KANNUR UNIVERSITY

Faculty of Engineering

Curriculum, Scheme of Examinations and Syllabi for M.Tech Degree Programme with effect from Academic Year 2012-2013

MECHANICAL ENGINEERING

M Tech in

THERMAL ENGINEERING

FIRST SEMESTER

Code	Subject	Hours/Week			Sessional Marks	University Examination		Credit
		L	T	P		Hrs	Marks	
*MTE*101	Advanced Engineering Mathematics	3	-	-	50	3	100	3
MTE 102	Advanced Heat Transfer	3	-	-	50	3	100	3
MTE 103	Postulational Thermodynamics	3	-	-	50	3	100	3
MTE 104	Advanced Fluid Mechanics	3	-	-	50	3	100	3
MTE 105	Elective I	3	-	-	50	3	100	3
MTE 106	Elective II	3	-	-	50	3	100	3
MTE 107 (P)	Engineering Software Lab	-	-	2	50	3	100	2
MTE 108 (P)	Seminar	-	-	2	50			2
TOTAL		**18**	**-**	**4**	**400**		**700**	**22**

ELECTIVE I
MTE 105 (A) Energy conservation & heat recovery system
MTE 105 (B) Computational fluid flow & heat transfer
MTE 105 (C) Combustion science
MTE 105 (D) Modern energy conversion system
MTE 105 (E) Nuclear engineering

ELECTIVE II
MTE 106 (A) Refrigeration Engineering
MTE 106 (B) Solar Thermal engineering
MTE 106 (C) Steam turbine
MTE 106 (D) Gas turbine
MTE 106 (E) Hydraulic, Pneumatic and Fluid Controls

Sessional marks for all the Theory based Subjects

The marks allotted for internal continuous assessment and end-semester university examinations shall be 50 marks and 100 marks respectively with a maximum of 150 marks for each theory subject.

SECOND SEMESTER

Code	Subject	Hours/Week			Sessional Marks	University Examination		Credit
		L	T	P		Hrs	Marks	
MTE 201	Internal Combustion Egine, Combustion & Pollution	3	-	-	50	3	100	3
MTE 202	Principles of Turbomachines	3	-	-	50	3	100	3
MTE 203	Measurements in Thermal Engineering	3	-	-	50	3	100	3
MTE 204	Elective III	3	-	-	50	3	100	3
MTE 205	Elective IV	3	-	-	50	3	100	3
MTE 206	Elective V	3	-	-	50	3	100	3
MTE 207 (P)	Advanced Heat Transfer Lab	-	-	2	50	3	100	2
MTE 208 (P)	Term Paper	-	-	2	50	3	100	2
TOTAL		**18**	**-**	**4**	**400**		**800**	**22**

ELECTIVE III
MTE 204 (A) Research methodology
MTE 204 (B) Design of heat transfer equipment
MTE 204 (C) Convection & two phase flow
MTE 204 (D) Multi phase flow
MTE 204 (E) Optimisation techniques

ELECTIVE IV
MTE 205 (A) Reliability engineering
MTE 205 (B) Finite Element analysis for heat transfer
MTE 205 (C) Industrial refrigeration system
MTE 205 (D) Transport phenomena
MTE 205 (E) Air conditioning & Ventilation

ELECTIVE V
MTE 206 (A) Renewable energy system
MTE 206 (B) Co generation & waste heat recovery system
MTE 206 (C) Advanced power plant engineering
MTE 206 (D) Boundary layer theory & turbulence
MTE 206 (E) Cryogenic engineering

THIRD SEMESTER

Code	Subject	Hours/Week			Marks					Credit
		L	T	P	Internal		University		Total	
					Guide	Evaluation Committee	Thesis	Viva		
MTE 301(P)	Thesis Preliminary			22	200	200	---	---	400	8
TOTAL				**22**	**200**	**200**			**400**	**8**

THESIS PRELIMINARY

This shall comprise of two seminars and submission of an interim thesis report. This report shall be evaluated by the evaluation committee. The fourth semester Thesis- Final shall be an extension of this work in the same area. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is presentation of the interim thesis report of the work completed and scope of the work which is to be accomplished in the fourth semester.

FOURTH SEMESTER

Code	Subject	Hours/Week			Marks					Credit
					Internal		University			
		L	T	P	Guide	Evaluation Committee	Thesis	Viva	Total	
MTE 401(P)	Thesis			22	200	200	100	100	600	12
TOTAL				**22**	**200**	**200**	**100**	**100**	**600**	**12**

Towards the middle of the semester there shall be a pre submission seminar to assess the quality and quantum of the work by the evaluation committee. This shall consist of a brief presentation of Third semester interim thesis report and the work done during the fourth semester. The comments of the examiners should be incorporated in the work and 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.

MTE 101/MTF 101 ADVANCED ENGINEERING MATHEMATICS

3 hours lecture per week

Fourier Transform methods – one-dimensional heat conduction problems in infinite and semi-infinite rod – Laplace Equation – Poisson Equation. Concept of variation and its properties – Euler's equation – Functionals dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Direct methods – Ritz and Kantorovich methods.

The Schwarz- Christoffel Transformation – Transformation of Boundaries In Parametric Form – Physical Applications: Fluid Flow And Heat Flow Problems.

First order PDEs, Linear equations, Lagrange method, Cauchy method, Charpits method, Jacobi method. Second order PDEs, Classifications, Formulation and method of solutions of Wave equation, Heat equation and Laplace equation.

One dimensional parabolic equation – Explicit and Crank-Nicolson Schemes – Thomas Algorithm – Weighted average approximation – Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method.

Solutions of Laplace and Poisson equations in a rectangular region – Finite difference in polar coordinates – Formulae for derivatives near a curved boundary while using a square mesh.

References:

1. Mitchell A.R. and Griffith D.F., The Finite difference method in partial differential equations, John Wiley and sons, New York (1980)
2. Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi (1997).
3. Introdrocution to PDE – K. Sankara Rao – Prentice hall of India.
4. Advanced Engg. Mathematics – Erwin Kreyzig
5. Partial Differential Equations-Sneddon
6. Introductory methods of numerical analysis – S.S. Sastry – Prentice hall of India.
7. Tychonov, A. N. and Samarskii, A. A., Partial Differntial Equations of Mathematical Physics, Holden-Day, 1964.
8. Pipes, L. A. and Harwill, L. R., Applied Mathematics for Engineers and Physicists, Third Edition, McGraw-Hill, 1970.
9. Ross, S. L., Differential Equations, Third Edition, John Wiley & Sons, 2004.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 102/MTF 103 ADVANCED HEAT TRANSFER

3 hours lecture per week

Conduction: Steady state conduction with uniform internal heat generation-temperature distribution and heat flux for regular solids with uniform heat generation-temperature dependent and location dependent heat generation-steady state conduction in two dimensional systems. Analytical, graphical analog and numerical methods. Unsteady state conduction: unsteady state heating or cooling-Newtonian heating or cooling- Heating or cooling of finite and semi-infinite slabs with negligible surface resistance for different boundary conditions-solutions of heating or cooling of regular solids with comparable internal and external resistance by simple analytical methods and use of charts-periodic variation of surface temperature of infinitely thick walls neglecting and considering surface resistances.

Convection: Forced convection: Equations of motion of a viscous fluid. General equation of energy transport -2D boundary layer equation for momentum and energy transport.

Laminar flow heat transfer: Exact solutions 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 and a horizontal cylinder – approximate solutions-free convection with a turbulent boundary layer-free convection in enclosed spaces.

Radiation: Radiative properties of real materials Radiative properties of metals and opaque non-metals-modifications of spectral characteristics.

Exchange of radiant energy between black isothermal surfaces. Radiative exchange between two surfaces- methods for evaluating configuration factors –radiation in a black enclosure

Radiation exchange in an enclosure composed of diffuse-gray surfaces Radiation between finite areas-radiation between infinitesimal areas, Solar and gas radiation.

References:

1. Conduction heat transfer: Schneider
2. Fundamentals of Heat and Mass Transfer- Incropera F P and Dewitt D P
3. Heat Transfer – Yunus A Cengal
4. Holman .J.P., Heat and mass transfer, Tata Mcgraw Hill.
5. Siegel and Howell, Thermal radiation Heat transfer, McGraw Hill,
6. Kays and Crawfard., Convective heat and mass transfer, Mc-Graw Hill
7. Eckert and Drake; Analysis of Heat and Mass Transfer
8. Bejan.A, Convective Heat Transfer.

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MTE 103/MTF 104 POSTULATIONAL THERMODYNAMICS

3 hours lecture per week

Review of the fundamentals of classical thermodynamics- First law applied to unsteady flow systems. Thermodynamic functions and property relations. Irreversible thermodynamics – coupled and uncoupled effects-examples.

Second law analysis of steady and unsteady flow systems. Entropy. Availabilty. Loss of Available energy. Exergy analysis. Vapour and Combined Power cycles. Properties of Gas mixtures. Second law of thermodynamics and concept of chemical equilibrium, Gibbs free energy and the equilibrium constant of a chemical reaction (Vant Hofts equation). Calculation of equilibrium composition of a chemical reaction.

Thermodynamics of Combustion. Equations of combustion – stoichiometry. Analysis by mass, volume and their conversion. Mole method for combustion problems. First and second law analysis of reacting systems. Introduction to thermochemistry – Heat of reaction and it's effect on temperature and pressure. Enthalpy of formation and types of heat changes.

Microscopic approach to thermodynamics. Kinetic theory of gases- equipartition of energy - Molecular flux - Survival equation- Application to Transport Phenomena – Viscosity, Thermal conductivity and diffusion.

Fundamentals of Statistical Thermodynamics - Micro and Macro States - Thermodynamic Probability. Partition Function and evaluation of thermodynamic properties –- Statistical interpretation of heat, work and entropy.

References:

1. Statistical Thermodynamics – Kellen
2. Thermodynamics – Michael A Saad
3. Thermodynamics, KineticTheory and Statistical
4. Thermodynamics –F.W. Sears & G. L. Salinger.
5. Kuo, K.K., Principles of combustion, Wiley Inter science , New york,1986.
6. Murthy,K.A., Introduction to combustion, Golden and Breach, New York, 1975.
7. Sharma, S.P and Chandra Mohan, Fuels and combustion, McGraw Hill, 1984.

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MTE 104 ADVANCED FLUID MECHANICS

3 hours lecture per week

Incompressible flow: Concept of continuum: Eulerian and Lagrangian methods of description-velocity and acceleration-equations governing fluid motion-derivation of governing equations: differential and control volume approaches-Reynolds transport theorem, viscosity-stress tensor, properties of stress tensor- rate of strain-equations relating stress and strain rates-Navier-Stokes equations- derivation for Cartesian and cylindrical coordinates only.

Exact solution of Navier-Stokes equation- parallel flow in a straight channel – flow between concentric rotating cylinders- Hagen-Poiseulli equation, Coutte flow- Flow of two immiscible fluids in a channel- developing flow in a parallel channel. Creeping flows- Stokes flow past a cylinder.

Potential flow theory - Irrotational flow-stream function-Vorticity-Simple flows such as: uniform flow, souce, sink and vortex flows - calculation of induced velocity at a point-Doublet- Complex flow potential-Development of complex flow potentials by method of super position- flow past a cylinder with circulation- calculation of forces.

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. White, F. M., Viscous Fluid Flow, Third Edition, McGraw-Hill, 2006
4. Foundations of Fluid Mechanics- Yuan S W
5. Schlitching, H., Boundary Layer Theory, Seventh Edition, McGraw-Hill, 1987.
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
9. Fluid Mechanics and its Applications- Gupta & Gupta

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MTE 105 (A)/MTF 105 (B) ENERGY CONSERVATION & HEAT RECOVERY SYSTEMS

3 hours lecture per week

Energy consumption and potential for energy conservation in industry-thermodynamics of energy conservation-energy flows-energy auditing-technologies for energy conservation-thermal insulation. waste heat recovery systems, thermal energy storage, heat exchanger, heat pumps, heat pipes, waste heat to mechanical energy conversion systems. design for conversion of energy, simulation and modelling. Applications and case studies.

Definition of energy management - Energy conservation schemes - Optimizing steam usage - Waste heat management - Insulation - Optimum selection of pipe size – Energy conservation in space conditioning – Energy and cost indices - Energy diagrams – Energy auditing - Thermodynamic availability analysis – Thermodynamic efficiencies - Available energy and fuel.

Thermodynamic analysis of common unit operations - Heat exchange - Expansion - Pressure let down - Mixing- Distillation - Combustion air pre-heating – Systematic design methods - Process synthesis - Application to cogeneration system – Thermo-economics - Systematic optimization - Improving process operations – Chemical reactions - Separation - Heat transfer - Process machinery - System interaction and economics

Potential for waste heat recovery - Direct utilization of waste heat boilers – Use of heat pumps – Improving boiler efficiency - Industrial boiler inventory – Use of fluidized beds - Potential for energy conservation – Power economics - General economic problems - Load curves - Selections of plants - Specific economic energy problems - Energy rates.

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 standards
6. A.P.E. Thummann: Fundamentals of Energy Engineering, Prentice Hall, 1984
7. M.H. Chiogioji: Industrial Energy Conservation, Marcel Dekker, 1979
8. W. R. Murphy and G. McKay: Energy Management, Butterworth-Heinemann, 2001

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MTE 105 (B) COMPUTATIONAL FLUID FLOW & HEAT TRANSFER

3 hours lecture per week

Introduction: Basic equations of fluid dynamics and heat transfer-nature of terms-physical and mathematical classification- boundary and initial conditions-Taylor series representation-finite difference approximation for space and time-forward, central and backward differences-analysis of 1D heat and wave equations for stability- Courant-Friedrich-Lewy criterion-Laplace and Poisson's equations in curvilinear coordinates-Grid generation: Elliptical and hyperbolic grids.

Numerical Heat Conduction: One dimensional steady state problem-governing equation-boundary condition(prescribed, convective and radiative). Method of solution: Gauss elimination, Gauss Seidel-Tridiagonal Matrix algorithm. Jacobi-over and under relaxation. Two dimensional steady state problem- Method of solution-line by line method-Three dimensional problem-plane by plane method-transient 1D problem- Discretisation: explicit, Crank-Nicholson and implicit methods- Two and Three dimensional transient conduction problems- grid independence test- axisymmetric problem-conduction through composite media-variable thermal conductivity-irregular geometries.

Convective Heat Transfer: Finite volume method for diffusion and convection diffusion problems- steady one dimensional convection and diffusion equation-upwind, hybrid and power-law schemes-Discretisation equation for 1,2 and 3 dimensions- false diffusion-calculation of flow field-algorithms for pressure velocity coupling- semi implicit method for pressure linked equation-its variants such as SIMPER, SIMPLEC and SIMPLEST. Higher order schemes-quick solution of 2D flow problems in rectangular and cylindrical coordinate systems-treatment for natural convection-Natural convective flow in rectangular and cylindrical enclosures- evaluation of Nusselt's number.

References:

1. Numerical Heat Transfer and Fluid Flow- S V Patankar
2. Computational Fluid Mechanics and Heat Transfer- D A Anderson, Tannehill J C & Pletcher.
3. Computational Fluid Dynamics in Practice-Rhodes
4. Muraleedhar, K. and Sundararajan, T. (eds.), Computational Fluid Flow and Heat Transfer, Second Edition, Narosa Publishing House, 2003.
5. Versteeg, H. K. and W. Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Addison Wesley – Longman, 1995

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MTE 105 (C)/MTF 105 (E) COMBUSTION SCIENCE

3 hours lecture per week

Thermodynamics of reactive 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. 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-flame velocity-measurement of flame velocity- 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-stabilisation by eddies-bluff body stabilization-effects of variables on stability limits. 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. 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

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MTE 105 (D) MODERN ENERGY CONVERSION SYSTEM

3 hours lecture per week

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.

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.

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, gasifiers – 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. Maheshwar Dayal: Energy-Today & Tomorrow

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MTE 105 (E) NUCLEAR ENGINEERING

3 hours lecture per week

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 model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half life - Neutron interactions - Cross sections

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. 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. Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment. Reactors - Types of reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors –

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. Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - Nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

References:

1. Nuclear Reactor Engineering- Gladstone & Sesonske
2. Source book on Atomic Energy- S.Glasston
3. Thomas J. Cannoly, “Fundamentals of Nuclear Engineering ", John Wiley (1978).
4. Collier J.G., and G.F.Hewitt, “Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
5. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
6. Lipschutz R.D. " Radioactive Waste - Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.

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MTE 106 (A)/MTF 106 (A) REFRIGERATION ENGINEERING

3 hours lecture per week

Review of thermodynamics of Refrigerants, Properties (packages like REFPROP), 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, Low temperature refrigeration, cascade systems.

Vapour absorption refrigeration systems, principles of operation, description of components and their constructional features-refrigerant, absorber combinations. criteria for selection-performance analysis

Energy sources in vapour absorption systems- thermal, solar and electric. Steam jet refrigeration systems, Thermo-electric refrigeration systems- Vortex and pulse tube refrigeration systems, air cycle refrigeration systems.

Environmental impact of Refrigerants - Global warming, Ozone depletion, Alternate refrigerants, future refrigerants

References:

1. Gosuey W.B.: Principles of Refrigeration
2. Stoecker: Principles of Refrigeration
3. Dossat: Principles of Refrigeration
4. Transactions of ASHRAE
5. Throlkeld J L: Thermal Environmental Engineering

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MTE 106 (B) SOLAR THERMAL ENGINEERING

3 hours lecture per week

Sun and it’s Energy: Solar spectrum, solar constant & solar radiations, Sun earth angles, solar hourly radiations-Radiations on Horizontal and inclined surfaces., solar radiation- solar radiation data, solar radiation geometry, empirical equations for predicting solar radiation, solar radiation on tilted surfaces, Measurement of Solar Radiation: Pyrheliometer, Pyranometer, Sunshine- Recorder.

Collection of Solar Energy : Flat plate collectors, classification, construction, heat transfer coefficients, optimisation of heat losses - Analysis of flat plate collectors, testing of collectors-Solar Air Heater : Description & classification, conventional air heater, air heater above the collector surface air heaters with flow on both sides of absorbers to pan air heater, air heater with finned absorbers, porous absorber

Thermal energy storage- sensible heat storage, latent heat storage , thermochemical storage. Solar Water heater: Collection cum storage water heater, Natural circulation & forced circulation water heater, shallow solar ponds. Solar Concentrators: Classification, characteristic parameters, types of concentrators materials in concentrators.

Passive Solar House: Thermal gain, Thermal cooling, Ventilation. Energy Storage: Sensible heat storage, Liquid, Solid, packed bed, Latent heat storage. Solar Distillation, Solar Cookers, Solar Refrigeration.

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
5. Tiwari, G.N. and Sayesta Suneja., Solar Thermal engineering Systems, Narosa Publishing House.
6. Duffie and Backuran, Solar Thermal Engineering.
7. H.P. Gupta.,Solar Engineering

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MTE 106 (C) STEAM TURBINE

3 hours lecture per week

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. Compounding of steam turbines

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, -losses in reaction blade passages. Flow passages with radial equilibrium-steam turbine control and performance.

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.

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

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MTE 106 (D) GAS TURBINE

3 hours lecture per week

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 inter-cooling 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.

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. Irreversibility's-losses in turbine stage-various efficiency for turbines- off design Performance. Three dimensional flows in axial turbo machines. Design of turbines.

High temperature turbine stages-effect of high gas temperature-methods of cooling-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.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 106 (E) /MTF 106 (D) HYDRAULIC, PNEUMATIC AND FLUID CONTROLS

3 hours lecture per week

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.

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. Design of hydraulic/pneumatic equipment/circuit to fulfil 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

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 107 (P) ENGINEERING SOFTWARE LAB

2 hours practical per week

Solving basic mathematical problems such as curve fitting, numerical differentiation and integration and numerical solution of differential equation using

C/C++/FORTRAN/JAVA/MATLAB

Modelling and analysis of Fluid dynamics and Heat transfer problems using software such as FLUENT / CFX / PHOENIX / ANSYS

Solving governing equation of fluid flow and heat transfer using numerical methods (By using C/C++/FORTRAN/JAVA/MATLAB.

Sessional work assessment

Regularity – 5 marks

Class work, Lab Record, Mini project Report (if any), viva – 30 marks

Test – 15 marks

Total: Internal continuous assessment: 50 marks

University evaluation

Examination will be for 100 marks of which 70 marks are allotted for writing the procedure / formulae / sample calculation details, preparing the circuit diagram / algorithm / flow chart, conduct of experiment, tabulation, plotting of required graphs, results, inference etc., as per the requirement of the lab experiments, 20 marks for the viva-voce and 10 marks for the lab record.

Note: Duly certified lab record must be submitted at the time of examination

MTE 108 (P) SEMINAR

2 hours practical per week

The student is expected to present a seminar in one of the current topics in the field of specialization and related areas. The student shall prepare a Paper and present a Seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit typed copy of the paper to the Department. Grades will be awarded on the basis of contents of the paper and the presentation. A common format in (.pdf format) shall be given for reports of Seminar and Project. All reports of Seminar and Project submitted by students shall be in this given format.

Sessional work assessment

Presentation : 25

Report : 25

Total marks : 50

MTE 201 INTERNAL COMBUSTION ENGINE, COMBUSTION & POLLUTION

3 hours lecture per week

Thermochemistry of Fuel-Air Mixtures – Characterisation of flames, Ideal Gas Model, Composition of Air & Fuels, Combustion Stoichiometry, first & second laws of thermodynamics applied to Combustion, Chemical Equilibrium, Chemical Reaction rates. Properties of working fluids – Unburned Mixture Composition, Burned and Unburned Mixture Charts, Relation between Unburned & Burned Mixture Charts, Transport Properties, Exhaust Gas Composition

Thermodynamic Relations for Engine Processes - Cycle Analysis with Ideal Gas Working Fluid, Fuel – Air Cycle Analysis, Over Expanded Engine Cycles, Availability Analysis of Engine Processes, Comparison with Real Engine Cycles. Combustion in S.I.Engines – Essential Features, Thermodynamic Analysis, Flame Structure & Speed, Cyclic Variations in Combustion, Partial Burning & Misfire, Spark Ignition, Abnormal Combustion – Knock & Surface Ignition, S.I. Engine Combustion Chamber Design. Combustion in C.I. Engines – Essential Features, Types of Diesel Combustion Systems

Phenomenological Model, Analysis of Cylinder Pressure Data, Fuel Spray Behaviour, Ignition delay, Mixing Controlled Combustion, Variables that affect C.I. Engine Performance. I.C.Engine Fuels –conventional and alternative fuels, characteristics, fuel rating. Supercharging & Turbocharging – Performance of 2 stroke & 4 stroke S.I. & C.I. Engines

Pollutant formation in S.I. and C.I. Engines and its Control – Pollutants – NO_x, CO, Unburned HC, Particulate Emissions, Exhaust Gas Treatment – Thermal & catalytic Converters, Particulate Traps, Emission Standards & Instrumentation to measure Pollution

Note : Use of approved tables and charts permitted in the examination

References:

1. Heywood J.B. , Internal Combustion Engine Fundamentals, McGraw Hill Book Co., 1989
2. Ferguson C.R. and Kirkpatrick A.T., Internal Combustion Engines, John Wiley & Sons Inc, 2001
3. Taylor C.F., The Internal Combustion Engine Theory & Practice, Vol I & II, The MIT Press, Cambridge, 1985
4. Obert E.F., Internal Combustion Engines & Air Pollution, Harper & Row Publication Inc., 1973
5. Chambell A.S., Thermodynamic Analysis of Combustion Engines, John Wiley & Sons Inc., 1986

Current Literature

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 202/MTF 202 PRINCIPLES OF TURBO MACHINES

3 hours lecture per week

Definition and Classification of Turbo machines, 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.

Axial flow turbines: Two dimensional theories. 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. 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 Turbomachinery, 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 Turbomachinery
6. G F Wislicunes: Fluid Mechanics of Turbomachinery
7. G T Csandy: Theory of Turbomachines

Question Pattern:

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MTE 203/MTF 203 MEASUREMENTS IN THERMAL ENGINEERING

3 hours lecture per week

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. Error estimates in Temperature measurements - Solids and fluids - Steady state and unsteady measurements -Radiation effects - Platinum resistance thermometers - Construction and usage – Calibration.

Fluid pressure measurement - Capacitive probes - Piezoelectric pressure sensors – Anemometry .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.

Thermal Analysis Techniques - Measurements in combustion: Species concentration, Reaction rates, Flame visualization, Charged species diagnostics, Particulate size measurements. Temperature Measurements in high temperature gases - Calorimetric, electrostatic, radiation, cyclic, transient pressure and heat flux probes. 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. Ernest O Doeblin : Measurement Systems - Application & Design
3. Donald P Eckman : Industrial Instrumentation
4. Willard, Mertt, Dean,Settle : Instrumental Methods of analysis
5. D. Patranabis : Principles of Industrial Instrumentation
6. Beckwith & Buck : Mechanical Measurements
7. Nakra & Chaudary : Industrial Instrumentation
8. Physical Measurements in Gas Dynamics and Combustion : High Speed Aerodynamics and Jet Propulsion Vol. IX

Question Pattern:

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MTE 204 (A)/ MCS 204 (A) RESEARCH METHODOLOGY

3 hours lecture per week

Introduction – Meaning of research – Objectives of research – Motivation in research – Types of research – Research approaches – Significance of research – Research methods vs Methodology – Criteria of good research.

Defining Research Problem – What is a research problem – Selecting the problem – Necessity of defining the problem – Literature review – Importance of literature review in defining a problem – Critical literature review – Identifying gap areas from literature review

Research design – Meaning of research design – Need– Features of good design – Important concepts relating to research design – Different types – Developing a research plan

Method of data collection – Collection of data- observation method – Interview method – Questionnaire method – Processing and analysis of data – Processing options – Types of analysis – Interpretation of results

Report writing – Types of report – Research Report, Research proposal ,Technical paper – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Simple exercises – Oral presentation – Planning – Preparation – Practice – Making presentation – Answering questions - Use of visual aids – Quality & Proper usage – Importance of effective communication – Illustration.

References:

1. Coley S M and Scheinberg C A, 1990, "Proposal Writing", Newbury Sage Publications.
2. Leedy P D, "Practical Research : Planning and Design", 4th Edition, N W MacMillan Publishing Co.
3. Day R A, *"How to Write and Publish a Scientific Paper"*, Cambridge University Press, 1989.
4. Kothari, C.R, “Research Methodologies- Methods & Techniques, 2nd Edn. New age international.
5. John.W, Best & James V Kalin, “Research in Education,”5th Edn.PHI New Delhi.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 204 (B) DESIGN OF HEAT TRANSFER EQUIPMENTS

3 hours lecture per week

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.

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. Thermal design of regenerators – classifications – governing equations – design parameters. Design of compact heat exchangers – plate and fin, fin-tube and plate and frame heat exchangers – fouling and corrosion in heat exchanger.

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. Heat Pipes-P Dunn and D A Reay
4. Heat Exchanger Design- A P Fraas and M N Ozisik
5. Hewitt , Process heat transfer
6. Das, S.K., Prosess heat transfer, Narosa publishing house.2005

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MTE 204 (C) CONVECTION & TWO PHASE FLOW

3 hours lecture per week

Convection heat transfer Equations: Conservation principles, differential equations of the boundary layer, Momentum, Mass diffusion and energy equations, simplified equations for velocity boundary layer and thermal boundary layer, integral equation of boundary layer, equations for turbulent boundary layer . Turbulent flow over a flat plate and a circular pipe-universal velocity distribution.

Convective heat transfer-Forced convection in laminar flow-flow inside smooth tubes-energy differential equations. Fully developed velocity and temperature profiles. Thermal entry length solutions for circular tubes-effect of axial variations of the surface temperature and heat flux-combined hydrodynamic and thermal entry length, the flat plate in Laminar flow-similarity solution-flow over bodies with boundary layer separation.

Forced convection in Turbulent flow. Analogy between momentum and heat transfer. Reynold's analogy, Karman-Boelte Martinelli analogy- circular tubes with fully developed flow, constant heat rate, modarare Prandtl Numbers. The eddy diffusivity near the centre line of a pipe-Fully developed profiles with constant surface temperature-fully turbulent flow between parallel planes-Thermal entry length in circular tubes-Effect of axial variation of surface temperature and heat flux. Influence of surface roughness- The plane plate in longitudinal flow. Free Convection : Boundary layer equations-vertical semi infinite plate, constant and variable temperature, effect of wall suction and blowing and variable properties. Approximate Integral solutions for free convection, free convection flow regimes, free convection between heated plates, solution for other geometry, combined free and forced convection.

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.

Note : Use of approved charts and tables will be permitted in the examinations.

References:

1. H.Schlitching : Boundary Layer Theory
2. W M Kays & M E Crawford : Convective Heat and Mass Transfer
3. Eckert and Drake; Analysis of Heat and Mass Transfer
4. Bejan. A, Convective Heat Transfer.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 200 (D) MULTI PHASE FLOW

3 hours lecture per week

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. 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.

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

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 204 (E)/MTF 205 (C) OPTIMISATION TECHNIQUES

3 hours lecture per week

Mathematical preliminaries: Mathematical programming problems-varieties and characteristics-Examples of problem formulation- difficulties caused by non- linearity-Convex sets-convex functions- concave functions- convex feasible region optimal solution-Quasi- convexity – unimodal function- Differentional functions-gradient and Hessian-properties of convex functions.

Unrestricted and classical optimization: search methods- Fibonacci search- Golden section search- Quadratic interpolation method- pattern search method-steepest descent method-Quasi Newton method- Hooke and Jeeves method-Lagrangier Multiplier method-Sufficiency condition- calculus of variations- Euler's equation-Necessary codition-transversality condition-problems with constraints

Constrained non-linear optimization: problems involving inequality constrainta-Kuhn-Tucker conditions-Quadratic programming – Wolfe's method- method of feasible directions-Frank and Wolf method- Convex simplex method- separable programming-Kelly's cutting plane method-Penalty and Barier methods

Integer and dynamic programming: dynamic programming- principles of optimality-tabular and calculus methods of solutions –Introduction to integer programming-Gomory's cutting plane method- Branch and Bound method

References:

1. Kambo,N.S, Mathematical programming techniques, Affiliated East West, 1984.
2. Intriligantor,M.D., Mathematical Optimization and Economic theory, Prentice Hall,1971.
3. Rao,S.S., Optimization theory and applications ,Wiley Eastern 1978.
4. Summons,D.L., Non-linear programming for operations research, prentice hall 1975.

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MTE 205 (A) RELIABILITY ENGINEERING

3 hours lecture per week

Probability distributions – Normal, Lognormal, Poisson, Exponential and Weibull distributions, Point Estimation, Interval Estimation, Goodness – of – fit Tests, Statistics of Extremes.

Types of failures, Reliability, Reliability function, expected life, failure rate, hazard function. Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate

Types of system- series, parallel, series parallel, stand by and complex; Analysis of various configurations of assemblies and sub-assemblies. methods of reliability evaluation - Development of logic diagram, Set theory, optimal Cut Set and Tie Set methods, Markov analysis. System reliability. System reliability determination through 'Event Tree' analysis and Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA).

Reliability Management - Reliability testing - Reliability and life cycle costs - Reliability allocation, Availability and Maintainability

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

References:

1. Balagrusamy, E., Reliability Engineering, Tata-McGraw Hill Publishing Company Limited, New Delhi, 1984.
2. Lewis, E.E., Introduction to Reliability Engineering, John Wiley & Sons, New York, 1987.
3. O'Connor Patric D.T., Practical Reliability Engineering, 3/e revised, John Wiley & Sons, 1995.
4. Stamatis D.H., Failure Mode and Effect Analysis, Productivity Press India (P) Madras, 1997.
5. Modarres, Reliability and Risk analysis, Mara Dekker Inc., 1993.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 205 (B) FINITE ELEMENT ANALYSIS FOR HEAT TRANSFER

3 hours lecture per week

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.

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. 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. O C Zeinkewicz: The Finite Element Method 1997.

Question Pattern:

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MTE 205 (C) INDUSTRIAL REFRIGERATION SYSTEM

3 hours lecture per week

Introduction to industrial refrigeration - difference from conventional system - applications - industrial and comfort air - conditioning - conditions for high COP.

Reciprocating and screw compressor: Multistage industrial applications, cylinder arrangement, cooling methods - oil injection and refrigeration injection, capacity regulations - Economizers.

Types of Evaporators, Liquid circulation: Mechanical pumping and gas pumping - advantage and disadvantage of liquid re-circulation - circulation ratio - top feed and bottom feed refrigerant - Net Positive Suction Head (NPSH) - two pumping vessel system - suction risers – design - piping loses. Different Industrial Condensers arrangement, Evaporators-Types and arrangement, liquid circulation, type of feed, refrigerant piping design , functional aspects. Lubricating oil: types - physical properties, types of circulation and oil separator.

Vessels in industrial refrigeration: High pressure receiver - flash tank - liquid and vapour separator - separation enhancers - low pressure receivers - surge drum - surge line accumulator - thermosyphon receiver - oil pots.

Energy conservation and design considerations - source of losses - energy efficient components - heat reclaim - thermal storage: ice builder and ice harvester. Insulation: critical thickness - insulation cost and energy cost - vapour barriers - construction methods of refrigerated spaces.

References:

1. Wilbert F.Stoecker, Industrial Refrigeration Hand Book, McGraw-Hill, 1998.
2. ASHRAE Hand Book: Fundamentals, 1997.
3. ASHRAE Hand Book: Refrigeration, 1998.
4. ASHRAE Hand Book: HVAC Systems and Equipment, 1996.
5. Transport properties of SUVA Refrigerants, Du-Pont Chemicals, 1993

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MTE 205 (D) TRANSPORT PHENOMENA

3 hours lecture per week

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.

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.

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.

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

References:

1. Transport Phenomena Bird R B, Stewart W E and Lightfoot F N

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MTE 205 (E) AIR CONDITIONING & VENTILATION

3 hours lecture per week

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.

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.

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

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MTE 206 (A) RENEWABLE ENERGY SYSTEMS

3 hours lecture per week

World energy use – Reserves of energy resources – Environmental aspects of energy utilisation – Renewable energy scenario in India – Potentials – Achievements – Applications.

Solar thermal – Flat plate and concentrating collectors – Solar heating and cooling techniques – Solar desalination – Solar Pond – Solar cooker – Solar thermal power plant – Solar photo voltaic conversion – Solar cells – PV applications.

Wind data and energy estimation – Types of wind energy systems – Performance – Details of wind turbine generator – Safety and Environmental Aspects.

Biomass direct combustion – Biomass gasifier – Biogas plant – Ethanol production – Bio diesel – Cogeneration – Biomass applications.

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy – Fuel cell systems.

References:

1. G.D Rai : Non conventional Energy Sources. Khanna Publishers, New Delhi
2. S.P Sukhatme : Solar Energy. Tata McGraw Hill Publishing company Ltd, New Delhi
3. Godfrey Boyle : Renewable energy, Power for a sustainable future. Oxford University press U.K
4. Twidell J W & Weir A : Renewable energy sources. EFN spon Ltd U.K
5. G N Tiwary : Solar Energy-Fundamental Design, modelling and application. Narosa Publishing house, New Delhi
6. L L Freris : Wind energy conversion system. Prentice Hall U K

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 206 (B) CO GENERATION & WASTE HEAT RECOVERY SYSTEM

3 hours lecture per week

Introduction – principles of thermodynamics – cycles – topping – bottoming – combined cycle – organic ranking cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc., Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment.

Selection criteria for waste heat recovery technologies – recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems.

Investment cost - economic concept - measure of economic performance – procedure for economic analysis – examples – procedure for optimised system selection and design – load curves – sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

References:

1. Charles H Butler : Cogeneration. McGraw Hill Book Co.
2. EDUCOGEN : The European Educational tool for Cogeneration.
3. Horlock J H : Cogeneration-Heat and Power, Thermodynamics and Economics. Oxford
4. Institute of Fuel ,London. Waste heat recovery, Chapman and Hal Publishers.
5. Sengupta Subrata, Lee SS EDS, Waste heat utilisation and management. Hemisphere Washington

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 206 (C) ADVANCED POWERPLANT ENGINEERING

3 hours lecture per week

Overview of the Indian power sector – load curves for various applications – types of power plants – merits and demerits – criteria for comparison and selection.

Rankine Cycle – Performance – thermodynamic analysis of cycles. Cycle improvements. Superheaters, reheaters – condenser and feed water heaters – operation and performance – layouts. Gas turbine cycles – optimization – thermodynamic analysis of cycles – cycle improvements – multi spool arrangement. Intercoolers, reheaters, regenerators – operation and performance – layouts.

Binary and combined cycle – coupled cycles – comparative analysis of combined heat and power cycles – IGCC – AFBC/PFBC cycles – Thermionic steam power plant.

Overview of Nuclear power plants – radioactivity – fission process – reaction rates – diffusion theory, elastic scattering and slowing down – criticality calculations – critical heat flux – power reactors – nuclear safety. MHD and MHD – steam power plants.

Air and water pollution – acid rains – thermal pollution – radioactive pollution – standardization – methods of control. Environmental legislations / Government policies. Economics of power plants.

References:

1. M.M.EI Wakil : Power Plant Technoligy, Tata McGraw-Hill
2. Nag: Power Plant Engineering, Tata McGraw-Hill
3. Vapat & Scrotski : Power station Engineering and Economy, Tata McGraw-Hill
4. Nagpal : Power Plant Engineering, Khanna Publications
5. R K Rajput : Power Plant Engineering, Laxmi Publications
6. P L Ballaney : Thermal Engineering, Khanna Publications

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 206 (D) BOUNDARY LAYER THEORY & TURBULENCE

3 hours lecture per week

Boundary – Layer Concept, Laminar Boundary Layer on a Flat Plate at zero incidence, Turbulent Boundary Layer on a Flat plate at zero incidence, Fully Developed Turbulent Flow in a pipe, Boundary Layer on an airfoil, Boundary Layer separation.

Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Law of the wall – Friction law – Fully developed Internal flows – Chennel Flow, Couettee – Poiseuille flows, Pipe Flow.

Nature of turbulence – Averaging Procedures – Characteristics of Turbulent Flows – Types of Turbulent Flows – Scales of Turbulence, Prandtl's Mixing length, Two-Equation Models, Low – Reynolds – Number Models, Large – Eddy Simulation.

Ensemble Average – Isotropic Turbulence and Homogeneous Turbulence – Kinematics of Isotropic Turbulence – Taylor's Hypothesis – Dynamics of Isotropic Turbulence – Grid Turbulence and decay – Turbulence in Stirred Tanks.

WALL Turbulent shear flows – Structure of wall flow – Turbulence characteristics of Boundary layer – Free Turbulence shear flows – Jets and wakes – Plane and axi - symmetric flows.

References:

1. G. Biswas and E. Eswaran, Turbulent Flows, Fundamentals, Experiments and Modelling, Narosa Publishing House, 2002.
2. H. Schlichting and Klaus Gersten, Boundary Layer Theory, Springer 2000.
3. R.J. Garde, Turbulent Flow, New Age International (p) Limited, Publishers, 2000.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 206 (E) CRYOGENIC ENGINEERING

3 hours lecture per week

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.

Gas liquefaction systems: Introduction-Production of low temperatures-General liquefaction systems- Joule Thomson effect, adiabatic expansion; liquefaction system for air, Neon, hydrogen and helium, effect of component efficiencies on system performance.-Critical components of liquefaction systems. Gas separation and purification – principles, plant calculation, air, hydrogen, and helium separation systems.

Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigerators using liquids and gases as refrigerants-refrigerators using solids as working media. Cryogenic temperature measurement; cryogenic fluid storage and transfer systems, storage vessels and insulation, two-phase flow in cryogenics transfer systems, cool down process.

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. Introduction to vacuum technology, down time, application of cryogenic systems, rocket and space simulation, cryopumping.

References:

1. Cryogenic Systems – Randall Barron
2. Cryogenic Engineering- R.B.Scott
3. Cryogenic Engineering – J.H.Bell Jr.
4. Timmerhaus, K. D. and Flynn, T. M., Cryogenic Process Engineering, Plenum Press, 1989.
5. Vance, R. W. and Duke, W. M., Applied Cryogenic Engineering, John Wiley, 1962.
6. Sitting, M., Cryogenics, D’ Van-Nostrand, 1963

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

MTE 207 (P) ADVANCED HEAT TRANSFER LAB

2 hours practical per week

Experimental Analysis of Heat Transfer Problems – Use of Data Acquisition System. Experiments shall include

i) Forced convection
ii) Natural convection
iii) Heat pipe heat transfer
iv) Drop wise / Film wise condensation
v) Extended surface heat transfer
vi) Shell and tube heat exchanger
vii) Wall solar chimney

Sessional work assessment

Regularity – 5 marks

Class work, Lab Record, Mini project Report (if any), viva – 30 marks

Test – 15 marks

Total: Internal continuous assessment: 50 marks

University evaluation

Examination will be for 100 marks of which 70 marks are allotted for writing the procedure / formulae / sample calculation details, preparing the circuit diagram / algorithm / flow chart, conduct of experiment, tabulation, plotting of required graphs, results, inference etc., as per the requirement of the lab experiments, 20 marks for the viva-voce and 10 marks for the lab record.

Note: Duly certified lab record must be submitted at the time of examination

MTE 208 (P) TERM PAPER

2 hours practical per week

The student is expected to present a report on the literature survey conducted as a prior requirement for the project to be taken up in the third and fourth semesters. Head of department can combine TP hours of many weeks and allot a maximum of 4 weeks exclusively for it. Students should execute the project work using the facilities of the institute. However, external projects can be taken up, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work. Project evaluation committee should study the feasibility of each project work before giving consent. An overview on the project work should be introduced before the closure of first semester. A paper should be prepared based on the project results and is to published in refereed Conferences/Journals.

Sessional work assessment

Presentation: 25

Report: 25

Total marks: 50

MTE 301 (P) THESIS PRELIMINARY

This shall comprise of two seminars and submission of an interim thesis report. This report shall be evaluated by the evaluation committee. The fourth semester Thesis-Final shall be an extension of this work in the same area. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is presentation of the interim thesis report of the work completed and scope of the work which is to be accomplished in the fourth semester.

Weightages for the 8 credits allotted for the Thesis-Preliminary

Evaluation of the Thesis-Preliminary work: by the guide - 50% (200 Marks)

Evaluation of the Thesis–Preliminary work: by the Evaluation Committee-50% (200 Marks)

MTE 401 (P) THESIS

Towards the end of the semester there shall be a pre submission seminar to assess the quality and quantum of the work by the evaluation committee. This shall consist of a brief presentation of Third semester interim thesis report and the work done during the fourth semester. 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 12 credits allotted for the Thesis-Final may be proportionally distributed between external and internal evaluation as follows.

Weightages for the 12 credits allotted for the Thesis

Internal Evaluation of the Thesis work: by the guide - (200 Marks)

Internal Evaluation of the Thesis work: by the Evaluation Committee - (200 Marks)

Final Evaluation of the Thesis work by the Internal and External Examiners:-

(Evaluation of Thesis + Viva Voce) - (100+100 Marks)