SunRise University

Approved by Govt. of Rajasthan vide Sunrise University Act, 2011
Recognized by UGC Act, 1956 u/s 2 (f)

COURSE SCHEME AND SYLLABUS

M. TECH.
THERMAL ENGINEERING

M. Tech.
Thermal Engineering
Teaching and Examination Scheme
1st Year – I Semester

SN	Category	Course Code	Course Title	Contact hrs/week L	T	P	Marks Exam Hrs	IA	ETE	Total	Cr
THEORY											
1	PCC	1MEMTE1-01	Advanced Thermodynamics	3	-	-	3	20	80	**100**	**3**
		1MEMTE1-02	Advanced Heat Transfer Techniques and Analysis	3	-	-	3	20	80	**100**	**3**
		1MEMTE1-03	Design of Thermal Systems	3	-	-	3	20	80	**100**	**3**
4	PEC-I	1MEMTE2-04	Steam Power Plant Analysis	3	-	-	3	20	80	**100**	**3**
		1MEMTE2-05	Combustion Techniques Analysis								
		1MEMTE2-06	Experimental Methods for Engineers								
		1MEMTE2-07	----------	-	-	-	-	-	-	-	-
5	PEC-II	1MEMTE2-08	Application Based Refrigeration and Air Conditioning System Analysis	3	-	-	3	20	80	**100**	**3**
		1MEMTE2-09	Gas Dynamics and Turbo Machines								
		1MEMTE2-10	Power Plant Economics								
		1MEMTE2-11	----------	-	-	-	-	-	-	-	-
6	OES	1MEMTE3-12	Human Values and Professional Ethics	2	-	-	3	20	80	**100**	**2**
			Sub Total	17						**600**	**17**
PRACTICAL & SESSIONAL											
7	PCC	1MEMTE1-13	Thermal Lab-I	-	-	2	-	60	40	**100**	**2**
8	FW	1MEMTE4-14	Field Work	-	-	2	-	60	40	**100**	**2**
9	AC	1MEMTE5-15	Human Values Practice School	-	-	2	-	30	20		-
			Sub- Total			6				**200**	**4**
			TOTAL OF I SEMESTER	17		6				**800**	**21**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits* ***ETE:*** *End Term Exam,* ***IA:*** *Internal Assessment*

PCC: Program Core Courses

PEC: Program Elective Courses

Electives Courses (3-4Nos.) should be relevant to the chosen specialization/branch

OES: Other Emerging Subjects: (i) Human Values and Professional Ethics
(ii) Research Methodology

It is decided common for all branches.

FW: Field Work

Student is required to work in the organization/industry concerned with his/her course.

AC: Audit Course

It is mandatory to pass the audit course. However, credit shall not be awarded

M. Tech.
Thermal Engineering
Teaching and Examination Scheme
1st Year – II Semester

SN	Category	Course Code	Course Title	Contact hrs/week L	T	P	Marks Exam Hrs	IA	ETE	Total	Cr
THEORY											
1	PCC	2MEMTE1-01	Advanced Fluid Dynamics	3	-	-	3	20	80	100	3
2		2MEMTE1-02	Design And Simulation of IC Engine	3	-	-	3	20	80	100	3
3		2MEMTE1-03	Design of Heat Exchangers	3	-	-	3	20	80	100	3
4	PEC-I	2MEMTE2-04	Cogeneration and Waste Heat Recovery Analysis	3	-	-	3	20	80	100	3
		2MEMTE2-05	Advanced Mathematical Methods in Engineering								
		2MEMTE2-06	Power Plant Integration: Theory and Analysis								
		2MEMTE2-07	----------								
5	PEC-II	2MEMTE2-08	Environmental Risk Management	3	-	-	3	20	80	100	3
		2MEMTE2-09	Hydro Power plant Analysis								
		2MEMTE2-10	Nuclear Power plant Analysis								
		2MEMTE2-11	----------								
6	OES	2MEMTE3-12	Research Methodology	2	-	-	3	20	80	100	**2**
			Sub Total	17						600	**17**
PRACTICAL & SESSIONAL											
7	PCC	2MEMTE1-13	Thermal Lab –II	-	-	2	-	60	40	100	**2**
8	FW	2MEMTE4-14	Field Work	-	-	2	-	60	40	100	**2**
			Sub- Total			4				200	**4**
			TOTAL OF II SEMESTER	17		4				800	**21**

M. Tech.
Thermal Engineering
Teaching and Examination Scheme
2nd Year – III Semester

PRACTICAL & SESSIONAL											
SN	Category	Course		Contact hrs/week			Marks				Cr
		Code	Title	L	T	P	Exam Hrs	IA	ETE	Total	
1	PSD	3MEMTE6-16	Industrial/ Field Project	-	-	28	-	360	240	**600**	**14**
2	PSD	3MEMTE6-17	Seminar	-	-	4	-	60	40	**100**	**2**
		TOTAL OF III SEMESTER				32				**700**	**16**

PSD: Industrial/Field Project, Seminar, Dissertation

M. Tech.
Thermal Engineering
Teaching and Examination Scheme
2nd Year – IVSemester

PRACTICAL & SESSIONAL											
SN	Category	Course		Contact hrs/week			Marks				Cr
		Code	Title	L	T	P	Exam Hrs	IA	ETE	Total	
1	PSD	4MEMTE6-18	Dissertation	-	-	32	-	420	280	**700**	**16**
		TOTAL OF IV SEMESTER				32				**700**	**16**

M. Tech.
Thermal Engineering
Syllabus

1MEMTE1-01: ADVANCED THERMODYNAMICS

Review of basic thermodynamic principles, entropy, availability, irreversibility, first and second law analysis of steady and unsteady systems, General thermodynamics relations, Fundamentals of partial derivatives, relations for specific heats, internal energy enthalpy and entropy, Joule – Thompson coefficient, Clapeyron equation.

Multi component systems, Review of equation of state for ideal and real gases, thermodynamic surfaces, gaseous mixtures, fugacity, ideal solutions, dilute solutions, activity, non ideal liquid solutions. Multi component phase equilibrium: Criteria of equilibrium, stability, heterogeneous equilibrium, binary vapour liquid systems, the nucleus of condensation and the behavior of stream with formation of large and small drops, Gibbs Phase rule, higher order phase transitions.

Thermodynamics of chemical reaction (combustion), internal energy and enthalpy, first law analysis and second law analysis, basic relations involving partial pressures, third law of thermodynamics, chemical equilibrium and chemical potential equilibrium constants, thermodynamics of low temperature, elementary concepts of irreversible thermodynamics.

Suggested Readings:

1. Y. Cengel, Thermodynamics, Tata McGraw Hill Co.
2. Howell, Dedcius, Fundamentals of Engineering Thermodynamics, McGraw Hill.
3. Van Wylen, Sonntag, Thermodynamics, John Wiley and Sons Inc.
4. Jones, Hawkings, Engineering Thermodynamics, John Wiley and Sons Inc., U.S.A.
5. Holman, Thermodynamics, McGraw Hill Inc.
6. V. M. Faires, Simmag, Thermodynamics, Macmillan Publishing Co. Inc.
7. Y. Y. C Rao, Postulational and Statistical Thermodynamics, Allied Publishers Inc.

1MEMTE1-02: ADVANCED HEAT TRANSFER TECHNIQUES AND ANALYSIS

Introduction to Conduction- Recapitulation: Steady and Transient conduction, Fins, Lumped parameter and semi-infinite solid approximations, Heisler and Grober charts, 3-D conduction, isotropic, orthotropic and anisotropic solids.

Analytical Methods: Mathematical formulations, analytical solutions, variation of parameters, integral method, periodic boundary conditions, Duhamels theorem and Greens function.

Introduction to Radiation- Recapitulation: Radiative properties of opaque surfaces, Intensity, emissive power, radiosity, Planck's law, Wien's displacement law, Black and Gray surfaces,

Emissivity, absorptivity, Spectral and directional variations, View factors. Enclosure with Transparent Medium: Enclosure analysis for diffuse-gray surfaces and nondiffuse, nongray surfaces, net radiation method. Enclosure with Participating Medium: Radiation in absorbing, emitting and scattering media. Absorption, scattering and extinction coefficients, Radiative transfer equation.

Combined Heat Transfer Modes: Combined mode heat transfer and method of their calculation.

Suggested Readings:

1. D. Poulikakos, Conduction Heat Transfer, Pearson College Div.
2. G Meyers, Analytical Methods in Conduction Heat Transfer, Amch.
3. N. Ozisik, Heat Conduction, John Wiley.
4. R. Siegel, J. Howell, Thermal Radiation Heat Transfer, CRC Press.
5. M. F. Modest, Radiative Heat Transfer, Elsevier.
6. E. M. Sparrow, R. D. Cess, Radiation Heat Transfer, Brooks Pub.
7. F. P. Incropera, D. P. Dewitt, Fundamental of Heat and Mass Transfer, John Wiley.

1MEMTE1-03: DESIGN OF THERMAL SYSTEMS

Introduction to engineering design, Thermal systems, Basic Considerations in design, Conceptual design, Steps in the design process, Computer-aided design of thermal systems, Material selection, Properties and characteristics for thermal systems.

Modeling of thermal systems, Types of models, Interaction between models, Mathematical modeling, physical modeling and dimensional analysis, Curve fitting, Numerical modeling and simulation, Solution procedure, Numerical model for a system, System simulation, Methods for numerical simulation.

Acceptable design of a thermal system, Design of system from different application, Economic consideration, Introduction, Calculation of interest, Worth of money as a function of time, Series of payments, Raising capital, Economic factor in design, Cost comparison, rate of return, Application to thermal systems.

Optimization in design, Basic concepts, Mathematical formulation, Optimization methods: Calculus methods, Search methods, Optimization of thermal systems, Optimization of unconstrained problems, Conversion of constrained to unconstrained, Optimization of constrained problems.

Suggested Readings:

1. Yogesh Jaluria, Design and Optimization of Thermal systems, CRC Press.
2. Kalyanmoy Deb, Optimization of Engineering Design, PHI.
3. W. F. Stoecker, Design of thermal systems, TMH Publication.

1MEMTE2-04: STEAM POWER PLANT ANALYSIS

Introduction, Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers, Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down, IBR, Boiler standards.

Piping & Insulation, Water Line, Steam line design and insulation, Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

Steam Systems, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices, Steam Based Equipment's / Systems.
Boiler Performance Assessment, Performance Test codes and procedure, Boiler Efficiency, Analysis of losses, performance evaluation of accessories, factors affecting boiler performance.

Energy Conservation and Waste Minimization, Energy conservation options in Boiler, waste minimization, methodology, economical viability of waste minimization.

Instrumentation & Control, Process instrumentation, control and monitoring, Flow, pressure and temperature measuring and controlling instruments, its selection.

Suggested Readings:

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar, A Course in Power Plant Engineering; Dhanapat Rai and Sons
3. Yunus A. Cengel and Boles, Engineering Thermodynamics,Tata McGraw-Hill Publishing Co. Ltd .
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems, Bureau of Energy Efficiency
6. J. B. Kitto, S. C. Stultz, Steam: Its Generation and Use, The Babcock and Wilcox Company.
7. P. Chatopadhyay, Boiler Operation Engineering: Questions and Answes; Tata Mc-Graw Hill Education Pvt. Ltd.

1MEMTE2-05: COMBUSTION TECHNIQUES ANALYSIS

Introduction, Heat of reaction and formation, Adiabatic flame temperature, Chemical equilibrium, Properties of equilibrium, Combustion products of air-fuel mixtures, Chemical kinetics, reaction rates, Law of mass action, Reaction order, Activation energy.
Flammability limits, SIT, Features of SI engines combustion processes, Burned and unburned mixture states, Features of CI engine combustion process, Spray structure, atomization, penetration, drop size distribution, evaporation, Ignition delay, Factors affecting delay,

Mixing controlled combustion.
Engine design variables and heat release rates, Vehicle emissions, Photochemical smog.

Formation of NO and NO_2 in SI & CI engines, Formation of CO_2, Unburned HC.

Flame quenching, Sources of HC in SI, Oxidation and emission, HC in CI engines, PM composition & Structure, Formation, growth, oxidation, adsorption & condensation. Emission regulations, regulated/unregulated pollutants, Effects of pollutants on human health, Introduction to EGR, EGR system classification, After treatment technologies, TWC, NOx, adsorber, selective catalytic reduction, formation of particulate matter, Diesel particulate filters, regeneration Measurement & test procedures, Exhaust smoke opacity meters, Bosch smoke meter, NDIR, FID, Chemi luminiescence detector, particulate matter measurement, IS codes for engine testing and pollution measurements.

Introduction to MPFI, Gasoline direct injection, Key technical features, HCCI combustion. Lubricating oils, properties, additives, engine friction & wear, lubricating oil tribology.

Suggested Readings:

1. D. P. Mishra, Fundamentals of Combustion, Prentice Hall of India
2. Samir Sarkar, Fuels and Combustion, CRC Press
3. S. P. Sharma and Chandra Mohan, Fuels and combustion, Tata McGraw –Hill
4. A. Murthy Kanury, Gordon, Breach, Introduction to combustion phenomena.
5. Kenneth K. Kuo, Principles of combustion, Wiley India Pvt. Ltd.
6. John B. Haywood, Internal Combustion Engine Fundamentals, Tata McGraw-Hill

1MEMTE2-06: EXPERIMENTAL METHODS FOR ENGINEERS

Instrument Classification, Characteristics of Instruments – Static and dynamic, Experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments. Data logging and acquisition, Use of intelligent instrument for error reduction, Elements of micro-computer interfacing, Intelligent instruments in use.

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 analyzers, Measurement of smoke, dust and moisture, Gas Chromatography, Spectrometry, Measurement of pH, Review of basic measurement techniques.

Suggested Readings:

1. J.P. Holman, Experimental methods for Engineers, McGraw-Hill.
2. Barney, Intelligent Instrumentation, Prentice Hall of India.
3. V. Prebrashensky, Measurement and Instrumentation in Heat Engineering, Vol.1.

4. C. S. Raman, G R Sharma, V .S V. Mani, Instrumentation Devices and Systems, Tata McGraw-Hill.
5. Doeblin, Measurement System Application and Design, McGraw-Hill.
6. A. S. Morris, Principles of Measurements and Instrumentation Prentice Hall of India.

1MEMTE2-08: APPLICATION BASED REFRIGERATION AND AIR CONDITIONING SYSTEM ANALYSIS

Introduction, Environmental impact of refrigerants, Analysis of VCR cycles, multistage, multi evaporator, cascade systems, supercritical and other advanced cycles.

Properties and selection of pure and mixed refrigerants, Properties of binary mixtures, Analysis of vapor absorption cycles, aqua-ammonia and Li-Br water cycles.

Air cycle refrigeration, vortex tube, steam jet ejector refrigeration, thermoelectric refrigeration, cryogenics, desiccant, cooling-solid and liquid systems, hybrid systems, heat pumps and heat transformers.

Suggested Readings:

1. R.J. Dossat, Principles of refrigeration, John Wiley, S.I. Version.
2. W.F. Stoecker, Refrigeration and Air conditioning, McGraw-Hill Book Company.
3. Jordan, Priester, Refrigeration and Air conditioning, Prentice-Hall.
4. W.B. Goshnay, Principles and Refrigeration, Cambridge University Press.
5. Langley C. Billy, Solid state electronic controls for HVACR, Prentice-Hall.

1MEMTE2-09: GAS DYNAMICS AND TURBO MACHINES

Deformation and the rate of strain, the deformation tensor, skew-symmetry of the deformation tensor, symmetry of the stress tensor, polar and non-polar fluids, stokesian and Newtonian fluids, Derivation of the general differential equations of continuity, momentum and energy in vector form, Euler and Navier-Stokes equations, integration of the momentum equation, the generalized Bernoulli's equation.

Exact solution, plane Poiselie and Couette flows, Hagen Poiselle flow through pipes. Flows with very small Reynolds number, Flows with very large Reynolds number, elements of two dimensional boundary layer theory, displacement thickness and momentum thickness, skin friction, Blassius solution for boundary layer on a flat plate without pressure gradient, the Karman-Polhausen integral method for obtaining approximate solutions.

Drag on bodies, form drag and skin friction drag profile drag and its measurement.
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.

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, multivane impellers, of impulse type, cross flow fans.

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. Special design and application of blowers induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

Suggested Readings:

1. A. J. Stepanoff, Turboblowers, John Wiley & Sons.
2. Brunoeck, Fans, Pergamon Press.
3. H. Austin. Church, Centrifugal pumps and blowers, John Wiley and Sons.
4. Dixon, Fluid Mechanics, Thermodynamics of turbo machinery Pergamon Press.
5. Dixon, Worked examples in turbo machinery, Pergamon Press.
6. F.M. White. Fluid mechanics, McGraw Hill
7. Som, Biswas, Fluid mechanics: Tata McGraw Hill.
8. P.K. Kundu, Ira M. Cohen, Fluid mechanics, Elsevier.
9. G. K. Batchelor, Fluid mechanics, Cambridge Mathematical Library.

1MEMTE2-10: POWER PLANT ECONOMICS

Power Station Layout and Siting: Planning for new power station, site selection and investigation, site layout. Power Station Design and Layout: Concept, station layout, T.G. systems, boiler systems, cooling water plant, coal handling, ash and dust handling, gas congregation and storage gas turbine plant, Fundamental of Energy conservation, Energy Management and Audit, Basics of Energy Demand and Supply.

Principles of Economic analysis in the Energy Management and Audit Programme, Supply side and demand side Energy Management, Boilers and Firing System, Steam, Condensation Systems, Energy Conservation and management in power plant, Energy Conservation in Building, Heating, Ventilation and Air Conditioning System, Energy Conversation opportunities in Chemical Industries. Waste heat recovery, Co-generation, Energy Conservation in Agricultural Sector, Energy Conservation in Illumination Engineering, Combustion stochiometry, air-fuel ratio, optimum loading in boilers etc.

Optimization techniques, efficiency analysis, methods for conservation of manpower, fuel and energy, Energy monitoring and targeting, information dissemination in term of energy consumption, production and cumulative sum of differences.
Details of Energy Management programme in industrial sector, Domestic sector, Agricultural and Transport sectors, Evaluation of heat loss and heat gain in buildings systems, thermal design building systems, evaluation of window and glazing, solar simulation of building systems Methods for improving thermal equality, estimation of energy loss in electrical utilities, electrical load management, preparation of project report on Energy Management and Audit.

Suggested Readings:

1. Wayne C. Turner, Energy Management Handbook, Fairmont Press
2. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, Guide to Energy Management, Fairmont Press
3. Wyne c. turner, Energy management handbook, C.H.I.P.S.
4. Tom W. Berrie, Electricity Economics and Planning, IEE power series, Barnes & Noble.

1MEMTE3-12: HUMAN VALUES AND PROFESSIONAL ETHICS

Need, Basic Guidelines, Content and Process For Value Education:
Understanding the need, basic guidelines, Self Exploration - its content and process; 'Natural Acceptance' and Experiential Validation, Continuous Happiness and Prosperity- Human Aspirations, Right understanding, Relationship and Physical Facilities, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

Understanding Harmony in the Human Being - Harmony in Myself:
Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha Understanding the Body as an instrument of 'I', Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship:
Understanding harmony in the Family, Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) , meaning of Vishwas; Difference between intention and competence, meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, harmony in the society , Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals ,Visualizing a universal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family.

Understanding Harmony in the Nature and Existence - Whole Existence as Coexistence:
Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all pervasive Space, Holistic perception of harmony at all levels of existence

Implications of the Above Holistic Understanding of Harmony on Professional Ethics Natural Acceptance of Human Values:

Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models. Strategy for transition from the present state to Universal Human Order: At the level of individual: as socially and ecologically responsible engineers, technologists and managers. Case studies related to values in professional life and individual life.

Suggested Readings:

1. R. R. Gaur, R Sangal, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, Excel Books
2. R. Subramanian, Professional Ethics includes Human Values, Oxford Univ. Press.
3. A. N. Tripathy, Human Values, New Age International Publishers.
4. M. Govindrajran, S Natrajan, V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
5. B. P. Banerjee, Foundations of Ethics and Management, Excel Books.
6. B. L. Bajpai, Indian Ethos and Modern Management, New Royal Book Co.

1MEMTE1-13: THERMAL LAB-I

Practicals:-

1. Performance test on Spark Ignition engines.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance test on variable compression ratio petrol and diesel engines.
4. Performance study in a cooling tower
5. Performance study in a refrigeration and heat pump systems
6. Performance Study in a solar water heater
7. Properties of fuel oils, biomass, biogas
8. Solar Radiation measurement
9. Boiler efficiency testing
10. Performance of Heat Exchangers
11. Study on Fuel Cell Systems
12. Study on Thermal Storage Systems

1MEMTE4-14: FIELD WORK

Student is required to work in the organization/industry concerned with his/her course.

1MEMTE5-15: HUMAN VALUES PRACTICE SCHOOL

This practice school in first semester will have two parts -

I. Industry Interaction

In this, students will start his industry interaction in the very first semester of the M.Tech. Course. He/ She has to visit an organization for 3 hours /week in any industry finalized/selected by competent authority. This interaction will give him feel and insight to the real time working.

A. This 3 hours /work will be after the classroom studies

B. Selection criteria of organization:
   1. Have turnover more than 20 lakhs
   2. Have more than 20 employees

C. During these hours, student will observe following points in the organisation:
   1. Organisational structure and hierarchy
   2. Different kind of jobs/works done by the employees at all levels in the company
   3. Working of different departments
   4. Types of skills require to work in an organisation
   5. Ways of internal and external communication
   6. Formal dressing and attitude
   7. Coordination and team work

II. Social Responsibility

To make students understand his role and responsibility in society & nature and co-existence as whole, student has to take an initiative towards contribution in any relevant social and environmental issue.

A. This work will be performed after the time of regular classes

B. Student will perform one or more of the following activities after the approval of mentor and HOD:
   1. Making contribution in increasing the income of any street vender or any needy person from under privileged section
   2. Cleanliness Campaign
   3. Donation of his/her belongings which is of no use to him/her to needy ones
   4. Plantation and care for nature (soil, natural resources, plants and animals)
   5. Girl child and women safety, education and empowerment.
   6. Blood donations and help of needy people at hospitals
   7. Helping the under – privileged section of the society
   8. Educating the street children or in schools when and where needed.
   9. Nukkad Natak on any topic of social or environmental concern.
   10. Any other relevant activities.

2MEMTE1-01: ADVANCED FLUID DYNAMICS

Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities.

Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel, Couette flow, creeping flows.

Potential Flow: Kelvin's theorem, Irrotational flow, Stream function-vorticity approach, Laminar Boundary layers: Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations.

Turbulent Flow: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution.

Experimental Techniques: Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry.

Suggested Readings:

1. Muralidhar Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International.
2. Irwin Shames, Mechanics of Fluids, McGraw Hill.
3. R.W. Fox, A. T. McDonald, Introduction to Fluid Mechanics, John Wiley and Sons Inc.
4. Piyush K. Kundu, Ira M Kohen, David R. Dawaling, Fluid Mechanics, Academic Press.

2MEMTE1-02: DESIGN AND SIMULATION OF IC ENGINE

Fundamentals: Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

Thermodynamic Combustion Models of CI Engines: Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.

Fuel spray behavior: Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls, Modeling of charging system, Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.

Mathematical models of SI Engines: Simulation of Otto cycle at full throttle, part throttles and supercharged conditions. Progressive combustion, Auto ignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines.

Suggested Readings:

1. John Haywood, I.C. Engines Fundamentals, McGraw Hill.
2. J. Ramos, Internal Combustion Engine Modeling**,** Hemisphere Publishing Company.
3. V. Ganeshan, Internal Combustion Engines, Tata McGraw Hill.
4. P.A. Lakshminarayanan, Y. V. Aghav, Modelling Diesel Combustion Springer.
5. Bernard Challen, Rodica Baranescu, Diesel Engine Reference Book Butterworth-Heinemann.

2MEMTE1-03: DESIGN OF HEAT EXCHANGERS

Classification of heat exchangers: Introduction, Recuperation & regeneration, Tabular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tabular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow, Multi pass. Cross flow heat exchanger design calculations: Double pipe heat exchanger: Film coefficient for fluids in annulus, fouling factors, calorific temperature, Average fluid temperature, the calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements. Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers.

Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1 -2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

Condensation of single vapours: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser Subcooler, Vertical reflux type condenser, Condensation of steam.

Vaporizers, evaporators and reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of reboiler.

Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.

Direct contact heat exchanger: Cooling towers, relation between wet bulb &dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

Suggested Readings:

1. D. Q. Kern, Process Heat Transfer, Tata Mc-Graw Hill.
2. A.P. Fraas, M.N.Ozisic, Heat Exchanger Design, John Wiley & Sons, New York.
3. J.D. Gurney, I.A. Cotter, Cooling Towers, London, Maclaren.

2MEMTE2-04: COGENERATION AND WASTE HEAT RECOVERY ANALYSIS

Introduction - Principles of Thermodynamic Cycles, Topping, Bottoming, combined cycle, Organic Rankine Cycles, Performance indices of cogeneration systems, Waste heat recovery, sources and types, Concept of tri generation.

Configuration and thermodynamic performance, Steam turbine cogeneration systems, Gas turbine cogeneration systems, Reciprocating IC engines cogeneration systems, Combined cycles cogeneration systems, advanced cogeneration systems, fuel cell, Stirling Engines.

Cogeneration plants electrical interconnection issues – Utility and cogeneration plant interconnection issues, Applications of Cogeneration in utility sector, Industrial sector, building sector, rural sector, Impacts of cogeneration plants, fuel, electricity and environment Selection criteria for waste heat recovery technologies, Recuperators, Regenerators, Economizers, Plate Heat Exchangers, Thermic fluid heaters, Waste Heat Boilers-Classification, Location, Service Conditions, Design Considerations - Fluidized bed heat exchangers, Heat pipe exchangers, Heat pumps, Absorption systems.

Investment cost – Economic concepts, Measures of economic performance, Procedure for economic analysis, Examples, Procedure for optimized system selection and design, Load curves, Sensitivity analysis, Regulatory and financial frame work for cogeneration and waste heat recovery systems.

Suggested Readings:

1. J. H. Horlock, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers.
3. Charles H. Butler, Cogeneration, McGraw Hill Book Co.
4. EDUCOGEN – The European Educational tool for cogeneration

2MEMTE2-05: ADVANCED MATHEMATICAL METHODS IN ENGINEERING

Ordinary Differential Equations: First-order equations (Linear, Equi- dimensional, Separable Exact, Homogeneous,); Second-order linear differential equations (homogeneous and non homogeneous); Solution methods such as un-determined coefficients and variation of parameters.

Partial Differential Equations: First order partial differential equations, Second order linear partial differential equations, Canonical forms; Fourier series, Second order equation (Parabolic, Elliptic and Hyperbolic) in rectangular, cylindrical polar and spherical coordinate systems; Solution techniques such as separation of variables, eigen function expansions, integral transforms (Fourier and Laplace transforms), D' Alembert's solution for the Wave equation; Maximum principle for Elliptic equations, Variation methods for approximate solutions of differential equations.

Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance.
ANOVA: One–way, Two–way with/without interactions, Latin Squares ANOVA technique, Principles of Design of Experiments, some standard designs such as CRD, RBD, LSD.

Suggested Readings:

1. J.B. Doshi, Differential Equations for Scientists and Engineers, Narosa.
2. Peter O'Neil, Advanced Engineering Mathematics, Seventh Edition, Cengage Learning, (Indian Edition).
3. Michael Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education.
4. A. Jennings, Matrix Computation for Engineers and Scientists. John Wiley and Sons.
5. Prem K Kythe, Pratap Puri, Michael R. Schafer kotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press.
6. Kreyszig, I.S. Erwin, Advanced Engineering Mathematics, Wiley.
7. V. Ramamurthy, Computer Aided Design in Mechanical Engineering, Tata McGraw Hill Publishing Co.
8. C R Hicks, K V Turner, Fundamental Concepts in the Design of Experiments, Oxford University Press;
9. Jay L Devore, Probability and Statistics for Engineering and the Sciences, Brooks-Cole.

2MEMTE2-06: POWER PLANT INTEGRATION: THEORY AND ANALYSIS

Power Station Layout and Siting: Planning for new power station, site selection and investigation, site layout.

Power Station Design and Layout: Concept, station layout, T.G. systems, boiler systems, cooling water plant, coal handling, ash and dust handling, gas congregation and storage gas turbine plant.

Turbine Generator and Auxiliaries: Schemes, turbine blading, casing, rotors, vibration and couplings, bearings pedestals, turning gears, lubrication system, jacking oil system, gland sealing, flange heating, LP exhaust cooling system, drain system, by pass system.

Feed Water Heating System: HP feed heating, deaerator system; LP feed heating, auxiliary steam system.
Condenser: On load cleaning, different pumps, cooling towers.
Instrumentation and Control: TG instruments, controls, boiler following turbine and turbine

following boiler.

Operation and Maintenance of TG: Start up and shut down procedure, start up curves, maintenance of TG and axillaries, safety and fire protection, Performance of TG, condenser, feed water heater, cooling tower and pumps.

Piping: Fundamentals, pipeline sizing and specialties, piping layout engineering, piping analysis, pipe supports, thermal insulation.

Economic Analysis of Power Plants and Tariffs: The cost of electrical energy calculation.

Suggested Readings:

1. E. BEIL Modern Power Station Practice - Vol A, Pergramon press
2. M. M. El Wakil : Power Plant Engineering, Tata Mc-Graw hill.

2MEMTE2-08: ENVIRONMENTAL RISK MANAGEMENT

Energy sources: Introduction to nexus between Energy, Environment and Sustainable Development, Energy transformation from source to services, Energy sources, sun as the source of energy, biological processes; photosynthesis, food chains, classification of energy sources, quality and concentration of energy sources, fossil fuel reserves - estimates, duration, theory of renewability, renewable resources; overview of global/ India's energy scenario.

Ecological Principles: Ecological principles, concept of ecosystems, ecosystem theories, energy resources and their inter-linkages, energy flow, the impacts of human activities on energy flow in major man-made ecosystems- agricultural, industrial and urban ecosystems.

Energy Systems and Environment: Environmental effects of energy extraction, conversion and use, sources of pollution from energy technologies (both renewable and non renewable), primary and secondary pollutants; consequence of pollution and population growth; air, water, soil, thermal, noise pollution -cause and effect; pollution control methods, sources and impacts; environmental laws on pollution control. Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Reducing Emissions from Deforestation and Degradation (REDD).

Green Innovation & Sustainability: Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends–process/product innovation, technological/ environmental leap-frogging, Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity-WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies), design for sustainability (D4S).

Green Energy and Sustainable Development: The inseparable linkages of life supporting systems, biodiversity and ecosystem services and their implications for sustainable development; global warming; greenhouse gas emissions, impacts, mitigation and adaptation, future energy Systems- clean/green energy technologies, International agreements/conventions on energy and sustainability-United Nations Framework Convention on Climate Change (UNFCC), sustainable development.

Suggested Readings:

1. Anne V. Whyte, Ian Burton, Environmental Risk Assessment, SCOPE, John Wiley.
2. Loulou, Richard, Waaub, Jean-Philippe;Energy and Environment Set: Mathematics of Decision Making, Zaccour, Georges (Eds.).
3. A. Kraushaar, J. Jack, A Kraushaar, P Jack Ristinen, A Robert, Energy and Environment, Wiley.
4. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N. York.

2MEMTE2-09: HYDRO POWER PLANT ANALYSIS

Overview of Hydropower systems-Preliminary Investigation, Determination of Requirements-preparation of Reports and Estimates-Review of World Resources, Cost of Hydroelectric Power, Basic Factors in Economic Analysis of Hydropower projects, Project Feasibility-Load Prediction and Planned Development.

Advances in Planning, Design and Construction of Hydroelectric Power Stations, Trends in Development of Generating Plant and Machinery, Plant Equipment for pumped Storage Schemes, Some aspects of Management and Operations-Updating and Refurbishing of Turbines.

Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability, Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future.

Problem of management-Maintenance of Civil Engineering works-Maintenance of Electrical Engineering works.

Computer Aided Hydropower System Analysis-Design, Execution, Testing, Operation and control of Monitoring of Hydropower Services.

Suggested Readings:

1. Small Hydro Power Potential in India, Central Electricity Authority, New Delhi.
2. A.W. Culp, Principles of Energy Conversion, McGraw- Hill
3. P. K. Nag, Power Plant Engineering, Tata McGraw- Hill
4. R. K. Rajput, Power Plant Engineering, Lakshmi Publications
5. P. C. Sharma, Power Plant Engineering, Koataria Publications.
6. M. M. El Wakil, Power Plant Engineering, Tata Mc-Graw Hill.

2MEMTE2-10: NUCLEAR POWER PLANT ANALYSIS

General Properties of Nuclei (Binding Energy, Statistics, Mass Formula, etc.), Nuclear Structure (Free Fermi Gas Model, Shell Models, Collective Models) , Nuclear Reactions (Formal Theory, Optical Model, Direct Reactions, Compound Nuclear Reactions, Statistical Model)

Neutron Physics of Fission and Fusion Reaction, Neutron Transport, Multi group Diffusion Theory, Nuclear Reactor Kinetics, Nuclear Reactor Core Design, Fuel Burn up, Fusion Reactions and Reactors Tritium Breading for Fusion Reactors, Evaluation will be by homework exercise, and final examination.

Radioactive Disintegration and Transmutation, Physical and Chemical Effects of Radiation on Atoms and Molecules, Radiation Detection and Application, Industrial Use of Radiation Instruments, Application of Particle Accelerators, Isotope Effects and Isotope Separation, Chemistry of Actinides.

Principles of Nuclear Reactor Design, Light Water Reactor Power Plant, Fast Breeder Reactor Plant

Fundamentals of Fusion Reactors, Fusion Reactor Design, Components of LWR, HWR, LMFBR reactors and material selection

Radiation Damage of Materials, Physical and Chemical Properties of U, UO_2, and PuO_2, Fabrication Process of Nuclear Fuels, Fission and Fusion Reactor Materials.

Safety Characteristics of LWR and FBR, Safety Culture, Nuclear Reactor Accidents. Safety Improvements and Advanced Nuclear Reactors, Effects of Fossil Fuel Burning on the Global Environment, General Aspects of Energy and Environmental Problems, Advanced Energy Conversion Technologies.

Suggested Readings:

1. P. K. Nag, Power Plant Engineering, Tata Mc-Graw Hill.
2. R. K. Rajput, Power Plant Engineering, Lakshmi Publications.
3. P. C. Sharma, Power Plant Engineering, Kataria Publications.
4. M. M. El Wakil, Power Plant Technology, Mc-Graw Hill.
5. S. C. Arora, S Domkundwar, A Course in Power Plant Engineering, Dhanpat Rai.

2MEMTE3-12: RESEARCH METHODOLOGY

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the

society in general. Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Literature Review: Need of Review, Guidelines for Review, Record of Research Review.

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software. Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chisquare, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids, Intellectual property, Plagiarism. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Technique, New Age International Publishers.
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers.
3. Ratan Khananabis, Suvasis Saha, Research Methodology, Universities Press.
4. Y. P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd.
5. Vijay Upagade, Aravind Shende, Research Methodology, S. Chand & Company Ltd.
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications.
7. Naval Bajjai, Business Research Methods, Pearson.
8. Prahalad Mishra, Business Research Methods, Oxford.

2MEMTE1-13: THERMAL LAB-II

Performance of Computational Fluid Flow and Heat Transfer/ Computational Methods in Thermal Engineering as per following:

1. Programs for solving simultaneous linear equations and differential equations.
2. Exercises on heat conduction, fluid flow, fins, etc. using commercial CFD solvers
3. Modeling of flow around streamlined and Bluff bodies using commercial CFD solvers
4. Simulation on natural and mixed convection problems, laminar/turbulent flows, forced convection problems using commercial CFD solvers.
5. Exercises on hydrodynamic and thermal boundary layer problems using commercial CFD solvers.

2MEMTE4-14: FIELD WORK

Student is required to work in the organization/industry concerned with his/her course.