYNAMICS

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Methods of prediction, theoretical calculation, Experimental investigation, Choice of prediction method, computational fluid dynamics as a research tool, CFD code. Pre-processor, solver, postprocessor, problem solving with CFD. Review of governing equations of fluid flow and heat transfer. Forms of governing equations particularly suited for CFD. Turbulence and its modeling-turbulence, effect of turbulence, turbulent models.

Module 2

Finite volume method for diffusion problems. Finite volume method for one dimensional, two - dimensional and three dimensional steady state diffusion. Finite volume method for convection diffusion problems- steady state one dimensional convection and diffusion, Central differencing method, properties of discretization schemes, upwind differencing scheme, hybrid differencing scheme, the power scheme, Higher order differencing schemes for convection diffusion problems. Solution algorithms for pressure velocity coupling in steady flows, staggered grid-momentum equation, SIMPLE algorithm, SIMPLER algorithm, SIMPLEC algorithm, PISO algorithm. solution of discretised equations:

Module 3

Tri diagonal matrix algorithm. Applications of TDMA to two and three dimensional problems, other solutions in CFD. The finite volume method for unsteady flows- one dimensional heat conduction-explicit scheme, Crank-Nicholson scheme, fully implicit scheme, two and three dimensional problems, solution procedures for unsteady flow calculations, transient SIMPLE, transient PISO, steady state calculations using pseudo transient approach. Implementation of boundary conditions-inlet boundary condition, outlet boundary condition, wall boundary condition, constant pressure boundary condition, symmetry boundary condition, periodic or cyclic boundary condition. Applications like combustion modelling etc. (simple cases only)

References :

1. Patankar S. V.- Numerical heat transfer and fluid flow, Taylor & Francis 1990
2. Anderson J. D. Jr.- Computational fluid dynamics , McGraw Hill 2000
3. Hofman K. F - Computational fluid dynamics 2001

Structure of the Question paper

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

MID 2001 RELIABILITY ENGINEERING

Structure of the Course

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

Course 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.

Learning 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 2002MODERN INFORMATION SYSTEMS

Structure of the Course

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

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 information

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

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

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

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

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 studen

SEMESTER III

MRC 3101Thesis Preliminary Part II

Structure of the Course

Thesis : 14 hrs/ Week Credits : 5

Internal Continuous Assessment : 200 Marks

The student has to continue the thesis work identified in the Second semester. The student has to present two seminars and submit an interim thesis report.

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 Third Semester

STREAM ELECTIVE III

MRE 3001 CRYOGENIC HEAT TRANSFER

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Introduction & Conductive Heat Transfer:

Introduction to cryogenic heat transfer, Special problems in cryogenic heat transfer, Applications in cryogenic heat transfer. Conduction heat transfer- Governing equations, one dimensional steady state conduction, Conduction shape factor, Conduction in composite materials, Thermal contact resistance, Conduction in fins. Properties of frost at cryogenic temperature levels, Cool down with coated surfaces, Cool down of cryogenic fluid storage vessels.

Convective Heat Transfer:

Convection heat transfer- Governing equations, Forced convection heat transfer in a circular tube, Heat transfer in non-circular channels, Forced convection heat transfer in external flow, free convection over plates, free convection over horizontal cylinders, Natural convection in enclosures, Heat transfer in near- critical region, Heat transfer correlations in the near-critical region, Kapitza conductance.

Module 2

Two-phase Heat Transfer and pressure drop:

Flow regimes in two-phase flow, Pressure drop in two-phase flow, Lockhart-Martinelli correlation, Homogenous flow model, Boiling heat transfer, Nucleate pool boiling, Peak nucleate pool boiling, Pool film boiling, Forced convection boiling, Condensation outside tubes, Freezing at cryogenic temperatures, Solid-liquid (slush) flow and heat transfer.

Radiation Heat Transfer:

Black Body radiation, Radiation configuration factor, Radial exchange between two grey surfaces, The network method for enclosures, Radiation from LNG fires, Free molecule flow, Free molecule heat transfer, Free molecular heat transfer in enclosures.

Module 3

Cryogenic Heat Exchangers:

Cryogenic heat exchangers- types-(i) Tubular exchangers, (ii) Giauque-Hampson exchanger, (iii) Plate-fin heat exchanger, (iv) Perforated plate heat exchangers, (v)Sintered metal powder exchangers.

NTU-effectiveness design method, Giauque-Hampson heat exchanger design, Plate-fin heat exchanger design, Perforated plate heat exchanger design, Regenerators, Regenerator design.

References:

1) Barron R F, - Cryogenic heat transfer, Taylor and Francis, 1999
2) Long C A- Essential heat transfer, First Indian reprint, Pearson Education Pvt Ltd, India 2000
3) Incropera F P & DeWitt- Fundamentals of heat and mass transfer, John Wiley and sons, 1996
4) Holman J.P. - Heat Transfer, McGraw Hill Book Company, Newyork 2000
5) Sachdeva R.S.- Fundamentals of engineering heat and mass transfer, Wiley Eastern limited 2000

Structure of the Question paper

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

MRE 3002 VACUUM TECHNOLOGY

Structure of the Course

Lecture : 3 hrs/ Week   Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination   : 60 Marks

Course Objectives:

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

MODULE I

Vacuum: Definition, Artificial and natural vacuum, Applications of vacuum technique, importance of vacuum technology. Rarefied gas theory for vacuum technology. Perfect and real gas laws, motion of molecules in rarefied gases, pressure and mean free path; transport phenomena in viscous states and molecular states, thermal diffusion and energy transport.

MODULE II

Gas flow at low pressures: flow regimes, conductance and throughput. Physical-chemical phenomena in vacuum transport: Evaporation-condensation, solubility and permeation sorption, desorption- outgassing.

MODULE III

Production of vacuum; Mechanical pumps, vapour pumps, Ion pumps, Sorption pumps, Cryo pumping, Gettering. Measurement of low pressures: Mechanical gauges, thermal conductivity gauges, Ionization gauges.

References :-

1. Roth A.- Vacuum Technology, North Holland 2005
2. American Vacuum Society manual. 2009

Structure of the Question paper

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

MRE 3003 FOOD PROCESSING, PRESERVATION AND TRANSPORT

Structure of the Course

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

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject

MODULE I

Introduction to microbiology of food products. Pre cooling of food stuffs- methods, equipments; calculation of time, refrigeration load, recommended conditions for storage of foods.

MODULE II

Design, operation and maintenance of cold stores, controlled environment storage for food product, insulation and vapour barriers for cold stores.

MODULE III

Packaging of food products, food dehydration, theory, techniques and equipment, Freeze drying. Considerations in road, rail, air and sea transport of food products.

References :

1. Leniger H. A, Everloo W.A - Food Process Engineering, D.Reidel Publishing Co (1975)
2. Joslyn M.A & Heid J.L - Food Process Operations Vol 1 to 3, The air Publishing Co (1964)
3. Gunteer R.C - Refrigeration, Air conditioning and Cold storage, Chuition Book Co Pensylvannia (1969)
4. Van D K, Arsdel W.E & Copley M. J. - Freezing preservation of foods. Vol 1 to 4, The Air Publishing Co (1968)
5. Ryall & Lipton WJ - Handling, Transportation and storage of Fruits and Vegetables, The Air Publishing Co (1972).

Structure of the Question paper

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

MRE 3004 EXPERIMENTAL METHODS IN ENGINEERING

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject

MODULE I

Basic concepts of measurement methods and planning and documenting experiments. Sensors, transducers, and measurements system behavior. Data sampling and computerised data acquisition systems. Statistical methods and uncertainty analysis applied to data reduction. Measurement of selected material properties. Thermal conductivity measurement- Guarded hot plate apparatus; measurement of conductivity of metals-thermal conductivity' of liquids and gases, concentric cylinder method apparatus for determination of thermal conductivity of gases at high temperatures.

MODULE II

Measurement of viscosity- rotating concentric cylinder apparatus- Saybolt viscometer. Diffusion- measurement of diffusion coefficient in of gases. Convection heat transfer measurements. Forced convection heat transfer coefficients in smooth tubes. Humidity measurements. Heat flux meters. Elastic elements for force measurements- simple cantilever and thin ring elastic elements; proving ring. Torque measurements, hollow cylinder for torque measurement- Prony brake hydraulic dynamometer- cradled dynamometer. Strain measurements- electrical resistance strain gauges- different types, characteristics of strain gauge materials. Temperature compensation for electrical resistance strain gauges- strain gauge rosettes- bonded un bonded resistance strain gauges, use at cryogenic temperature levels.

MODULE III

Cantilever beam used as frequency measuring device. Principles of seismic instrument- practical considerations for seismic instruments-electrical resistance strain gauge seismic instrument, Piezo-electric transducer type seismic instrument. Sound measurement microphones-characteristics of microphones- psycho acoustic factors- sound level meter, acoustic properties of materials- sound absorption coefficients- noise reduction coefficients. Pollution measurement-units for pollution measurement- air pollution standards Air sampling train.

References :-

1) Holman J.P, Experimental methods for Engineers TMH 2000
2) Doebelin E. O., Measurement systems- application & design McGrawHill 2000
3) Eckman D P, Industrial Instrumentation 2004 TMH 2001
4) Beckwith T.G, Marangani R D, and Leinhard J F, Mechanical measurements TMH 2005
5) Bentley J P, Principles of measurement systems TMH 2006

Structure of the Question paper

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

SEMESTER IV

MRC 4101 THESIS

Structure of the Course

Thesis : 21 hrs/ Week Credits : 12
Internal Continuous Assessment : 300 Marks
Thesis Evaluation + Viva-Voce : 300 Marks

The student has to continue the thesis work identified in the Second semester. There shall be two seminars (a mid term evaluation on the progress of the work and the 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 internal and External examiners :
(Evaluation of Thesis :200 marks + Viva voce :100 marks) – 300 Marks