UNIVERSITY OF MUMBAI
No.UG/ 326 of 2004

CIRCULAR :

Attention of Principals of the affiliated colleges in Engineering is hereby invited to the Ordinances, Regulations and syllabi relating to the M.E. (Civil, Mechanical, Electrical, Production, Electronics and Computer Engineering) degree course vide pamphlet No.190 and to this office Circular No.UG 80 dated 4th March, 2004 and they are hereby informed that the recommendation made by the faculty of Technology at its meeting held on 28th April, 2004 has been accepted by the Academic Council at its meeting held on 18th June, 2004 vide item No.4.3 and subsequently approved by the Management Council at its meeting held on 31st July, 2004 vide item No.17 and that in accordance therewith M.E. (Mechanical) degree course with Thermal Engineering subjects has been introduced from the academic year 2004-2005.

They are also informed that the scheme and syllabus for the M.E (Mechanical) degree course with Thermal Engineering subjects is as per Appendix.

Further, they are informed that the O.5134 relating to the eligibility criteria for admission to the M.E. degree course has been amended to read as under and that the same has been brought into force with effect from the academic year 2004-2005:-

O.5134 : Any person who has passed an examination for the degree of Bachelor of Engineering of this University or the degree of Bachelor of Engineering of any other University recognized as equivalent to the Bachelor of Engineering degree of this University be deemed eligible for admission to the Master's degree course in Engineering in the specific branch in which he has taken the degree of Bachelor of Engineering of a related branch as listed below :-

I. Civil Engineering with (i) Environmental Engineering subjects	a. Civil Engineering Or b. Environmental Engineering Or c. Construction Engineering
(ii) Structural Engineering subjects	a. Civil Engineering Or b. Construction Engineering
(iii) Traffic and Transportation	a. Civil Engineering

(iv) Construction Management subjects	a. Civil Engineering Or b. Construction Engineering
(v) Hydraulics Engineering subjects	a. Civil Engineering Or b. Construction Engineering Or c. Environmental Engineering
(vi) Geo-technical Engineering subjects	a. Civil Engineering Or b. Construction Engineering
2. Mechanical Engineering with (i) Machine Design subjects	a. Mechanical Engineering Or b. Machine Tool Engineering Or c. Automobile Engineering Or d. Production Engineering
(ii) Automobile Engineering subjects	a. Mechanical Engineering Or b. Automobile Engineering Or c. Machine Tool Engineering
(iii) Fluid Pumping Machines subjects	a. Mechanical Engineering
(iv) Internal Combustion Engineering subjects	a. Mechanical Engineering Or b. Automobile Engineering
(v) CAD/CAM & Automation	a. Mechanical Engineering Or b. Automobile Engineering Or c. Production Engineering Or d. Machine Tool Engineering
(vi) Thermal Engineering subjects	a. Mechanical Engineering Or b. Automobile Engineering Or c. Production Eng...

3. Electrical Engineering with (i) Control Systems Engineering subjects	a. Electrical Engineering Or b. Electronics Engineering Or c. Electronics and Tele-communication Engineering Or d. Instrumentation Engineering
(ii) Power Systems Engineering subjects	a. Electrical Engineering
4. Electronics Engineering	a. Electrical Engineering Or b. Electronics Engineering Or c. Electronics and Tele-communication Engineering Or d. Instrumentation Engineering Or e. Computer Engineering
5. Electronics and Telecommunication Engineering	a. Electrical Engineering Or b. Electronics Engineering Or c. Electronics and Tele-communication Engineering Or d. Instrumentation Engineering Or e. Computer Engineering
6. Instrumentation & Controls Engineering	a. Electrical Engineering Or b. Electronics Engineering Or c. Instrumentation Engineering

7. Computer Engineering	a. Computer Engineering Or b. Electrical Engineering Or c. Electronics Engineering Or d. Electronics and Tele-communication Engineering Or e. Instrumentation Engineering Or f. Information Technology
8. Information Technology	All branches of the Bachelor of Engineering (B.E.) degree course
9. Biomedical Engineering	a. Biomedical Engineering Or b. Computer Engineering Or c. Instrumentation Engineering Or d. Electronics Engineering Or e. Electronics and Tele-communication Engineering
10. Production Engineering	a. Production Engineering Or b. Mechanical Engineering Or c. Industrial Engineering Or d. Machine Tool Engineering Or e. Automobile Engineering Or f. Metallurgical Engineering

Notwithstanding what is stated above, candidates who have passed Section A and Section B examination conducted by the (1) Institution of Electronics and Telecommunication Engineers (India), New Delhi and (2) The Institution of Engineers (India), Calcutta – 700 020, and qualified at the GATE examination conducted by the Government of India through the I.I.T.'s will also be deemed eligible for admission to the Master of Engineering degree course in the specific branch in which they have passed Section A and Section B examination of a related branch as listed above.

Mumbai 400 032
9th August, 2004

for I/c REGISTRAR

To,

Principals of the affiliated college in Engineering.

A.C.4.3/18.06.2004

No.UG/ 326-A of 2004

9th August, 2004

Copy forwarded with compliments for information to :-

1) the Dean, Faculty of Technology,
2) the Chairman, Board of Studies in various branches in Engineering.

for I/c REGISTRAR.

Copy to :

The Director, Board of College and University Development, the Controller of Examinations, the Deputy Registrar (Eligibility & Migration Section) the Director of Students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-centre, Ratnagiri, for information.

The Controller of Examinations (10 copies), F. & A.O. (Accounts Section), Fort (2 copies), Record Section (5 copies), Publication Section (5 copies), D.R. (Enrolment, Eligibility & Migration Section – 3 copies), D.R. (Statistical Unit) (2 copies), D.R. (Accounts Section) Vidyanagari (2 copies), D.R. (Affiliation Section) (2 copies), the Director, U.C.C., I.D.E. Bldg., Vidyanagari, D.R. (U.G. & P.G. Unit) (2 copies), A.R., A.A. Unit (2 copies) He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council/Management Council, referred to in the above Circular and that no separate Action Taken Report will be sent in this connection, A.R., CONCOL (2 copies), BUCTU (1 copy), Dy.Asst. (Unit V) (1 copy), In-charge, C.C.F. (1 copy), Receptionist (1 copy), Telephone Operator (1 copy), Secretary, MUASA (1 copy), Supdt., P.G. Section (2 copies).

Vol. Cir.1070804

A.C. Item No. 4.3 dt. 18/6/2004

UNIVERSITY OF MUMBAI

Scheme of Instruction and Evaluation

for

M. E. (Mechanical)

with

Thermal Engineering Subjects

(with effect from the academic year 2004-2005)

UNIVERSITY OF MUMBAI

SCHEME OF INSTRUCTION AND EVALUATION

COURSE: M.E. (Mechanical)
with
Thermal Engineering Subjects

SEMESTER - I

Sr. No.	Subject	Lectures	Practical / Seminar	Duration of Examination in Hrs.	Theory Paper (Marks)	Internal Assessment
1	Advanced Thermodynamics	3	2	4	100	50
2	Advanced Heat Transfer	3	2	4	100	50
3	Instrumentation In Thermal Engineering	3	2	4	100	50
4	Computational Fluid Dynamics	3	2	4	100	50
5	Elective-I	3	2	4	100	50
	TOTAL	15	10		500	250

Elective-I
1. Gas Turbine
2. Refrigeration System Design
3. Solar And Wind Energy
4. Energy Conservation And Management

SEMESTER – I I

Sr. No.	Subject	Lectures	Practical / Seminar	Duration of Examination in Hrs	Theory Paper (Marks)	Internal Assessment
1	Design of Heat Exchanger	3	2	4	100	50
2	Fuel and combustion	3	2	4	100	50
3	Cryogenics	3	2	4	100	50
4	Environmental Engineering and Thermal Pollution	3	2	4	100	50
5	Elective-II	3	2	4	100	50
	TOTAL	15	10		500	250

Elective-II
1. Advanced Turbo Machinery
2. Modeling And Simulation Of I.C. Engine
3. Rocket And Jet Propulsion
4. Air conditioning System Design

SEMESTER – I I I

Sr. no.	Subjects	Internal Assessment
1	Seminar on Thrust areas	50
2	Dissertation Seminar	50
	TOTAL	100

SEMESTER – I V

Sr. no.	Subjects	Internal Assessment
1	Pre Synopsis dissertation seminar	50
2	Dissertation and Viva Voce	50
	TOTAL	100

ME-101: THERMAL ENGG.		SEMESTER – I	
SUBJECT: ADVANCED THERMODYNAMICS			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

BASIC CONCEPTS: First and Second law of thermodynamics, Entropy, Reversible work, Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-State Control Volume.

THERMODYNAMIC PROPERTY RELATIONS: Maxwell relations, Generalised relations for changes in Entropy, Internal Energy, Enthalpy, Cp and Cv. Clausius Clayperon Equation, Joule-Thomson Coefficient,

REACTIVE SYSTEM: Degree of reaction, Reaction equilibrium, Equilibrium constant, Law of mass action, Heat of reaction, Heat of formation, Effect of temperature on heat of reaction and equilibrium constant. First Law analysis of reacting systems, Adiabatic Flame temparture, Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion for reaction equilibrium composition, Chemical Availabilty, Availability of reacting systems.

STASTICAL THERMODYNAMICS: Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Partition function, Calculation of the Macroscopic properties from partition functions, Equilibrium constant statistical thermodynamic approach.

References:

1. Kenneth Wark Jr.,Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 1995.
2. Bejan, A., Advanced EngineeringThermodynamics, John Wiley and Sons, 1988.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc.,1988.
4. Smith, J.M. and Van Ness., H.C., Introduction to Chemical Engineering Thermodynamics, Fourth Edition, McGraw-Hill Inc.,1987.
5. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical and Statistical, Third Edition, John Wiley and Sons, 1991.
6. Sears, F.W.and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third edition, Narosa Publishing House,New Delhi, 1993.
7. DeHotf,R.T. Thermodynamics in Materials Science, McGraw-Hill Inc.,1993.
8. Rao,Y.V.C., Postulational and Statistical Thermodynamics, Allied Publisher Limited,New Delhi,1994.

ME 102: THERMAL ENGINEERING		SEMESTER – I	
SUBJECT: ADVANCED HEAT AND MASS TRANSFER			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

CONDUCTION AND RADIATION HEAT TRANSFER: One dimensional energy equations and boundary condition, three dimensional heat conduction equations, Extended surface heat transfer, Conduction with moving boundaries, Porous-media heat transfer, Radiation in gases and vapor.

TURBULENT FORCED CONVECTIVE HEAT TRANSFER: Momentum and Energy Equations, Turbulent Boundary Layer Heat Transfer, Mixing length concept, Turbulence Analogy between Heat and Momentum Transfer - Reynolds, Colburn, Von Karman, Turbulent flow in a Tube

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER: Boiling - pool and flow boiling, Heat exchanger, E-NTU approach and design procedure, compact heat exchangers.

NUMERICAL METHODS IN HEAT TRANSFER:Finite difference formulation of steady and transient heat condition problems - Discretization schemes - Explicit, Crank Nicolson and Fully implicit schemes, Control volume formulation, Steady one dimensional convection problems, Calculation of the flow field - SIMPLER Algorithm.

References:

1. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons,
2. Eckert. E.R.G., and Drake.R.M., Analysis of Heat and Mass Transfer,McGraw Hill Co., 1980.
3. Ozisik. M.N., Heat Transfer - Basic Approach, McGraw-Hill Co., 1985.
4. Bejan. A., Convection Heat Transfer, John Wiley and Sons, 1984.
5. Rohsenow. W.M., Harnett. J.P., and Ganic. E.N., Handbook of Heat Transfer Applications, McGraw-Hill, NY1985.
6. Patankar. S.V. Numerical heat Transfer and Fluid flow, Hemisphere Publishing Corporation, 1980.
7. Carnahan.B., Luther.H.A., and Wilkes, J.O., Applied Numerical Methods, Wiley and Sons, 1976.

ME-103: THERMAL ENGG.		SEMESTER – I	
SUBJECT: INSTRUMENTATION IN THERMAL ENGINEERING			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

MEASUREMENT CHARACTERSTICS & ANALYSIS: Instrument classification, Characteristics of Instruments - Static and dynamic, experimental error analysis, systematic and random errors, Statistical analysis, Uncentainity, Experimental planning and selection of measuring instruments, Reliability of instruments. Review of basic measurement techniques.

MICROPROCESSORS AND COMPUTERS IN MEASUREMENT: Data logging and acquisition, use of intelligent instruments for error reduction, element of micro-computer interfacing, intelligent instruments in use.

MEASUREMENT OF PHYSICAL QUANTITIES: Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of intelligent instruments for the physical variables. Techniques, shadow graph, Schlieren, interferometer, Laser Doppler anemometer, heat flux measurement, Telemetry in engines. Chemical, thermal, magnetic and optical gas analysers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH,

References:

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988.
2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky, V., Measurements and Instrumentation in Heat Engineering, Vol.1 and 2, MIR Publishers,1980.
4. Raman, C.S., Sharma, G.R., Mani, V.S.V., Instumentation Dervices and systems, Tata McGraw Hill, NewDelhi, 1983.
5. Doeblin, Measurements System Application and Design, McGraw Hill, 1978.
6. Morris. A.S, Principles of Measurements and Instrumentation, Prentice Hall of India, 1998.

ME 104: THERMAL ENGINEERING		SEMESTER – I	
SUBJECT: COMPUTATIONAL FLUID DYNAMICS			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

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

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

INCOMPRESSIBLE FLUID FLOW :Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.

CONVECTION HEAT TRANSFER AND FEM: Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection - Diffusion, Unsteady two-dimensional convection - Diffusion - Introduction to finite element method - Solution of
steady heat conduction by FEM - Incompressible flow - Simulation by FEM.

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

References:

1. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House ,New Delhi1995.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation
4. Taylor, C and Hughes J.B.,Finite Element Programming of the Navier Stock Equation, Pineridge Press Ltd.,U.K.1981.
5. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer,Hemishphere Publishing Corporation, New York, USA, 1984.
6. Fletcher, C.A.J.,"Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag,1987.
7. Flectcher, C.A.J., "Computational Techniques for Different Flow Categories, Springer-Verlage
8. Bose,T.K.,"Numerical Fluid Dynamics" Narosa Publishing House, 1997.

ME 105: THERMAL ENGINEERING		SEMESTER – I	
SUBJECT: GAS TURBINE (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

INTRODUCTION: Power plant cycles for stationary and aerospace applications, component behaviours, analysis of ramjet, turbojet and turbo-propeller. Inlets and nozzels.

COMPRESSORS: Centrifugal and axial flow compressors momentum and energy transfer in rotors, velocity diagrams, stage performance, compressibility effects, cascade testing and characteristics. Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics.

AXIAL AND RADIAL FLOW TURBINE: Elementary theory, blade profile, pitch and chord, cooling, performance

COMBUSTORS: Combustion system, combustion process, performance.

PERFOMANCE PREDICTION: Off design operation and improving part load performance.

References:

1. Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd, 1989.

2. Gordon C, Dates, Aero-thermodynamics of Gas Turbine and Rocket Propulsion AIAA Education Series, NY1984.

3. Kerrebrock, J.L., Aircraft Engines and gas turbines, The MIT Press.

4. Yahya, S.H. Turbines, compressors and Fans, Tata McGraw-Hill, 1983.

5. Earl Logan, Jr., Handbook of Turbomachinery, Marcel Dekker, Inc., USA, 1992.

6. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, Pergamon Press, 1978.

7. Ganesan, V., Gas Turbines, Tata McGraw-Hill Pub.Co.Ltd., New Delhi, 1999.

ME 106: THERMAL ENGINEERING		SEMESTER – I	
SUBJECT: SOLAR ENERGY AND WIND ENERGY (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

SOLAR RADIATION: Availability - Measurement and Estimation.

MODELING OF SOLAR THERMAL SYSTEMS AND SIMULATIONS IN PROCESS : Isotropic and an Isotropic Models – Introduction to Solar Collectors (Liquid Flat - Plate Collector, Air Heater and Concentrating Collector) and Thermal Storage - Steady State Transient Analysis - Solar Pond - Solar Refrigeration. DESIGN - Design of Active Systems by f-chart and Utility Methods - Water Heating Systems - Active and Passive - Passive Heating and Cooling of Buildings - Solar Distillation - Solar Drying.

PHOTOVOLTAIC SOLAR CELL: P:N Junction - Metal - Schottky Junction, Electrolyte - Semiconductor Junction, Types of Solar Cells - their Applications - Experimental Techniques to determine the Characteristics of Solar Cells - Photovoltaic Hybrid Systems Photovoltaic
Thermal Systems – Storage Battery - Solar Array and their Characteristics Evaluation - Solar Chargeable Battery.

WIND: Its Structure - Statistics - Measurements and Data Presentation

WIND ENERGY CONVERSION SYSTEM (WECS): Wind Turbine Aerodynamics - Momentum Theories - Basics Aerodynamics - Airfoils and their Characteristics - HAWT - Blade Element Theory - Prandtl's Lifting Line Theory (prescribed wake analysis) - VAWT Aerodynamics - Wind Turbine Loads - Aerodynamic Loads in Steady Operation - Wind Turbulence - Yawed Operation and Tower Shadow. Siting - Rotor Selection - Annual Energy Output - Horizontal Axis Wind Turbine (HAWT) Vertical Axis Wind Turbine - Rotor Design Considertions - Number of Blades – Blade Profile -2/3 Blades and Teetering - Coning - Upwind/Downwind - Power Regulation - Yaw System - Tower - Synchronous and Asynchronous Generators and Loads – Integration of Wind Enengy Converters to Electrical Networks - Inverters - Testing of WECS - WECS Control System - Requirements and Startegies - Miscellaneous Topics - Noise etc - Other Applications.

Refernece books:

1. L.L.Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
2. D.A.Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering ASME Press.
3. S.P.Sukhatme-Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill
4. J.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley (1991).
5. J.F.Kreider and F.Kreith-Solar Energy Handbook McGraw-Hill (1981).

ME 107: THERMAL ENGINEERING		SEMESTER – I	
SUBJECT: REFRIGERATION SYSTEMS DESIGN (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

REFRIGERATION CYCLES: Analysis. Multi-pressure Systems, Cascade Systems.

REFRIGERANTS: Classification of Refrigerants, Refrigerant Properties, Oil Compatibility, Blends, Eco Friendly Refrigerants.

SYSTEM COMPONENTS: Refrigeration Compressors, Different Types, Performance, Capacity Control - Evaporators, Evaporator Circuitry, Applications and Different Types - Condensers, Types, Evaporative Condenser, Optimum Cooling Water Rate and Velocity, Cooling Towers, Range and Approach, Air Washers, Spray Ponds, Natural and Induced Draught System-Expansion Devices. Testing of Condensers and Evaporators electrical components & controls: starting and running circuits, relay types and controls.

REFRIGERATION TECHNOLOGIES OF FOOD PRODUCTS: Food Processing Techniques, Optimum Cold Storage Conditions, Standard Norms for Processing, Plant Layout, Preservation of Milk, Butter, Fruits, Vegetables, Meat Products etc. Freeze Drying Principles, Techniques and Equipments, Refrigerated Transportation Testing of Cold Storages - Code of Practice for Fire Safety in General

SYSTEM BALANCING & CONTROLS: Estimation of Cooling Load, system Equilibrium and Cycling Controls

UNCONVENTIONAL REFRIGERATION CYCLES: Vapor Absorption Systems - Aqua Ammonia & LiBr Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration.

References:

1. Dossat R.J., Principles of refrigeration, John Wiley, 1984.
2. W.F. Stoecker, Refrigeration and Air conditioning, McGraw Hill Book Company, 1985.
3. Jordan and Priester, Refrigeration and Air conditioning, 1985.
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langley, Billy C., 'Solid state electronic controls for HVACR' pentice-Hall 1989.
6. Ibrahim Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub. 1997.
7. Stanley E. Charm, Fundamentals of Food engineering III Ed.AVI Pub.Company Inc. 1989.
8. Clive V.I.Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub.New York 1991.

ME 108: THERMAL ENGINEERING		SEMESTER – I	
SUBJECT: ENERGY CONSERVATION & MANAGEMENT(Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

INTRODUCTION: Energy Scenario - Principles and Impeartives of Energy Conservation - Energy Consumption Pattern – Resource Availability - Role of Energy Managers in Industries

ENERGY AUDITIING: Purpose, Methodology with respect to process Industries - Power plants, Boilers etc., Characteristic method Employed in Certain Energy Intensive Industries - Various Energy Conservation Measures in Steam System - Losses in Boiler, Methodology of Upgrading Boiler Performance Energy conservation in pumps, Fans & Compressors, Air conditioning and refrigeration systems, Steam Traps-Types, Function, Necessity

TOTAL ENERGY SYSTEMS - Concept of Total Energy - Advantages & Limitations - Total Energy system & Application - Various Possible Schemes

ROLE OF INSTRUMENTATION IN ENERGY CONSERVATION: Employing Steam Turbines Movers Used in Total Energy Systems, Potential & Economics of Total Energy Systems

ELECTRICAL ENERGY AUDITING: Potential Areas for Electrical Energy Conservation in Various Industries-Energy Management Opportunities in Electrical Heating, Lighting system, Cable selection - Energy Efficient Motors - Factors involved in determination of Motor EfficiencyAdjustable AC Drives, Applications & its use variable speed Drives/Belt Drives

ENERGY MANAGEMENT: Importance of Energy Management, Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing

References:

1. CB Smith, Enegy Management Principles, Pergamon Press, NewYork, 1981
2. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington, 1980
3. Trivedi, PR, Jolka KR, Energy Managemnent, Commonwealth Publication, NewDelhi, 1997
4. Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington,1988
5. Diamant, RME, Total Energy, Pergamon, Oxford, 1970.

ME-201: THERMAL ENGG.		SEMESTER – II	
SUBJECT: DESIGN OF HEAT EXCHANGER			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

CONSTRUCTIONAL DETAILS:

Types - Shell and Tube Heat Exchangers - Regenerators and Recuperators - Industrial Applications

HEAT TRANSFER: Temperature Distribution and its Implications - LMTD - Effectiveness

FLOW DISTRIBUTION AND STRESS ANALYSIS:

Effect of Turbulence - Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater sheets and Pressure Vessels –Thermal Stresses - Shear Stresses - Types of Failures

DESIGN ASPECTS:

Heat Transfer and Pressure Loss - Flow Configuration - Effect of Baffles - Effect of Deviations from Ideality - Design of Typical Liquid - Gas-Gas-Liquid Heat Exchangers

CONDENSORS AND EVAPORATORS DESIGN:

Design of Surface and Evaporative Condenser - Design of Shell and Tube - Plate Type Evaporators Packaging - Spray Design - Selection of Pumps - Fans and Pipes - Testing and Maintenance - Experimental

References:

1. T. Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980

2. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980

3. Arthur P. Fraas, Heat Exchanger Design, John Wiley & Sons, 1988

ME-202: THERMAL ENGG.		SEMESTER – II	
SUBJECT: FUEL AND COMBUSTION			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

INTRODUCTION

General, Conventional Energy Sources, Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy, Energy Survey of India, Rocket Fuels.

SOLID, LIQUID & GASEOUS FUELS

General, Family of Coal, Origin of Coal, Gasification of Coal, Analysis and Properties of Coal, Action of Heat on Coal, Classification of Coal, Oxidation of Coal, Hydrogenation of Coal, Efficient use of Solid Fuels.Manufactured Fuels, Agro Fuels, Solid Fuel Handling, Properties Related to Combustion, Handling Storage Origin and Classification of Petroleum, Refining and Other Conversion Processes, Composition of Petroleum with respect to Combustion, Property & Testing of Petroleum Products, Various Petroleum Products, Nature of Indian Crudes & Petroleum Refining in India, Liquid Fuels from Other Sources, Storage and Handling of Liquid Fuels, Liquid Fuels Combustion Equipment Types of Gaseous Fuels, Natural Gases, Methane from Coal Mines, Manufactured Gases, Producer Gas, Water Gas, Carburetted Water Gas, Blast Furnace Gas Fuels, Through Non-Thermal Route - Biogas, Refinery Gas, LPG, Cleaning and Purification of Gaseous Fuels.

THEORY OF COMBUSTION PROCESS

Stoichiometry and Thermodynamics, Combustion Stoichiometry General, Rapid Methods of Combustion Stoichiometry, Combustion Thermodynamics, Problem, Combustion Problems with Chemical Reactions Burners

STOICHIOMETRY

Stoichiometry Relations, Theoretical Air Required for Complete Combustion, Calculation of Minimum Amount of Air Required for a Fuel of known Composition, Calculation of Dry Flue Gases if Fuel Composition is Known, Calculation of the Composition of Fuel & Excess Air Supplied,from Exhaust Gas Analysis, Dew Point of Products, Flue Gas Analysis (O 2, CO 2, CO, NO x, SO x).

Ignition, Concept of Ignition, Auto Ignition, Ignition Temperature. Flame Propagation, Various Methods of Flame Stabilization,

BURNER DESIGN

Incorporation in Burner Design, Basic Features and Types of Solid, Liquid and Gaseous Fuel Burner, Design Consideration of Different Types of Coal - Oil and Gas Burners, Recuperative & Regenerative Burners.

References books:

1. *Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990*
2. *Bhatt ,vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984*
3. *Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988*
4. *Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966*
5. *Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984*

ME-203: THERMAL ENGG.		SEMESTER – II	
SUBJECT: CRYOGENICS			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

INTRODUCTION

Basic thermodynamics applied to liquification and refrigeration processes – isothermal, adiabetic and Joule Thompson Expansion process – adiabatic dimagnetisation. Low temperature properties of engineering materials, Properties of Cryogenic fluids.

LIQUEFACTION CYCLES:

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle.

GAS LIQUIFICATION SYSTEMS:

Helium Regrigerated Hydrogen Liquefaction Systems. Crtical components in Liquefaction Systems Binary Mixtures, T-C and H-C. Diagrams, Principle of Rectification, Rectification Column Analysis – McCabe Thiele Method. Adsorption Systems for purification.

CRYOGENIC REFRIGERATORS

J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators. Cryogenic Dewar Construction and Design, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems,

MEASUREMENT AND APPLICATIONS OF CRYOGENICS

Different Types of Vacuum Pumps, Instrumentation to measure Flow, Level and Temperature. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications. Biology and medicine.

References :

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Randall F.Barron, Cryogenic Systems, McGraw Hill, 1985.
3. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.
4. Herald Weinstock, Cryogenic Technology, 1969.

ME-204: THERMAL ENGG.		SEMESTER – II	
SUBJECT: ENVIRONMENTAL ENGINEERING AND THERMAL POLLUTION			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

AIR POLLUTION

Sources and Effect - Acid Rain - Air Sampling and Measurement - Analysis of Air Pollutants - Air Pollution Control Methods and Equipments - Issues in Air Pollution control.

SOLID WASTE MANAGEMENT

Sources and Classification - Charecteristics of solid waste-Potential methods of solid waste Disposal – Process and Equipments for Energy Recovery from Municipal Solid Waste and Industrial Solid Waste.

WATER POLLUTION

Sources and Classification of Water Pollutants - Characteristics - Waste Water Sampling Analysis - Waste Water Treatment - Monitoring compliance with Standards - Treatment, Utilization and Disposal of Sludge.

OTHER TYPES OF POLLUTION

Noise Pollution and its impact - Oil Pollution - Pesticides - Radioactivity Pollution Prevention and Control Instrumentation for pollution control - Water Pollution from Tanneries and other Industries and their control.

POLLUTION FROM POWER GENERATION

Acid precipitation, fluid gas de-sulferisation, thermal pollution, Radioactive pollution.

References:

1. Environmental Considerations in Energy Development, Asian Development Bank (ADB), Manilla(1991)
2. G.Masters (1991): Introduction to Environmental Enginering and Science, Prentice -Hall International Editions.
3. H.S.Peavy, D.R..Rowe, G.Tchobanoglous (1985):Environmental Enginering - McGraw- Hill Book Company, NewYork.
4. H.Ludwig, W.Evans (1991): Manual of Environmental Technology in Developing Countries, W.Y. Brockelman and B.N.Lohani, International Book Company, Absecon Highlands, N.J.

ME-205: THERMAL ENGG.		SEMESTER – II	
SUBJECT: ADVANCED TURBO MACHINERY (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

PRINCIPLES OF TURBO MACHINERY

Introduction to turbo machines - Transfer of energy to fluids - Performance characteristics - fan laws - Dimensionless parameters - Specific speed - selection of centrifugal, axial, mixed flow, Axial flow machines.

ANALYSIS OF CENTRIFUGAL BLOWER

Centrifugal Blowers: Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficiency, flow through impeller casing inlet nozzle. volute, diffusers, leakage disc friction mechanical losses multi-vane impellers of impulse type, cross flow fans.

ANALYSIS OF AXIAL FLOW

Axial flow fans : Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

TESTING AND CONTROL OF FANS

Fan testing, noise control, materials and components blower regulation, speed control, throttling control at discharge and inlet.

DESING AND APPLICATIONS OF BLOWERS

Special design and applications of blower, induced and forced draft fans for airconditioning plants, cooling towers, ventilation systems, booster sytems.

References:

1. *Stepanoff A.J. Turboblowers, John Wiley & sons, 1970.*
2. *Brunoeck, Fans, Pergamon Press, 1973.*
3. *Austin H. Chruch, Centrifugal pumps and blowers, John wiley and Sons, 1980.*
4. *Dixon, Fluid Mechanics, Thermodynamics of turbomachinery Pergamon Press, 1984.*
5. *Dixon. Worked examples in turbomachinery, Pergamon Press, 1984.*

ME-206: THERMAL ENGG.		SEMESTER – II	
SUBJECT: MODELING AND SIMULATION OF IC ENGINE (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

GENERAL CONSIDERATIONS OF MODELING:

Governing equations, conservation of mass, conservation of energy, second law Analysis, Numerical methodology, computing mesh, Discretisation, Grid Formation.

SPRAY MODELING:

Spray equation Models, Thin spray models, Thick Spray Models, Droplet turbulence interactions, Droplet impingement on walls.

IN-CYLINDER FLOW MODELING:

Full Field Model, K-e Model, laminar flow modeling, probability density functions, Ekman layers roll-up vortex, vortex structures. Compression generated turbulence, effective viscosity, turbulent diffusivity.

INTRODUCTION TO COMBUSTION MODELING:

Classification, zero-dimensional modeling, quasi-dimensional modeling, multidimensional modeling, comparison of different combustion systems, combustion efficiency, applications

COMBUSTION MODELS:

Multi zone Models, Kono's model, Cummins engine model, Hiroyasu's model,. Single zone models, Premixed diffusive models, Heat Transfer Cp-relations, Weibe's function analysis, Whitehouse-way model, Two zone models, Mathematical modeling of Catalytic converters, one dimensional model-2D axi-symmetric model of monolithic reactor, Computation of chemical reactions, two dimensional transient temperature field.

References :

1. J.I.Ramos "Internal Combustion Engine Modeling" Hemisphere Publishing Corporation, 1989.
2. James N.Mattavi and Charles A.Amann "Combustion Modeling in Reciprocaating Engines". Plenum Press - 1980.
3. John.B.Heywood, "Internal Combustion Engine Fundamentals" McGraw-Hill International Editions, Automotive technology Series, 1988.

4. Pkandylas,G.C.Koltsakis and A.M.Stamatelos "Mathematical Modeling of Precious Metals Catalytic Converters for Diesel Nox Reduction". Proc.Institution of Mechanical Engineers Vol. 213 Pard D.
5. Sandeep Maju, Robert I.Sager.Jr., and Benny J.Srider, "Predicting Durability" Mechanical Engineering Vol. 64, March 1999.
6. A.J.Baxendale "Computational Fluid Dynamics in Exhaust System Design and Development", SAE Paper No. 931072, 1993.

ME-207: THERMAL ENGG.		SEMESTER – II	
SUBJECT: ROCKET AND JET PROPULSION (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

THERMODYNAMICS OF AIRCRAFT JET ENGINES

Theory of Jet Propulsion - Thrust and efficiency - Ram Jet - Turbojet and Turbofan engines - Turboprop and Turboshaft Engines - Thrust augmentations - Typical engine performance - Engine - Aircraft matching.

AERO-THERMODYNAMICS OF JET PROPULSION SUBSYSTEMS

Subsonic inlets - Supersonic inlets - Gas turbine combustors - After burners and Ramjet Combustors - Supersonic Combustion - Exhaust Nozzles.

PERFORMANCE OF ROCKET VEHICLES

Static performance - Vehicle acceleration - Chemical rockets - Electrical rocket vehicles - Space missions.

CHEMICAL ROCKET PROPELLANT COMBUSTION & EXPANSION

Performance Characteristics - Nozzles - Rocket Heat Transfer - Liquid Propellant Rocket Performance. Liquid propellants - Equilibrium composition - Non equilibrium expansion - Liquid - Propellant combustion chambers - Combustion Instabilities.

References:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition,
Addition - Wesley Publishing Company, New York, 1992.
2. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons Inc, New York, 1970.
3. Zucrow N.J. Aircraft and Missile Propulsion, Vol.I and Vol.II, John Wiley and Sons Inc, New York, 1975.
4. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1985.
5. S.M. Yahya, Gas Dynamics and Jet Propulsion.

ME-208: THERMAL ENGG.		SEMESTER – II	
SUBJECT: AIR-CONDITIONING SYSTEM DESIGN (Elective)			
Periods / Week 1 Period of 1 hours	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment		50

PSYCHROMETRICS:

Introduction, Properties of air and water vapour mixture, Psychrometrics chart and its use in air-conditioning, Air and Human comfort,

DESIGN OF EQUIPMENTS:

Analysis of air conditioning load, load calculation. Equipment selection, and balancing, Piping System, Valves, Receivers, Oil Trap, Oil Regenerators, Driers and Strainers.

AIR CONDITIONING SYSTEMS:

Window Type, Package Type, Split Type, Central Units – direct and indirect, Construction Details, Specification and Testing, Evaporative cooling system

AIR DISTRIBUTION:

Air Distribution Devices - Air Circuits – Design of Air Supply System . Noise consideration

APPLICATION:

Air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and other Commercial Applications.

AIR-CONDITIONING CONTROLS:

Control System of Temperature, Pressure, Oil Flow, Compressor Motor - Protection Devices.

REFERENCES:

1. Dossat, R.J. "Principles of Refrigeration", John Wiley & Sons, 1989.

2. Hains, J.B. "Automoatic Control of Heating & Airconditioning" Mc Graw Hill, 1981.

3. Althouse, A.D. & Turnquist, C.H. "Modern Refrigeration and Airconditioning" Good Heart - Wilcox Co.Inc.,

4. Harris N.C. & Conde D.F. Modern Air-Conditioning practice, Mc Graw Hill

5. ASHRAE Hand book (Fundamentals & Equipments)

6. Cooper & Williams, B. "Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting" Eagle Wood Cliffs (NT) Prentice Hall, 1989.

SEMESTER – I I I

Sr. no.	Subjects	Internal Assessment
1	Seminar on Thrust areas	50
2	Dissertation Seminar	50
	TOTAL	100

SEMESTER – I V

Sr. no.	Subjects	Internal Assessment
1	Pre Synopsis dissertation seminar	50
2	Dissertation and Viva Voce	50
	TOTAL	100

SEMESTER – I I I

SEMINAR ON THRUST AREAS:

A student has to present a seminar on a thrust area that should contain –

- Choosing an appropriate thrust area.
- Literature survey report
- Study of fundamentals and Formulating the principles for solving of the problems.
- Basic Design
- Working out details of control mechanism required if any.
- Development of software if necessary.
- Suggestion for improvements
- Cost Analysis.

The seminar should be submitted in a booklet that is bound.

SEMESTER – I V

A project should be assigned to each student at the beginning of the Third semester either through a industry sponsorship or of academic but practical utility topic on any of the subject areas which involves the principles being studies in the above ten subjects. The project will be worked full time in the third and fourth semester for one year duration. The general scheme of working will be as follows:

- Literature survey
- Basic study of the project and formulating the principles for solving the problems.
- Preparation of workable scheme.
- Basic design preparation.
- Working out details of control mechanismrequired if any.
- Development of software if necessary.
- Fabricating the prototype model
- Testing of the model
- Suggestion for improvements
- Cost Analysis.