S Y L L A B U S

MASTER OF TECHNOLOGY

TWO YEAR INTERGRATED COURSE

M. Tech. Examination, 2014/2015
Mechanical Engineering- (Thermal Engineering)

JODHPUR NATIONAL UNIVERSITY
JODHPUR

Jodhpur National University, Jodhpur

M. Tech. Programme (Thermal Engineering)

Mechanical Engineering

TEACHING/EXAMINATION SCHEME & SYLLABUS

I SEMESTER

Subject Code	Subject	Hrs./ Week				Marks			Exam Hrs
		L	T	P	Total	Theory\ Practical Exam	Internal Assessment	Total	
MME 101	Strategic Management	4	2	-	6	100	50	150	3
MME 102	Advanced Thermodynamics	4	2	-	6	100	50	150	3
MME 103	Advanced Heat Transfer	4	2	-	6	100	50	150	3
MME 104	Advanced Fluid Mechanics	4	2	-	6	100	50	150	3
MME 105	Thermal Engg. Lab-I	-	-	6	6	50	50	100	3
	Total	**16**	**8**	**6**	**30**	**450**	**250**	**700**	**15**

II SEMESTER

Subject Code	Subject	Hrs./ Week				Marks			Exam Hrs
		L	T	P	Total	Theory\ Practical Exam	Internal Assessment	Total	
MME 201	Gas Turbines And Jet Propulsion	4	2	-	6	100	50	150	3
MME 202	Combustion Engineering	4	2	-	6	100	50	150	3
	ELECTIVE-I (Any One)	4	2	-	6	100	50	150	3
MME 203.1	Refrigeration Systems								
MME 203.2	Energy Conservation & Management								
MME 203.3	Solar Thermal Processes								
	ELECTIVE-II (Any One)								
MME 204.1	Design Of Heat Transfer Equipments	4	2	-	6	100	50	150	4
MME 204.2	Advance Air Conditioning								
MME 204.3	Alternative Fuels For I. C. Engines								
MME 205	Thermal Engg. Lab-II	-	-	6	6	50	50	100	3
	Total	**16**	**8**	**6**	**30**	**450**	**250**	**700**	**16**

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III SEMESTER

Subject Code	Subject	Hrs./ Week				Marks			Exam Hrs
		L	**T**	**P**	**Total**	**Theory\ Practical Exam**	**Internal Assessment**	**Total**	
	ELECTIVE-III & IV (Any Two)	4	2	-	6	100	50	150	3
		4	2		6	100	50	150	3
MME 301.1\302.1	Advanced I. C. Engine Technology								
MME 301.2\302.2	Non-Conventional Energy System								
MME 301.3\302.3	Advanced Turbo Machinery								
MME 301.4\302.4	Direct Energy Conversion								
MME 301.5\302.5	Cryogenic systems								
MME 301.6\302.6	Advanced Power Plants								
MME 301.7\302.7	Finite Element Method								
MME 301.8\302.8	Cold Preservation of Food								
MME 303	SEMINAR (Literature Survey& Presentation)	-	-	-	-	50	50	100	
	Total	**8**	**4**	**-**	**12**	**250**	**150**	**400**	**6**

IV SEMESTER

Subject Code	Subject	Hrs./ Week				Marks		
		L	**T**	**P**	**Total**	**Theory Practical Exam/ Viva voce**	**Internal Assessment**	**Total**
MME 401	Dissertation	-	-	-	-	200	-	200
	Total	**0**	**0**	**-**	**-**	**200**	**-**	**200**

Total Marks: 700+700+400+200 = 2000

MME 101 STRATEGIC MANAGEMENT [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

'Strategic Management' Could Be A Useful Subjects Of 1st Semester Of M-Tech Courses. 'Strategic Management' As Detailed Below Prepares A Young Budding Technocrat To Manage Assets In More Efficient Way And Lead His/Her Team More Effectively.

This Subject Would Cover The Following Issues:-

A) **Managing Change: -** Effective Change Management Is The Need Of The Hour. Situations Change Rather Fast These Days And Has To Prepare Or Mould His / Her Organization To Face Such Changes And Come Out Winningly.

B) **Crisis Management: -** Every Organization Or Every Individual Do Face Crisis Many Times. A Good Management Or A Good Leader Keeps Himself / Herself Always Prepare For Such Eventualities. Training In This Area Has Often Been Neglected.

C) **Innovation And Creativity: -** Human Brain Is Very Creative. Creative Thinking Is A Must For The Fast Changing World. Creative Things Results In Innovation And New Finds. Creativity Could Be Developed In A Positive Sense By Training.

D) **Entrepreneurship: -** Young Budding Technocrats Need Encouragement For Creating Small/Medium Size Organizations. Sessions On This Subject From Industry Leaders Will Help In It.

E) **Work Study And Re-Engineering:-** Re-Engineering Is Term Used These Days In Place Of Old Terms 'Work Study' Re-Engineering Is Needed Not Only For The Product But Also For The Processes As Well As For The 'Organization'.

F) **Managing Intangibles: -** An Organization Have (I) Tangibles Assets Like Machines, Material Etc. And Also (Ii) Intangibles Assets Like Staff, Line Managers Etc. Managing 'People' Or Rather 'Leading' People Needs To Be Taught To Young Engineers.

G) **Communication Skills: -** We Expect Our Managers To Lead Their Terms. For This Communication Skill Is A Must. This Could Be Covered In Class Room Sessions Along With Practice Sessions In Groups Under The Supervision Of A Teacher.

H) **Quality And Customers Care: -** ISO-9000 Has Become A Hallmark For Quality. This Can Cover Pre-Requisites For An Organization And How To Go About For Getting IS0-9000 Certification.

I) **Safety And Ergonomics: -** Safety Is Often Talked About But Not Cared For To That Extent Ergonomics Is Even Less Known. Technocrats Need To Know More About Safety And Ergonomics.

Books Recommended:

TEXT BOOKS:

1. Rehfeld, J.E. Alchemy of a Leader: Combining Western and Japanese Management skills to transform your company, John Whily & Sons, New York.1994
2. Buzzell, R. and Gale, B. The PIMS Principles: Linking Strategy to Performance, Free Press, New York, 1987.

MME 102 ADVANCED THERMODYNAMICS [L4+2T] **EXAM HRS: - 3**
M.M:- 100

Review of Basics: First law and Second law of thermodynamics, Unsteady flow processes- concept of entropy – principle of increase of entropy – entropy generation – Availability – concept of exergy, exergy balance and second law efficiency– exergy analysis of combustion processes.

Helmholtz function – Gibb's function.

Thermodynamic relations:- Maxwell's relations, T-ds equations – specific heat relations, energy equations – Joule Thomson effect – Clausius Claperyon Equation, Evaluation of Thermodynamic Properties.

Mixture and Solutions :- Pseudopure substance models for real gas mixture, Partial Molar Properties, Changes in Properties, Properties relations for variable compositions, Gibbs function and entropy, Fugacity relation and other properties, Gibb's phase rule, compressibility factor, computations from generalized chart, activity Types of equilibrium, Conditions for local equilibrium and stability ; Equilibrium between two phases and multiphase – multi components systems.

Chemical Reactions:- Combustion process, enthalpy of formation, First law analysis, adiabatic flame temperature, enthalpy, internal energy, heat of reactions; Third law of thermodynamics and absolute entropy; Second law analysis, actual combustion analysis, requirements for equilibrium, chemical equilibrium, equilibrium constant, simultaneous reactions.

Statistical Thermodynamics: Thermodynamics probability, Maxwell statistics, Fermi Dirac and Bose– Einstein statistics, Entropy and probability, Degeneracy of energy levels, Partition functions Thermodynamics Properties

Kinetic Theory of Gases – Molecular Model, Velocities Collisions, Pressure, Absolute Temperature, Clausius and Van der Walls Equations of state, Maxwell- Boltzmann Velocity Distribution, Average, Root Mean- Square and Most Probable Speeds, Speed Range, Energy Distribution Function, Equipartition of Energy, Specific heat of a Gas and mean free path, transport properties

Books Recommended:

TEXT BOOKS:

1. P.K. Nag, Engineering Thermodynamics - Tata McGraw-Hill Publications.
2. G. Van Wylen and R.E. Sonntag, Fundamentals of Classical Thermodynamics - Wiley, 1989..
3. Michel A Saad ,Thermodynamics for Engineers, Prentice- Hall of India Pvt. Ltd. 1972
4. J.P. Holman., 'Thermodynamics', 4th Ed., McGraw Hill, 1988.
5. Francis W, sears and Gerhard L. Salinger, Thermodynamics kinetic Theory and statistical thermodynamics Addison Wesley Publishing Co. 3ed Ed. 1975,
6. Francis W,. sears Addison, Thermodynamics Kinetic Theory and Statistical. Mechanics Wiley Publishing Co. 1953
7. Joseph H Keenan, John Thermodynamics Wiley & Sons.

REFERENCE BOOKS:

1. J. Hsieg, 'Principles of Thermodynamics', McGraw Hill, 1978.
2. V. Nastrand, S. Glasstne., Thermodynamics for Chemists', 1974.
3. M.D. Burghardt, 'Engineering Thermodynamics for Engineers', Harper and Row, NY, 1987.
4. K. Wark, 'Advanced Thermodynamics for Engineers', McGraw Hill, NY, 1987.
5. K. Smith, H.C. Van Ness, Introduction to Chemical Engineering Thermodynamics McGraw Hill, 1987.

MME 103 ADVANCED HEAT TRANSFER [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Conduction: General Heat Conduction Differential Equation in Rectilinear, Cylindrical and Spherical Co-Ordinates, Straight Fins of Rectangular, Triangular and Trapezoidal Sections, Effectiveness Of Fins.

Two-Dimensional Steady State Conduction: Semi Infinite and Finite Flat Plate, Temperature Field In Infinite And Finite Cylinders, Conduction Through Spherical Shell, Graphical Methods, Numerical Methods,
Unsteady State Conduction, Sudden Changes in Temperature of Infinite Plates, Cylinders, And Other Semi-Infinite Body, Solutions Using Grover's And Heisler's Charts.

Convection: Review Of Continuity And Momentum, Differential Equations For Incompressible Fluids, Differential Equation Of Energy Momentum And Thermal Boundary Layers, Convective Heat Transfer Coefficient, Local And Integrated Values, Nusselt Number And Friction Factor Co–Relation, Heat Transfer In Laminar Flow, Free Convection Between Parallel Plates, Forced Internal Flow Through Circular Tubes Fully Developed Flow, Velocity And Thermal Entry Lengths, Solutions With Constant Wall Temperature And With Constant Heat Flux, Forced External Flow Over Flat Plate, The Two Dimensional Velocity And Temperature Boundary Layer Equations, The Karman-Pohlhanton Approximate Integral Method.

Heat Transfer In Turbulent Flow: Eddy Heat Diffusivity, Reynolds Analogy Between Skin Friction and Heat Transfer, Prandti Taylor, Von Karman, Meritnelii Analogies, Turbulent Flow Through Circular Tubes.

Radiation: Radiation Through Non-Absorbing Media, Hottels Method Of Successive Reflection, Review Of Methods Of Analogous, Electrical Circuits, Radiation Through Absorbing Media, Logarithmic Decrement Of Radiation, Gas Radiation, Apparent Absorptivities Of Simple Shaped Gas Bodies, Net Heat Exchange Between Surfaces Separated By An Absorbing Gas, Radiation Of Luminous Gas Flames.

Books recommended:

TEXT BOOKS:

1. V.S Arpaci – Conduction Heat Transfer
2. E.M Sparrow, R.D Cess – Radiation Heat Transfer
3. J.P. Holman., 'Heat and Mass Transfer', Tata McGraw Hill, 8th Ed., 1989.
4. D.D. Kern, 'Extended Surface Heat Transfer', New Age International Ltd., 1985.

REFERENCE BOOKS:

1. Heat Transfer – A Basic Approach - Ozisik M.N., McGraw-Hill Publications, 1985.
2. Principles of Heat Transfer - Frank Kreith & M. S. Bohn, Thomson Publications, 2001.
3. R.Siegal and J.R Howell-Thermal radiation heat transfer.
4. F.P. Incropera and D. P. Dewit, =Fundamentals of Heat and Mass Transfer', 4th Ed. John.
5. C.P. Kothandaraman., =Fundamentals of Heat and Mass Transfer', 2nd Ed., New Age International, 1997.
6. E.R.D Eckert and R.M. Drake, =Analysis of Heat and Mass Transfer', McGraw Hill, 1980.
7. Kays, W.M. and Crawford W., =Convective Heat and Mass Transfer', McGraw Hill Inc., 1993.
8. Burmister L.C., 'Convective Heat Transfer', John Willey and Sons, 1983

MME 104 ADVANCED FLUID MECHANICS [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Fundamental Equations Of The Flow Of Viscous Compressible Fluids: The Equation of continuity-conservation of mass, equation of motion (navier-stokes equation) -conservation of momentum, the energy equation-conservation of energy, the equation of state and perfect gases.

Three Dimensional Inviscid Incompressible Flow: stream function in three dimensional motion, three dimensional axially symmertric flow, uniform flow, radial flow, source and sink doublet, motion of solid bodies in a fluid, superposition of source and rectilinear flow and doublet, three dimensional motion, sphere in uniform stream.

Laminar Flow Viscous Incompressible Fluids: similarity of flow. The reynold's number, viscosity from the point of view of the kinetic theory, flow between parallel flat plates, couetee flow, plane poiseeuille flow in pipes. Flow through a pipe. The heganpoiseuile flow. Flow between two coaxial cylinders, applications of the parallel flow theory. The measure of viscosity, hydrodynamics of bearing lubricant. Unsteady flow around a sphere. Theory of very slow motion, unsteady flow around a sphere. Theory of very slow motion, unsteady motion of a flat plate.

The Laminar Boundary Layer: Properties of navier-stokes equations-boundary layer concept, the boundary layer equation in two dimensional flow, the boundary layer-along a flat plate, the blasius solution, shearing stress and boundary layer thickness, boundary layer on a surface with pressure gradient, momentum-integral theorems for the boundary layer, the von karman-integral relation, von karman-integral relation by momentum law, other forms of the von karman. Integral relation application of momentum, integral equations to boundary layer-von karman-pohlhausen method, separation of boundary layer flow, mathematical criterion, physical example, prediction of boundary layer separation, prevention of boundary layer separation.

Introduction to turbulent flow: the origin of turbulence, reynold's modification of the navier-stoke's equation for turbulent flow, mean values and fluctuations, reynold's equation and reynold's stresses, semi empirical theories of turbulence, prandtl's mixing length theory, von karman similarity hypothesis, universal velocity profile near a wall, turbulent flow in pipe, empirical relation for smooth pipes, flow in rough pipes, turbulent boundary layer over a smooth flat plate, fully boundary layer, boundary layer in the transition range, laminar boundary layer equation in compressible flow, velocity and temperature relation in laminar boundary layers , boundary layer with pressure gradient, boundary layer with zero pressure gradient, integral theorems for the boundary layers, application of momentum integral equation to boundary layers.

Books Recommended:

TEXT BOOKS:

1. Foundations of fluid mechanics - S.W. Yuan, Prentice Hall of India, 1976.
2. Engineering Fluid Mechanics - P.A. Aswatha Narayana & K.N. Seetharamu, Narosa publications, 2005.

REFERENCE BOOKS:

1. Fluid Mechanics - F.M. White, McGraw-Hill publications.
2. Advanced fluid mechanics - K. Muralidhar and G. Biswas, Narosa publications, 1996.
3. Introduction to fluid dynamics - Principles of analysis & design - Stanley Middleman, Wiley, 1997.
4. Currie, LG., *Fundamental Mechanics of Fluids, 3rd* ed., CRC Press, 2002.
5. White, P.M., *Viscous Fluid Flow, 2nd* ed., McGraw-Hill, 1991.
6. Ockendon, H. and Ockendon, J., *Viscous Flow,* Cambridge Uni. Press, 1995.
7. Robertson. *'Hydrodynamics Theory and Application'*, Prentice Hall of India, 1965.
8. M.J Zucrwo and J.D. Hoffman*, 'Gas dynamics'*, Vol. I and II, John Wiley and Sons Inc.1977.

MME 201 GAS TURBINES AND JET PROPULSION [4-2-0] EXAM HRS: - 3

M.M:- 100+50=150

Introduction: Applications, gas dynamics, compressibility effect, steady one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, isentropic two dimensional, supersonic expansion and compression.

Gas Power Cycle: Introduction, assumptions, stagnation properties, compressor and turbine efficiencies, ideal and practical cycles with heat exchanger, reheat & intercooler, pressure, flow, mechanical & combustion losses, heat exchanger effectiveness, effect of variable mass flow rate & specific heat, polytropic efficiency of compressor and turbine, performance, ericsson cycle.

Axial Turbine Stages: Velocity triangles, performance parameters, impulse stage, velocity & pressure-compounded impulse, reaction stage, enthalpy-entropy diagram, degree of reaction, blade-to-gas speed ratio, losses & efficiencies, performance charts low hub-tip ratio & partial admission turbine stages, radial equilibrium, free vortex stage, constant nozzle angle & specific mass flow stage, supersonic flow.

High Temperature (Cooled) Turbine Stages: Effects of high gas temperature, methods of cooling, high temperature materials, heat exchange in a cooled blade, variation of coolant & blade surface temperature, ideal & actual cooled stage work & their efficiencies.

Jet Propulsion: Different engines for air craft propulsions, cycle, theory, air standard efficiency, performance, efficiency of components, combustion chamber, propeller thrust, jet thrust, propulsive, thermal & overall efficiencies, specific fuel consumption, ramjet & pulse jet and their efficiencies, effect of altitude, thrust augmentation, after burner, injection of water - alcohol mixture.

Component matching and Performance Evaluation: Introduction**,** performance characteristics, equilibrium running diagram, procedure to find equilibrium point, performance evaluation of single spool turbojet engine, operating line, General matching procedure, Transient operation.

Wind Turbines: Elements of a Wind Power Plant, Available Energy, Wind Energy Data, Horizontal & Vertical Axis Wind Turbines, Wind Power Applications, Advantages & Disadvantages.

Books Recommended:

TEXT BOOKS:

1. Fundamentals of compressible Flow by S. M. Yahya, Tata McGraw Hill
2. Gas Turbines Theory by Cohen & Rogers, Pearson Education.
3. Turbines Compressors and Fans by S. M. Yahya, Tata McGraw Hill
4. Gas Turbine by V. Ganeshan, Tata McGraw Hill

REFERENCE BOOKS:

1. J.E Lee, Theory and design of stream and gas turbine.
2. S. L. Dixon, Fluid Mechanics & Thermodynamics of Turbomachinary.

MME 202 COMBUSTION ENGINEERING [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Introduction: Importance of Combustion; Combustion Equipments, Hostile Fire Problems, Pollution Problems Arising From Combustion.

Thermodynamics Of Combustion: Enthalpy Of Formation; Enthalpy Of Reaction; Heating Values; First and Second Laws; Analysis Of Reaction System, Chemical Equilibrium, Equilibrium Composition; Adiabatic and Equilibrium, Flame Temperature.

Kinetics Of Combustion: Law Of Mass Action; Reaction Rate; Simple And Complex Reaction; Reaction Order and Molecularity, Arhenius Laws; Activation Energy; Chain Reaction; Steady Rate and Partial Equilibrium Approximation; Chain Explosion; Explosion Limit And Oxidation Characteristics Of Hydrogen, Carbon Monoxide, Hydrocarbons.

Flames: Remixed Flame Structure and Propagation of Flames in Homogeneous Mixtures; Simplified Rankine Hugoniot Relation, Properties of Hugoniot Curve, Analysis Of Deflagration and Detonation Branches, Properties Of Chapmen Jouguet Wave, Laminar Flame Structure; Theories Of Flame Propagation & Calculation Of Flame Speed Measurements. Stability Limits Of Laminar Flames; Flammability Limits & Quenching Distant, Burner Design, Mechanism Of Flame Stabilization In Laminar & Turbulent Flows, Flame Quenching, Diffusion Flames; Comparison Of Diffusion With Premixed Flame, Combustion Of Gaseous Fuel, Jets Burke & Schumann Development.

Burning Of Condensed Phase: General Mass Burning Considerations, Combustion of Fuels Droplet In A Quiescent And Convective Environment, Introduction To Combustion Of Fuel Sprays.

Ignition: Concept Of Ignition, Chain Ignition, Thermal Spontaneous Ignition, Forced Ignition.

Combustion Generated Pollution & Its Control: Introduction, Nitrogen Oxide, Thermal Fixation of Atmospheric Nitrogen Prompts, NO, Thermal Nox & Control In Combustors. Fuel Nox & Control, Post Combustion Destruction Of Nox, Nitrogen Dioxide, Carbon Monoxide Oxidation-Quenching, Hydrocarbons, Sulphur Oxide.

Books Recommended:

TEXT BOOKS:

1. C.R. Ferguson and A.T. Kirk Patrick, Internal Combustion Engines, John Wiley & Sons Inc. 2001.
2. Stephen R Turns, Introduction to Combustion: Concepts and Applications, McGraw Hill, 2000
3. G.L. Borman and K.N. Ragland, Combustion Engineering, McGraw Hill, 1998.
4. D.Winterbone, Advanced Thermodynamics for Engineers, Elsevier, 1996

REFERENCE BOOKS:

1. Energy. Combustion and Environment - N.A. Chigier, McGraw- Hill, 1981.
2. Introduction to combustion phenomena - A. Murthy Kanury, Gordon and Breach, 1975.
3. Fuels and combustion - S.P. Sharma and Chandra Mohan, Tata McGraw-Hill, 1984.
4. Engineering Thermodynamics - Onkar Singh. New age International Publications.

MME 203.1 REFRIGERATION SYSTEMS [4-2-0] **EXAM HRS: - 3**
M.M:- 100+50=150

Review of Thermodynamic Principles of Refrigeration: Vapour Compression Cycle, Actual Vapour Compression Cycle, Multistage, Multi Evaporator System, Cascade System, Gas Cycle Refrigeration, Aircraft Refrigeration.

Refrigeration Systems: Estimation Of Thermal Load, Description, Selection And Matching Of Components Compressors, Evaporators, Condensers, Expansion Devices. Design of a Condenser, Evaporators & Capillary Tube, Cyclic Controls Requirements Of Refrigerants, Lubricants In Refrigeration,

Refrigerants: Types, Classifications, Designation, Properties, Effects of Chlorine, Fluorine and Hydrogen Elements on Properties of Organic Refrigerants, Mixed Refrigerants. Common Refrigerants, Comparison, Selection and Applications. Alternative Refrigerants, Ozone Depletion and Global Warming Potential of CFC. Secondary Refrigerants, Purpose, Theory of Brines.

Vapour Absorption : Theory of Mixtures, Enthalpy - Composition Diagrams, Absorption System Calculations, Aqua Ammonia Systems, Water - Libr System and analysis, Three Fluid Absorption Systems, Properties of Refrigerants Pairs, Solar Refrigeration System.

Other Refrigeration Systems: Water Refrigeration, Centrifugal Refrigeration, Steam Jet Refrigeration, Theory, Performance and Analysis. Vortex Tube and Pulse Tube Refrigeration Systems, Theory, Analysis, Characteristics and Applications. Thermo-electric Systems, Analysis. Production Of Dry Ice(Solid Carbon Dioxide) Cryogenic Systems: Introduction: Insight On Cryogenics, Properties Of Cryogenic Fluids, Material Properties At Cryogenic Temperatures. Inversion Curve-Joule Thomson Effect. Liquefaction Cycles: Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claude Cycle, Dual Cycle, Helium Refrigerated Hydrogen Liquefaction Systems. Critical Components In Liquefaction Systems; Cryogenic Refrigerators: J.T. Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Regenerators Used In Cryogenic Refrigerators, Magnetic Refrigerators Applications: Applications Of Cryogenics In Space Programmes, Superconductivity, Cryo Metallurgy, Medical Applications.

(Revised w.e.f. 2014-15)

Books Recommended:

TEXT BOOKS:

1. C.P.Arora, *A Course in Refrigeration and Air-conditioning,* Tata Mc. Graz-Hill
2. H.F. Stoecker, *A Text Book of Refrigeration and Air-conditioning*, Tata Mc. Graw-Hill.
3. Manohar Prasad, Refrigeration & Air Conditioning., New Age International Publications
4. R.C. Arora, Refrigeration and Air Conditioning, PHI, New Delhi, 2010.
5. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration
6. R.J. Dossat, Principles of Refrigeration, Pearson Education Asia.
7. A Course in refrigeration and Air- Conditioning - Arora and Domkundawar, Danpat Rai & Co Publications
8. Basic Refrigeration and Air Conditioning - P.N. Ananthanarayanan, McGraw-Hill Publications

General Energy Problem, Energy Uses Patterns and Scope of Conservation.

Energy Management Principle: Need, Organizing and Managing an Energy Management Program.

Energy Auditing: Elements and Concepts, Type of Energy Audits Instruments Used In Energy Auditing.

Economic Analysis: Cash Flows, Time Value Of Money, Formulae Relating Present And Future Cash Flows-Single Amount, Uniform Series.

Financial Appraisal Methods: Pay Back Periods, Net Present Value, Benefit Cost Ratio, Internal Rate of Return And Life Cycle Cost / Benefits.

Thermodynamics of Energy Conservation: Energy Conservation in Boilers and Furnaces, Energy Conservation in Stream and Condensate System.

Cogeneration and Cascading: Concepts, Type of Cogeneration System, Performance Evaluation of a Cogeneration System.

Waste Heat Recovery: Potential, Benefit, Waste Heat Recovery Equipments. Space Heating, Ventilation Air Conditioning (HVAC) And Water Heating Of Building, Transfer Of Heat, Space Heating Methods, Ventilation And Air Conditioning, Heat Pumps, Insulation, Cooling Load, Electric Water Heating Systems, Electric Energy Conversation Methods.

Industrial Insulation: Insulation Materials, Insulation Selection, Economical Thickness Of Insulation. Industrial Heating: Heating By Indirect Resistance, Direct Resistance Heating (Salt Bath Furnace), Heat Treatment By Induction Heating In The Electric Furnace Industry.

Energy Conservation In Electric Utility And Industry: Energy Cost And Two-Part Tariff, Energy Conservation In Utility By Improving Load Factor, Load Curve Analysis, Energy Efficient Motors, Energy Conservation In Illuminating System, Importance Of Power Factor In Energy Conservation - Power Factor Improvement Methods, Energy Conservation In Industries.

Books Recommended:

TEXT BOOKS:

1. Energy management handbook - Wayne C. Turner, CRC Press Publications, 2004.

REFERENCE BOOKS:

1. Electrical Energy Utilization and Conservation - S.C. Tripathy, Tata McGraw-Hill, 1991.
2. Industrial Energy Conversation - D.A. Reay, Pergamon Press.
3. Industrial energy conservation Manuals: MIT Press.

MME 203.3 SOLAR THERMAL PROCESSES [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Solar Radiations: Solar Angles, Solar Constant, Spartial Distribution of Extraterrestrial Radiations, Beam And Diffuse Radiations.

Measurement Of Solar Radiations: Measuring Instruments Phyrheliometers And Pyranometers, Scale Of Solar Radiations, Estimation Of Average Solar Radiations And Hourly Solar Radiations, Ratio Of Beam And Total Radiations On A Titled Surface To Horizontal Surface, Effect Of Surface Orientation And Motion.

Radiation Characteristics Of Opaque Materials: Electromagnetic Spectrum, Photon Radiations, The Black Body, Planck's, Wiens And Stefan Boltzmann's Laws, Radiation Intensity And Flux, Kirchoff's Law, Absorptance, Emittance And Reflectance And Relation Between Them, Measurement Of The Surface Radiation Properties.

Transmission Of Radiation Through Transparent Media: Reflection, Absorption and Transmission of Solar Radiations in a Transparent Media.

Focusing Collectors: Solar Disc and Theoretical Solar Images Concentrators, Receivers and Orienting Systems, General Characteristics, Optical Losses, Thermal Performance, Heat Capacity Effects, Optimization of Maximum Energy Delivery Materials and Construction of Reflectors.

Energy Storage: Process Loads and Collector Output Energy Storage in Systems, Water Storage, Packed Bed Storage and Phase Change Storage, Capacity of Storage System.

Solar Heating and Cooling: Water Heater Systems, Sizing Of Systems, Auxiliary Energy Flow, Distribution In Collectors, Performance Of Natural Convention Systems, Comfort Solar Heating Systems, Economics Of Heating, Architectural Considerations, Performance And Cost Calculations.

Solar Absorption Cooling and Its Performance: Economics Of Heating And Cooling, Combined Heating And Cooling Systems, Modeling Of Heating And Cooling Systems, Performance And Cost Of A Heating And Cooling System, Collector Storage Well Systems And Collector Radiation Storage Systems, Collector Radiator Heat Pump System, Open Cycle Cooling System, Solar Ponds, Solar Power and Solar Distillation-Introduction.

Books Recommended:

TEXT BOOKS:

1. 1. S.P.Sukhatme, =*Solar Energy Principle of Thermal Collection and Storage'*, Tata McGraw Hill, 1990.
2. G.L. Johnson, *Wind energy systems*, Prentice Hall Inc. New Jersey.
3. J.M.Kriender, =*Principles of Solar Engineering'*, McGraw Hill, 1987.

REFERENCE BOOKS:

1. V.S. Mangal, =*Solar Engineering'*, Tata McGraw Hill, 1992.
2. N.K.Bansal, =*Renewable Energy Source and Conversion Technology'*, Tata McGraw Hill, 1989.
3. P.J. Lunde., =*Solar Thermal Engineering'*, John Willey & Sons, New York, 1988.
4. J.A. Duffie, and W.A. Beckman, =*Solar Engineering of Thermal Processes'*, Wiley & Sons, 1990.

MME 204.1 DESIGN OF HEAT TRANSFER EQUIPMENTS [4-2-0] EXAM HRS: - 4
M.M:- 100+50=150

Review of Fundamentals: Overall Coefficients Of Heat Transfer, Controlling, Controlling Film Coefficient, Log-Mean-Temperature Difference (LMTD) For Counter Flow And Parallel Flow Heat Exchanger, Caloric Or Average Fluid Temperature, Wall Temperature, And Various Types Of Heat Exchangers, Introduction To Heat Exchanger Optimization.

Design Of Double-Pipe Heat Exchangers: Introduction, Film Coefficients For Fluids In Pipes And Tubes, Film Coefficients And Equivalent Diameter For Flow In Annuali, Fouling Factors, Pressure Drop In Pipes And Annuali, Double-Pipe Exchangers In Series-Parallel Arrangements.

Design Of Shell And Tube Heat Exchangers: 1-2 Parallel-Counter Flow Shell And Tube Heat Exchanger, Constructional Features Of Various Types, Layout Of Tubes, Various Types Of Baffles And Expansion Joints, Shell-Side Film Coefficients, Shell-Side Mass Velocity And Shell Equivalent Diameter, True Temperature Difference In 1-2 Exchanger, Shell And Tube Side Pressure Drops, Analysis Of Performance, Exchangers Without Baffles, Flow Arrangements For Increased Heat, Recovery: 2-4 Exchangers And Their Comparison With 1-2 Exchangers, 1-2 Exchangers In Series, 1-1 True Counter Flow Exchangers, Design Calculations**.**

Design of Heat Exchangers With Extended Surfaces: Introduction And Classification, Fin Efficiency, Longitudinal Fins And Double Pipe Exchangers, Extended-Surface-Shell And Tube Exchanger: Cross-Flow LMTD, Film Coefficients and Pressure Drop For Transverse Fins.

Design of Condensors: Drop wise And Film Condensation, Condensing Heat Transfer Coefficients, Horizontal and Vertical Tube Condensors, Brief Introduction to Desuperheater Condensers and Condenser-Sub coolers.

Books Recommended:

TEXT BOOKS:

1. R. K. Shah & D. P. Sekulic, *Fundamentals of Heat Exchanger Design*, John Wiley, 2003.
2. E. M. Smith, *Advances in Thermal Design of Heat Exchangers*, John Wiley, 2005.

REFERENCE BOOKS:

1. E. Hesselgreaves, *Compact Heat Exchangers*, Elsevier, 2001.
2. R.F. Barron, *Cryogenic Systems*, McGraw Hill, 1985.

MME 204.2 ADVANCED AIR CONDITIONING [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Review of Psychrometrics : History, Psychrometric properties, WBT, Thermodynamic WBT, Psychrometric chart, Processes, Air Washers, Air-conditioner systems, Summer Air-conditioning, Apparatus Due Point Temperature, Winter Air-conditioning.

Design Conditions : Choice of inside Design Condition, Comfort Air-Conditioning, Heat Exchange between Human Body and Environment, Effective Temperature, Outside Design Condition, Choice of Supply Design Condition, Critical Loading Conditions, Clean Spaces.

Solar Radiations : Distribution of Solar Radiations, Earth Sun Angles and Relationship, Wall Solar Azimuth Angle and Angle of Incidence, Direct Solar Radiation and Diffuse Radiations, Heat gain through glasses, Shading from Reveals, Overhangs and Fins, Effect of Shading Device.

Heat Transfer through Building Structure : Fabric Heat Gain, Periodic Heat Transfer through Walls and Roofs, finite Difference Approximation of One-dimensional Heat Transfer through Walls, Empirical Methods to Evaluate Heat Transfer through Walls and Roofs, Natural Ventilation through Infiltration, Passive Heating and Cooling of Buildings, Water Vapour Transfer through Structures.

Load Calculation and Applied Psychrometry : Preliminary Considerations, Internal Heat Gains, System Heat Gains, Break-up of Ventilation Load and Effective Sensible Heat Factor, Cooling Load and Heating Load Estimates, Psychrometric Calculations for Cooling, Selections of Air-Conditioning Apparatus for Cooling and Dehumidification, Evaporative Cooling, Building Requirements and Energy Conservation in Air-Conditioning Building.

Design of Air Conditioning Apparatus : Heat and Moisture Transfer in Air-Conditioning, Design of Cooling and Dehumidifying Coil, Optimum Design, Spray Equipments, Design of Air Washer and Cooling Towers.

Transmission and Distribution of Air : Room Air Distribution, Total, Static and Velocity Pressures, Friction Loss in Duct, Air Flow through Simple Duct System, Air Duct Design, Processing, Transmission and Distribution of Air in Rooms, Air Locks, Air Curtains and Air Showers.

Air-Conditioning Controls : Bypass Controls, Reheat Controls, Noise Level and Acoustic Control, Automatic Controls in Air-Conditioning.

(Revised w.e.f. 2014-15)

Books Recommended:

TEXT BOOKS:

1. C.P.Arora, *A Course in Refrigeration and Air-conditioning,* Tata Mc. Graz-Hill
2. R.C. Arora, Refrigeration and Air Conditioning, PHI, New Delhi, 2010.
3. H.F. Stoecker, *A Text Book of Refrigeration and Air-conditioning*, Tata Mc. Graw-Hill.
4. Refrigeration & Air Conditioning - Manohar Prasad., New Age International Publications
5. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration
6. Basic Refrigeration and Air Conditioning - P.N. Ananthanarayanan, McGraw-Hill Publications

MME 204.3 ALTERNATIVE FUELS FOR I. C. ENGINES [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Fuels: Introduction, Structure Of Petroleum, Refining Process, Products Of Refining Process, Fuels For Spark Ignition, Knock Rating Of SI Engine Fuels, Octane Number Requirement, Diesel Fuels.

Properties Of Petroleum Products: Specific Gravity, Density, Molecular Weight, Vapour Pressure, Viscosity, Flash Point, Fire Point, Cloud Point, Pour Point, Freezing Point, Smoke Point & Char Value, Aniline Point, Octane Number, Performance Number, Cetane Number, Emulsification, Oxidation Stability, Acid Value/Number, Distillation Range, And Sulphur Content.

Alternative Fuels For I.C. Engines: Need For Alternative Fuels Such As Ethanol, Methanol, LPG, CNG, Hydrogen, Biogas And Producer Gas And Their Methods Of Manufacturing.

Single Fuel Engines: Properties Of Alternative Fuels, Use Of Alternative Fuels In SI Engines, Engine Modifications Required, Performance And Emission Characteristics Of Alternative Fuels In SI Mode Of Operation V/S Gasoline Operation.

Dual Fuel Engine: Need And Advantages, The Working Principle, Combustion In Dual Fuel Engines, Factors Affecting Combustion In Dual Fuel Engine, Use Of Alcohols, LPG, CNG, Hydrogen, Biogas And Producer Gas In CI Engines In Dual Fuel Mode. Engine Modifications Required. Performance And Emission Characteristics Of Alternative Fuels (Mentioned Above) In Dual Fuel Mode Of Operation V/S Diesel Operation.

Bio-Diesels: What Are Bio-Diesels Need Of Bio-Diesels, Properties Of Biodiesels V/S Petro-Diesel, Performance And Emission Characteristics Of Biodiesels V/S Petro Diesel Operation.

Availability: Suitability & Future Prospects Of These Gaseous Fuels In Indian Context.

Environmental Pollution: With Conventional and Alternate Fuels, Pollution Control Methods And Packages.

Books Recommended:

TEXT BOOKS:

1. **A Course in Internal Combustion Engines -** R.P Sharma & M.L. Mathur, Danpat Rai & Sons.
2. **Internal Combustion Engines -** V. Ganesan, Tata McGraw-Hill Publications.
3. John B. Heywood, “IC Engines fundamentals”, McGraw-Hill Publications
4. M. Dayal, "*Energy today & tomorrow* ", I & B Horishr India, 1982.
5. Nagpal, "*Power Plant Engineering* ", Khanna Publishers, 1991.

REFERENCE BOOKS:

1. **Elements of Fuels, Furnaces & Refractories -** O.P. Gupta, Khanna Publishers.
2. **Internal Combustion Engines -** Domkundwar V.M., I Edition, Dhanpat Rai & Sons.
3. **Internal Combustion Engines Fundamentals -** John B. Heywood, McGraw Hill International Edition.
4. **Present and Future Automotive Fuels -** Osamu Hirao & Richard Pefley, Wiley Interscience Publications.

Combustion in S.I. Engine – Introduction, Ignition limits, Stages of combustion in S.I. engine, Concept of combustion quality, Effects of engine variables on ignition lag and flame propagation, Rate of pressure rise, Cycle variations, Abnormal combustion and surface ignition, detonation or knocking phenomenon, Theories, effects and Chemistry of detonation, Effects of engine variables on detonation and control, Knock evaluation, Observations of burning gas by cinematography, Various types of combustion chambers, Design principles.

Combustion in C.I. Engine – Introduction, Air fuel ratio, Delay period or ignition lag, Variables affecting delay period, Diesel knock and control, Different combustion chamber, Fuel spray behavior, Spray structure, Swirl cold starting aids.

Electronic Injection Systems and Ignition Systems – Introduction, Types of injection system, MPFI, Port, Throttle body, D-MPFI, L-MPFI, MPFI electronic control system, Cold start, Injection timings, Group gasoline injection system, Electronic diesel injection systems – Unit injectors, injector pumps, Common rail. TCI, CDI, Computer controlled coil ignition system, Ignition system with magnetic pick-up.

Engine Emissions and their controls – Introduction, Air pollution due to IC engines, Euro and Bharat norms. S.I. Engine emissions, HC, CO, NO_x particulates and other emissions. Effects of engine variables on emission and their controls – Engine design modifications, Thermal converters, Catalytic converters with their constructions, EGR. Non-exhaust emissions and control – Charcoal Canister, Blow-by Control, PCV. Diesel engine emissions – Effects of engine type and mode of operation, Diesel smoke and causes, Soot, Smoke measurement and control. Diesel odour, Effects of various parameters and control. Ammonia Injection for NO_x. Zero emission vehicles.

Supercharging – Objects, Thermodynamic cycle, Supercharging of S.I. and C.I. engines, Effects on performance and evaluation, Limits, Methods of supercharging and Turbo-charging arrangements, Types and controls, superchargers.

Modern Developments in I.C. Engines – Lean burn engines, Multi-valve engine, Cam less valve gearing, Variable valve timing, Basic concepts of engine simulations, Governing equations, Simulation of processes in C.I. and S.I. engines, Thermodynamic and fluid based models, Engine for special application – Mining, Defence, Hybrid car and electrical vehicles.

(Revised w.e.f. 2014-15)

Books Recommended:

TEXT BOOKS:

1. **A Course in Internal Combustion Engines -** R.P Sharma & M.L. Mathur, Danpat Rai & Sons.
2. **Internal Combustion Engines -** V. Ganesan, Tata McGraw-Hill Publications.
3. John B. Heywood, "IC Engines fundamentals", McGraw-Hill Publications.
4. The Internal Combustion Engine In Theory And Practice Volume I & II
   By Charles Fayette Taylor. The MIT Press.

REFERENCE BOOKS:

1. **Internal Combustion Engines -** Domkundwar V.M., I Edition, Dhanpat Rai & Sons.
2. **Internal Combustion Engines Fundamentals -** John B. Heywood, McGraw Hill International Edition.
3. **Present and Future Automotive Fuels -** Osamu Hirao & Richard Pefley, Wiley Interscience Publications.

MME 301.2\302.2 NON – CONVENTIONAL ENERGY SYSTEMS [4-2-0] EXAM HRS:3
M.M:- 100+50=150

Man and Energy: World's Production and Reserve of Commercial Energy Sources, India's Production and Reserves, Energy Alternatives, Different Forms of Non-Conventional Energy Source, Limitations of Conventional and Non-Conventional Sources of Energy.

Solar Energy: The Sun – Collection and transfer of Solar energy – Sun-Earth angles – Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation – Solar thermal collectors – General description and characteristics – Flat plate collectors – Heat transfer – Short term and long term collector performance – Solar concentrators – Design, analysis and performance evaluation.

Solar Photovoltaic Systems – Operating principles, Photovoltaic cell concepts, Characteristics, Cell modules, array, Series and parallel connections, Balance of system (BOS), Maximum power point tracking. Applications: Power generation, Battery charging, Pumping, Lighting and Peltier cooling.

Energy from Biomass – Sources of biomass – Different species – Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion – Properties of biomass – Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas. Bio-diesel combustion engine.

Wind Energy – Basic principles of Wind Energy Conversion, Wind patterns, Wind data, Site selection, Betz theory, Aero foil blade structure, Energy estimation, Aerodynamic forces, WEC systems, Wind power plant design, Types of wind machines, Performance, Generating systems and controls, Storage, Operations, Maintenance, Applications, Safety, Environmental aspects.

Ocean Energy – OTEC, Electrical power generation, Open and close cycles, Site selection and Hybrid cycle. Tide energy, Principles and components of tidal power plant and Power estimation of single and double basin system. Ocean waves, Energy from waves, Energy conversion devices and estimation of power.

Mini and Micro Hydel Plants – Requirement, Development, Classification, Components of hydro electric system, Turbine and generators, Protection, Control and management of equipments, Advantage and hybrid system.

Geothermal Energy – Estimation of power, Geothermal fields, Sources ; Hydrothermal, Geo pressured, Hot and dry rock, Magma resources, Power systems, Performance, Prime movers, Applications, Materials for geothermal plant, Environmental impact, Prospects in India.

(Revised w.e.f. 2014-15)

REFERENCES :-

1. J.A. Duffie and W.A. Beckman: Solar Energy thermal processes, J. Willey, 1994.
2. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modeling and Applications, Nerosa Publishers, 2002.
3. Ahmed: Wind energy Theory and Practice, PHI, Eastern Economy Edition, 2012.
4. K.M. Mittal: Non-conventional Energy Systems-Principles, Progress and Prospects, Wheeler Publications, 1997.
5. Kothari: Renewal Energy Sources and Emerging Technologies, PHI, Eastern Economy Edition, 2012.
6. G.L. Johnson, Wind energy systems, Prentice Hall Inc. New Jersey.
7. N.K. Bansal, Renewal Energy Source and Conversion Technology, Tata McGraw Hill, 1989.
8. B.H. Khan: Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi.
9. G.D. Rai: Non-Conventional Energy Resources, Khanna Publishers, New Delhi

MME 301.3\302.3 ADVANCED TURBO-MACHINERY [4-2-0] EXAM HRS: - 3

M.M:- 100+50=150

Introduction: Dimensional Analysis: Similitude Definition of turbomachines. Dimensional analysis and Performance laws. Incompressible fluid analysis. Performance characteristics variable geometry turbomachines. Specific speed. **Cavitation:** cavitation limits, compressible fluid analysis.

Two Dimensional Cascades: Cascade nomenclature. Analysis of cascade forces. **Energy losses:** Lift and Drag. Circulation and lift, efficiency of compressor cascade, performance of two dimensional cascades. The cascade wind tunnel. Cascade test results. Compressor cascade performance. Turbine cascade performance, compressor cascade correlations. Fluid deviation, off design performance. Much number effects. Turbine cascade co-relation (Ainley) Optimum space chord ratio of turbine blades (Zweifel)

Three Dimensional Flows in Axial Turbomachines: Theory of radial equilibrium. The indirect problem. The direct problem. Compressible flow through a fixed blade row. Constant specific mass flow. Off design performance of a stage free vortex turbine stage. Actuator disc approach, Blade row interaction effects, computer aided methods of solving the through flow problems

Centrifugal Compressor, Fan & Blowers: Elements of centrifugal compressor stage, velocity triangles, enthalpy-entropy diagram, stage efficiency, reaction, nature of impeller flow, slip factor, stodola's, stanitz's & Balje's formula, diffuser, volute casing, free vortex design, losses, performance chrematistics.

Types of centrifugal fans, stage & design parameters, drum type, partial flow fans, losses, bearings, drives, noise, duct erosion of fans.

Axial Compressor, Fans and Propellers: Stage velocity triangles, enthalpy-entropy diagram, efficiencies, reaction ratio, choice of reaction, flow through blade rows, stage losses & efficiency, work done factor, forced & free vortex flow, swirl distribution, supersonic & transonic stage, performance characteristics, surging & stalling.

Axial fan applications, stage parameters, types of stages, propellers, slip stream & blade elements theory, performance of axial fans.

Radial flow Gas Turbine: Description, velocity diagram, cantilever blade I.F.R turbine, 90 º I.F.R turbine, Enthalpy-Entropy diagram, spouting velocity, Effect of exhaust diffuser, Degree of reaction, stage losses, performance characteristics Mach number limitation, outward flow radial turbine.

Books Recommended:

TEXT BOOKS:

1. Lee, =*Theory and Design of Steam and Gas Turbine'*, McGraw Hill, 1954.

2. Yahya, =*Turbines, Compressions & Fans'*, Tata McGraw Hill, 1983.

REFERENCE BOOKS:

1. Fundamentals of turbomachinery: B.K VENKANNA

2. STRUCTURAL DYNAMICS OF TURBO-MACHINES:A.S RANGWALA.

3. D.G. Stephard, =*Principles of Turbo machines'*, Macmillan Co., 1984.

4. W.J Kerten, =*Steam Turbine Theory and Practice'*, CBS Publisher & Distributors, 1988.

5. C. Rogers, S Muttoo, =*Gas Turbine Theory*', Long man, 1988.

6. W N.Bathe, =*Fundamentals of Gas Turbines'*, Willey & Sons, 1994.

MME 301.4\302.4 DIRECT ENERGY CONVERSION [4-2-0] EXAM HRS: - 3
M.M:- 100+50=150

Background of Direct Energy Conversion: Primary Energy Sources, Limitation on Energy Utilization, Principles of Energy conversion.

Irreversible Thermodynamics: Unified Theory of energy conversion.

(a) Thermoelectric Generation: Thermoelectric effect, The analysis of Thermoelectric Generator, The analysis of Thermoelectric Cooler; Figure of merit, Device configuration magneto thermo electricity.

(b) Thermoelectric Generation: Radiation Principles.

(c) Thermoelectric Generation: Thermoelectric Analysis of Thermoelectric Consort. The closed space high Vacuum thermonic converter. The Low Pursuer Diode. The High pressure Cesium Converter.

Thermoelectric Generation: Radiation Principles. The p-n junction as a converter, the properties desired in semiconductor for cell use. The design of a converter, Fabrication of cell, Reliability of Solar Cell.

Magneto-Hydrodynamic Power Generation: Gaseous Conductor, Analysis of a M.H.D. Grantor, Problem associated with M.H.D. Power Generator.

Fuel Cells: Thermodynamic Principles. The efficiency of a Fuel Cell, Types of Fuel Cell, Design Consideration.

Books Recommended:

TEXT BOOKS:

1. Direct Energy Conversion: W.R. Corliss
2. Direct Energy Conversion – Stanley W. Angrist, Allyn, Bacon

MME 301.5\302.5 **CRYOGENIC SYSTEMS [4-2-0]** **EXAM HRS: - 3**
M.M:- 100+50=150

Introduction & Low Temperature Properties of Engineering Materials: Historical Background, Present Area Involving Cryogenics, Mechanical Properties; Thermal Properties; Electrical and Magnetic Properties; Properties Of Cryogenic Fluids.

Gas Liquefaction System: Joule Thompson Effect; Adiabatic Expansion; Simple Linde-Hampson, Precooled Linde- Hampson System; Liquid Dual Pressure System; Cascaded System; Claude System, Kapitza System, Collins Helium Liquefaction System.

Critical Component Of Liquefaction System: Effect Of Heat Exchanger; Effectiveness Of System Performance, Effect Of Compressor And Expander Efficiency On System Performance; Effect Of Heat Transfer To The System.

Cryogenic Refrigeration System: Phillips Refrigerator, Importance Refrigerator, Effectiveness for Phillips Refrigerator, Gifford-Mcmohan Refrigerator.

Measurement System of Low Temperature: Temperature Measurement, Flow Rate Measurement, Liquid Level Measurement.

Cryogenic Storage & Transfer System: Cryogenic Fluid Storage Vessels, Insulation, Cryogenic Transfer System.

Vacuum Technology: Importance Of Vacuum Technology In Cryogenics, Flow Regimes In Vacuum Systems; Conductance In Vacuum Systems, Calculation Of Pump Down Time For A Vacuum System, Components Of Vacuum Systems, Mechanical Vacuum Pumps, Diffusion Pumps, Ion Pumps, Cryopumping, Vacuum Gauges & Valves.

Books Recommended:

TEXT BOOKS:

1. R.Barron, Cryogenic systems, McGraw–Hill Company
2. G.G.Hasseldon. Cryogenic Fundamentals, Academic Press
3. Bailey, Advanced Cryogenics, Plenum Press
4. W.F.Stoecker, Industrial Refrigeration Handbook, McGraw-Hill
5. John A.Corinchock, Technician's Guide to Refrigeration systems, McGraw–Hill
6. P.C.Koelet, Industrial Refrigeration: Principles, Design and Applications, Macmillan
7. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration
8. Graham Walker, Miniature Refrigerators for Cryogenic Sensors and Cold Electronics, Clarendon Press

MME 301.6\302.6 **ADVANCED POWER PLANT ENGG [4-2-0]** **EXAM HRS: - 3**
M.M:- 100+50=150

Analysis Of Steam Cycles: Rankine Cycle, Carnot Cycle, Mean Temperature Of Heat Addition, Effect Of Variation Of Steam Condition On Thermal Efficiency Of Steam Power Plant, Reheating Of Steam, Regeneration, Regenerative Feed Water Heating, Feed Water Heaters, Carnotization Of Rankine Cycle, Optimum Degree Of Regeneration, Super Critical Pressure Cycle, Steam Power Plant Appraisal, Deaerator, Typical Layout Of Steam Power Plant, Efficiencies In A Steam Power Plant, Cogeneration Of Power And Process Heat, Numerical Problems.

Combined Cycle Power Generation: Flaws Of Steam As Working Fluid In Power Cycle, Characteristics Of Ideal Working Fluid In Vapor Power Cycle, Binary Vapor Cycles, Coupled Cycles , Combined Cycle Plants, Gas Turbine- Steam Turbine Power Plant, MHD-Steam Power Plant, Thermionic- Steam Power Plant, Numerical Problems.

Fuels And Combustion : Coal, Fuel Oil, Natural And Petroleum Gas, Emulsion Firing, Coal – Oil And Coal – Water Mixtures, Synthetic Fuels, Biomass, Combustion Reactions, Heat Of Combustion And Enthalpy Of Combustion, Theoretical Flame Temperature, Free Energy Of Formation, Equilibrium Constant, Effect Of Dissociation, Numerical Problems.

Combustion Mechanisms : Kinetics Of Combustion, Mechanisms Of Solid Fuel Combustion, Kinetic And Diffusion Control, Pulverized Coal Firing System, Fuel-Bed Combustion, Fluidized Bed Combustion, Coal Gassifiers, Combustion Of Fuel Oil, Combustion Of Gas, Combined Gas Fuel Oil Burners, Numerical Problems.

Steam Generators: Basic Type of Steam Generators, Fire Tube Boilers, Water Tube Boilers. Economizers, Superheaters, Reheaters, Steam Generator Control, Air Preheater, Fluidized Bed Boilers, Electrostatic Precipitator, Fabric Filters And Bag Houses, Ash Handling System, Feed Water Treatment, Deaeration, Evaporation, Internal Treatment, Boiler Blow Down, Steam Purity, Numerical Problems.

Condenser, Feed Water And Circulating Water Systems: Need Of Condenser, Direct Contact Condensers, Feed Water Heaters, Circulating Water System, Cooling Towers, Calculations, Numerical Problems.

Nuclear Power Plants: Chemical And Nuclear Reactions, Nuclear Stability And Binding Energy, Radioactive Decay And Half Life, Nuclear Fission, Chain Reaction, Neutron Energies. Neutron Flux And Reaction Rates, Moderating Power And Moderating Ratio, Variation Of Neutron Cross Sections With Neutron Energy, Neutron Life Cycle. Reflectors, Types Of Reactor, PWR, BWR, Gas Cooled Reactors. Liquid Metal Fast Breeder Reactor, Heavy Water Reactors, Fusion Power Reactors, Numerical Problems.

Hydro Electric Power Plant: Introduction, Advantages And Disadvantages Of Water Power, Optimization Of Hydro – Thermal Mix, Hydrological Cycles, Storage And Pondage, Essential Elements Of Hydro Electric Power Plant, Classification, Hydraulic Turbines – Pelton Wheel, Francis Turbine, Propeller And Kaplan Turbines, Deriaz Turbine, Bulb Turbine, Comparisons Of Turbines, Selection Of Turbines, Numerical Problems.

Books Recommended:

TEXT BOOKS:

1. **Power Plant Engineering -** P.K. Nag, Tata McGraw-Hill Publications.
2. **Power Plant Engineering -** M.M. EI-Wakil, McGraw- Hill Publications.

Introduction: Importance of Stress Analysis, Heat Transfer and Fluid Flow, Conservation Laws For Mass, Omentum And Energy; Fourier Equation, N-S Equations; Energy Principles In Stress Analysis; Basic Equations In Elasticity; Boundary Conditions. Some Basic Discrete Systems: Discrete Systems As Basis For FEM Analysis; Examples Of Discrete Systems In Stress Analysis, Heat Transfer And Fluid Flow. 1-D Finite Elements: Introduction; Elements and Shape Functions – One Dimensional Linear Element (Bar Element), One Dimensional Quadratic Element.

2-D Finite Elements: Two Dimensional Linear Triangular Elements, Local And Global Coordinate Systems, Quadratic Triangular Elements, Two Dimensional Quadrilateral Elements, Iso-Parametric Elements, Three Dimensional Elements, Beam, Plate And Shell Elements, Composite Materials.

Formulation: Introduction; Variational Approach; Methods of Weighted Residuals for Heat Transfer Problems, Principle Of Virtual Work For Stress Analysis Problems; Mixed Formulation; Penalty Formulation For Fluid Flow Problems. Primitive Variables Formulation for Flow Problems.

Heat Conduction Problems: FEM Analysis Of Steady State Heat Conduction In One Dimension Using Linear And Quadratic Elements; Steady State Heat Conduction In Two Dimensions Using Triangular And Rectangular Elements; Three Dimensions Problems, Axi-Symmetric Problems.

Transient And Phase Change Problems: Transient Heat Conduction In One And Multi Dimensional Problems; Time Stepping Scheme Using Finite Difference And Finite Element Methods; Phase Change Problems – Solidification And Melting; Inverse Heat Conduction Problems.

Stress Analysis Problems: Introduction; Stress Analysis In One, Two (Plane Stress And Plane Strain) And Three Dimensions; Axi-Symmetric Problems; Beam And Plate Bending Problems; Thermal Stress Development; Shrinkage Stress Development; Prediction Of Distortions In Manufactured Products; Introduction To Simple Dynamic Problems.

Convective Heat Transfer Problems: Introduction; Galerkin Method Of Steady, Convection-Diffusion Problems; Upwind Finite Element In One Dimension - Petro-Galerkin Formulation, Artificial Diffusion; Upwind Method Extended To Multi-Dimension; Transient Convection - Diffusion Problems - FEM Solutions, Extension To Multi Dimensions; Primitive Variables Approach (U, V, W, P, T Formulation); Characteristic - Based Split Scheme (CBS); Artificial Compressibility Scheme; Calculation Of Nusselt Number, Drag And Stream Function; Mesh Convergence; Introduction To Convection In Porous Media; Laminar And Turbulent Flows.

Books Recommended:

TEXT BOOKS:

1. The finite element method in heat transfer and fluid dynamics - J.N. Reddy and Gartling D.K., CRC publications, 2000.
2. The finite element method volume 3: fluid dynamics - O.C. Zienkiewicz and R.L. Taylor, John Wiley & Sons, 2001.
3. The finite element and for solid and structural mechanics - O.C. Zienkiewicz and R.L. Taylor, Elsevier Publishers, 2005.
4. Introduction to Finite Elements in Engineering - Tirupathi R. Chandrupatla, Ashok D. Belegundu, Prentice-Hall Ltd., 2002.
5. Finite Element Analysis - S.S. Bavikatti, New Age International, 2005.

REFERENCE BOOKS:

1. FINITE ELEMENT METHODS FOR ENGINEERS – U.S.Dixit

MME 301.8\302.8 **COLD PRESERVATION OF FOOD [4-2-0]** **EXAM HRS: - 3**
M.M:- 100+50=150

Introduction: Necessity of Food Preservation; General Techniques; Cold Preservation of Food. **Biological Aspects:** Live and Dead Foods; Biology of Food Products Such As Fruits, Vegetables, Milk, Meat and Fish; Effect of Temperature on Food Ingredients; Respiration Rates of Food Products; Controlled Atmospheric Storage; Disease and Deterioration of Foods.

Cold Preservation Of Food: Short And Long Term Preservation; Methods Of Chilling; Freezing And Freeze-Drying; Heat And Mass Transfer Analysis Of Cooling And Freezing.

Cold Storages: Necessity And Present Status In The Country; Site Selection; Building Constructional Features, Load Calculation, Equipment, Selection, Safety Consideration, Insurance And Management Of Cold Storages; Storages Of Some Important Food Products; Modern Trends In Cold Storage Practices.

Refrigerated Food Handling: Preparation For Cooling/Freezing; Packaging Of Foods; Modes Of Transportation-Land, Sea And Air; Their Thermal Load And Equipment; Marketing Of Refrigerated Food.

Books Recommended:

TEXT BOOKS:

1. STOCKING UP: THE THIRD EDITION OF THE CLASSIC PRESERVING GUIDE BY CAROL HUPPING 1990
2. THE BIG BOOK OF PRESERVING THE HARVEST- CAROL W COSTENBADEN PAMELA LAPPIES-1997
3. THE BUSY PERSON'S GUIDE TO PRESON'S GUIDE TO PRESERVING FOOD-JANET BACHAND CHADWICK-1995