

AFFILIATED INSTITUTIONS
ANNA UNIVERSITY, CHENNAI
R - 2009
CURRICULUM I SEMESTER
M.TECH. ENERGY CONSERVATION AND MANAGEMENT

SEMESTER I

S.NO.	COURSE CODE	COURSE	L	T	P	C
THEORY						
1	EM9311	Advanced Thermodynamics	3	1	0	4
2	EM9312	Renewable Energy Systems	3	0	0	3
3	EM9313	Fuels and Combustion Technology	3	1	0	4
4	EM9314	Nuclear, Hydel and Other Power Plants	3	0	0	3
5	EM9315	Advanced Heat Transfer	3	1	0	4
6	EM9316	Process Instrumentation and Control	3	1	0	4
TOTAL			18	4	0	22

UNIT I CONDUCTION AND EXTENDED SURFACES 9

Conduction: Steady state one-dimensional law of heat conduction – Fourier heat conduction – heat conduction through a plane wall-radial conduction in long hollow cylinders – Radial conduction through hollow sphere – General three dimensional heat conduction equation – Transient heat conduction in plane walls, cylinders and spheres with convective boundary conditions – Transient heat flow in semi-infinite bodies – Finite – Difference methods for solving heat conduction problems.

Extended Surfaces: Extended surface heat transfer – Conduction and convection systems in fin – rectangular fin of constant cross section – Heat transfer from rectangular, triangular and circumferential fins – Fin efficiency.

UNIT II CONVECTION 9

Fundamental laws of convection – The governing equations of free convection – Working correlations for free convection – Mixed, free and forced convection – Forced convection heat transfer co-efficient – Heat transfer for laminar flow in circular tubes – Heat transfer for turbulent flow in circular tubes – Analogy between heat and momentum transfer – Reynolds, Colburn, Van kerman analogy – Forced convection heat transfer coefficient for flow over bodies – Heat transfer co-efficient for turbulent flow over flat plates.

UNIT III RADIATION 9

Thermal radiation – Introduction – Stefan – Boltzmann Law, the black body and emissive power – Basic radiation properties – Radiation shape factors and their relationships – Radiant heat transfer between two black bodies forming an enclosure shields – Directional aspects of emitted radiation – Radiation shape factor – Radiation in gases.

UNIT IV BOILING AND CONDENSATION 9

Boiling Liquids: Regimes of boiling – Free convection regime, Nucleate boiling regime – Mechanism of nucleate boiling – Peak heat flux and critical ΔT – Nucleate surface boiling of sub-cooled liquids – Forced convection boiling inside tubes – Heat transfer relations.

Condensing Vapors: Condensation theory – Condensation on vertical surfaces, inclined surfaces, Horizontal tube banks – Drop wise condensation of pure vapors – Film wise condensation both inside and outside horizontal tubes – Effect of non-condensable gases in condensers.

UNIT V NUMERICAL METHODS IN HEAT TRANSFER 9

Finite difference formulation of steady and transient heat conduction problems – Discretization schemes – Explicit, Crank Nicolson and fully implicit schemes – Control volume formulation – Steady one dimensional convection and diffusion problems – Calculation of the flow field – SIMPLER Algorithm

L : 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOKS

1. Knudsen, J.G. and Katz, D. L., "Fluid Dynamics and Heat Transfer", Mc Graw Hill Publishers, 1958.
2. Mc William Adams, H., "Heat Transmissions", McGraw Hill Intl, 2001.
3. Chattopadhyay, P., "Problems in Heat Transfer", 3rd Edition, Khanna Publishers, 2003.

REFERENCES

1. Nag, P.K., "Heat Transfer", Tata McGraw Hill, 2002.
2. Chuen, Yen Chow., "An Introduction to computational Fluid Mechanics", John Wiley and Sons, 2005.
3. Kollmann, W., "Computational Fluid Dynamics", A Von Karman Inst. Book
4. Mc Graw Hill Intl, 2001.
5. Patankar, S.V., "Numerical heat transfer and Fluid Flow", Hemisphere Publishing Corporation, 1980.

UNIT I AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS 9

Reversible work – Availability – Irreversibility and second law efficiency for a closed System and steady-State control volume – Availability analysis of simple cycles – Thermodynamic potentials – Maxwell relations – Generalized relations for changes in entropy, internal energy and enthalpy – Generalized relations for C_p and C_v – Clausius clayperon equation – The Joule-Thomson coefficient – Bridgman tables for thermodynamic relations.

UNIT II REAL GAS BEHAVIOURS AND MULTICOMPONENT SYSTEMS 9

Different equations of state – Fugacity – Compressibility – Principle of corresponding states – Use of generalized charts for enthalpy and entropy departure – Fugacity coefficient – Lee-Kesler generalized three parameter tables – Fundamental property relations for systems of variable composition – Partial molar properties – Real gas mixtures – Ideal solution of real gases and liquids – Activity – Equilibrium in multi phase systems – Gibbs phase rule for nonreactive components.

UNIT III VAPOUR AND COMBINED POWER CYCLES 9

Simple steam power cycle – Rankine cycle – Comparison of Rankine and Carnot cycle – Reheat cycle – Regenerative cycle – Direct contact and surface contact regenerators – Characteristics of an ideal working fluid in vapor cycle – Binary vapor cycle – Thermodynamics of combined cycles.

UNIT IV REFRIGERATION CYCLE 9

Refrigerators and heat pumps – The reversed carnot cycle – Ideal and actual vapor compression Refrigeration cycle – Selection of refrigerants – Multistage compression refrigeration systems – Absorption refrigeration cycle – Gas refrigeration cycle – Absorption refrigeration systems.

UNIT V STATISTICAL AND IRREVERSIBLE THERMODYNAMICS 9

Statistical 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 – Calculation of statistical thermodynamic approach.

Irreversible Thermodynamics: Conjugate fluxes and forces – Entropy production – Onsager's reciprocity relations – Thermo-electric phenomena formulations – Power generation – Refrigeration.

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TEXT BOOKS

1. Nag, P.K., "Engineering Thermodynamics", 3rd Edition, Tata McGraw Hill, 2005.
2. Gordon Van Vylan., "Applied Thermodynamics for Engineers", 3rd Edition, John Wiley International Edition, 2004.
3. Holman, J.P., "Thermodynamics", 4th Edition, McGraw Hill Inc., 1988.

REFERENCES

1. Ballaney, P.L., "Thermal Engineering", Khanna Publishers, 2005.
2. Natarajan, M.K., "Thermodynamic analysis of energy systems", Khanna Publishers, 2006.
3. Smith, J.M. and Van Ness., "Introduction to Chemical Engineering Thermodynamics", 5th Edition, McGraw Hill, 1996.

UNIT I SOLAR ENERGY**9**

Introduction – Solar radiation – Measurement, data estimation – Design of flat plate water heater and solar air heater – Performance analysis – Applications – Economic feasibility – Selective coatings – Concentrating collectors – Characteristics of cylindrical / parabolic / compound parabolic collectors – Central receiver tower – Introduction to solar ponds – Merits and demerits of solar pond – Economics of solar pond.

UNIT II SOLAR ENERGY APPLICANCES**9**

Solar energy storage – Types of storage systems – Characteristics and limitation of storage systems with respect to sensible heat and latent heat – Thermo chemical storages – Economic feasibility of solar cookers – Types – Working principle – Efficiency prediction – Comparison of various models – Economic aspect – Photovoltaics – Introduction – Principle of operation – Performance prediction – Solar lanterns – Solar powered vehicles.

UNIT III BIOMASS ENERGY**9**

Introduction – Origin – Types of biomass – Availability data – Characteristic of biomass – Classifications – Biomass utilization – Pretreatment processes – drying – Size reduction – Densification – Pelletization – Baling – Briquetting – Merits and demerits of biomass utilization as fuel – Transportation – Pollution aspects – Types of combustion in boilers – Gasification of biomass – Principle of gasification – Type of gasifiers – Utility of gasification process – Problems encountered in gasification – Pyrolysis of biomass – Principle – Production of charcoal – Economics.

UNIT IV BIO GAS TECHNOLOGY**9**

Historical background of biomethanation – Aerobic fermentation – Properties of biogas – Biogas plant designs construction, operation and maintenance – Factors affecting biogas yield – Biogas from different organic waste – Types of biogas reactors – Biogas reactor design, case studies and its economics – Applications and usage of biogas.

UNIT V WIND ENERGY**9**

Uses of wind energy – Betz limit – Classification of wind machines – Features and comparison horizontal and vertical axis wind machines – Application of wind mill for water pumping – Types of wind energy systems, wind – diesel and wind solar combinations – Battery storage – Limitations of wind energy – Wind mill design, case studies and economic aspects.

TOTAL : 45 PERIODS**TEXT BOOKS**

1. Rai, G.D., "Non-conventional energy sources", Khanna Publishers, 2005.
2. Sukhatme, S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill, 1984.

REFERENCES

1. Pachauri, R K., "Global Energy Interactions", Energy Policy Issues, Volume 1, Allied Publishers, 1985.
2. Duffie, J.A. and Beckmann W.A., "Solar Engineering of Thermal Processes", John Wiley, 1980.
3. Kreith, F. and Kreider J.F., "Principles of Solar Engineering", McGraw Hill, 1978.
4. Kreider, J.F. and Kreith F., "Solar Energy Handbook", McGraw Hill, 1981.

UNIT I FUELS, FUEL ANALYSIS and COMBUSTION STOICHIOMETRY 9

Fuels and Fuel Analysis: Solid fuels – Coal – Origin of coal – Analysis of coal – Composition and properties of coal – Coal Petrology – Coal classification – Other solid fuels – Classification and analysis of other solid fuels – Storage and handling of solid fuels – Liquid fuels – Origin of petroleum – Classification and composition of petroleum – Petroleum processing – Other liquid fuel – Storage and handling of liquid fuel – Gaseous fuels – Types of gaseous fuels – Natural gas, coal gas, manufactured gases – Cleaning and purification of gaseous fuel – Properties and testing of fuel gases.

Combustion Stoichiometry: Stoichiometry relations – Conservation of mass principles – Theoretical and actual combustion processes – Calculation of air fuel ratio for a fuel of known composition – Calculation of flue gas composition of fuel and excess air supplied from exhaust gas analysis – Combustion calculation with sub-stoichiometric air – Calculation of atmospheric air moisture – Dew point temperature of the combustion products – Flue gas analysis and Calorific value determination.

UNIT II THERMODYNAMICS OF COMBUSTION PROCESSES 9

Combustion Thermodynamics: Enthalpy of formation – Enthalpy of combustion – Calculation of heat of formation and heat of combustion – First law analysis of reacting systems – Adiabatic flame temperature calculation – Entropy change of reacting systems – Second law analysis of reacting systems.

Combustion Kinetics: Reversible reactions – equilibrium – Criteria of equilibrium – Laws of mass action – Gibbs free energy – equilibrium constant – Vant Hoff's isotherm – Rate of reaction – Factors affecting rate of reaction – Calculation of equilibrium constant and composition of reacting systems.

UNIT III HEAT TREATMENT FURNACES 9

Industrial furnaces – process furnaces – Kilns – Batch and continuous furnaces – Advantages of ceramic coating – Heat source – Distributions of heat source in furnaces – Blast furnace – Open hearth furnace – Pot and crucible furnace – Waste heat recovery in furnaces – Recuperator – Regenerators – Furnace atmospheres – Furnace Heat balance calculations.

UNIT IV FLAME, FLAME STRUCTURE, IGNITION, IGNITORS 9

Flame – Flame structure – Flame propagation – Deflagration – Detonations – Flame front – Ignition – Self and forced ignition – Ignition temperature and ignition limits – Factors influencing ignition – SIT – Ignition lag – Limits of inflammability and its determination – Factors affecting inflammability limits – Calculation of inflammability limits – Flame blow off, blow out and flash back – Flame quenching, Flame structure – Flame stability – Premixed and diffused flames – Velocity of flame propagation – Various methods of flame stabilization.

UNIT V COMBUSTION APPLIANCES 9

Gas burners: Functional requirement of burners – Gas burner classification – Premix burners – Aerated gas burners – Air aspiration gas burners – Diffusion flame burners – Radiant or tile port burners – Atmospheric gas burners.

Liquid fuel burners: Pressure jet atomization – Air blast atomizers – Steam atomizers – Rotary cup atomizers – Vaporizing burners – Low NO_x burners – Swirl number and its significance – Selection of appropriate type of burners.

Coal burning equipments: Coal burning methods – Over feed and underfeed supply of coal – Mechanical Stokers – Traveling grate and spreader stoker – Vibrating grate stoker – Advantages and disadvantages of stoker firing over pulverized systems of firing – Problems encountered with burning of high ash coal – Pulverized fuel burners – Streamlined burner – Turbulent burners – Tangential burner – Cyclone burner.

L : 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOKS

1. Sharma, S.P. and Chander Mohan., "Fuels and Combustion", Tata Mc Graw Hill, Publishing Co.Ltd, 1984.
2. Samir Sarkar.S., "Fuels and Combustion", 2nd Edition, Orient Longman, 1990.

REFERENCES

1. Blokh, A.G., "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corporation, 1994.
2. Gupta, O.P., "Elements of Fuels, Furnaces and Refractories", 3rd Edition, Khanna Publishers, 1996.
3. Gilchrist, J. D., "Fuels, Furnaces and Refractories", Pergamom Press, 1999.

CH9312 PROCESS INSTRUMENTATION AND CONTROL L T P C

3 1 0 4

UNIT I INTRODUCTION TO MEASUREMENT TECHNIQUES 9

General concepts of measurements, static and dynamic characteristics, Introduction to calibrations, calibration standards – characteristics of instruments – Definition – True value – Accuracy – Precision – Sensitivity –Resolution – errors and its measurements.

UNIT II MEASUREMENT OF PRESSURE AND TEMPERATURE 9

Measurement of Pressure: Different units of pressure – Classification of pressure gauges – Manometers – Pressure balance gauges – Force balancing gauges – Elastic deformation – Commercial pressure gauges using the above principles – Ring balance type elements. Measurement of vacuum – Mcleod gauge – Pirani gauge – Measurement using strain gauges. Measurement of Pressure using electronic/micro processor based transmitter.

Measurement of Temperature: Different temperature scales – Non-electrical methods – Change in volume of liquid – Change in pressure of gas – Change in vapour pressure. Electrical methods – Thermocouple – Resistance temperature detector – Radiation pyrometer – Optical pyrometer – Thermistors – Temperature measurement using electronic/micro processor based transmitter – Measurement of electrical energy – Voltage – Current – Power Factor.

UNIT III MEASUREMENT OF FLOW, LEVEL, HUMIDITY AND OTHER MISCELLEANEOUS PARAMETERS 9

Flow measurement – Types – Differential pressure type flow meter – Orifice meter – Ventury tube – Flow nozzle – Pitot tube – Positive displacement type flow meter – Inferential flow meter – Turbine flow meter – Variable area flow meter (rotameter) – Mass flow meter – Low flow measurement using pizzo ring – Ultra Sonic flow meter for high flow.

Level measurement – Basic methods – Measuring hydrostatic pressure – Measuring the movement of the float – Electric conduction method – Sight glass – Non-contact measurement techniques –Level measurement by DP transmitter.

Definition of humidity – Hygrometer and psychrometer – Humidity measurement measurement of pH-pH scale – Methods of pH measurements – Mass spectrometer and chromatograph. Hazardous area and its classification.

UNIT IV TRANSDUCERS 9

Classification of Transducers – Active and passive transducers – Analog and digital transducers. Advantages of electrical transducers over mechanical transducers – Different type – Resistance – Inductance – Capacitance – Piezo electric transducers.

UNIT V PROCESS CONTROL**9**

Functional block diagram of a process control loop and their elements – Definition of set point, controlled variable, measured variable, manipulated variable, dead zone, dead time, disturbance, deviation, (definitions only) – Basic definition of control system – Open and closed loop control system – feed forward control – Ratio control – Cascade control – Basic control actions and applications – Characteristics of on-off, proportional, integral and derivative control modes – Composite control actions – PI, PD and PID control modes – Examples of control loops – Boiler controls – Combustion control, Drum level control and steam temperature control – Programmable logic controllers and Distributed controlled system – Computer control using supervisory computer.

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1. Bentley, J. P., "Principles of Measurement Systems", 3rd Edition, Addison Wesley Longman Ltd, 2000.
2. Neubert, H.K.P., "Instrument Transducers An introduction their performance and Design", 2nd Edition, Oxford University Press, 1999.
3. Patranabis, D., Sensors and Transducers, Wheeler Publishing Co., 1997.

REFERENCES

1. Liptak, B. G., "Process Control ", 3rd Edition, Chilton Book Company, 1995.
2. Liptak B. G., "Measurement and Analysis", 3rd Edition, Chilton Book Company 1995.
3. Noltingk, B.E., "Instrumentation", 2nd Edition, Butterworth Heinemann, Oxford, 1996.
4. Stephanopoulos., "Chemical Process Control – An Introduction to Theory and practice", PHI, 1999.

EM9314**NUCLEAR, HYDEL AND OTHER POWER PLANTS****L T P C
3 0 0 3****UNIT I NUCLEAR POWER****9**

Introduction –Nuclear power for developing countries – Role of nuclear power – Radioactivity and radioactive charge – Unit of radioactivity – Mass energy equivalence – Usefulness of einstein theory – Types of nuclear reaction – Nuclear fission and fusion – Fertile materials and breeding – Location of nuclear power plants – General components of nuclear reactors – Fuel – Moderator – Reflector – Coolant – Control rods – Shielding – Reflector vessel – General problem of reactor operation.

UNIT II NUCLEAR REACTORS**9**

Current Generation power reactors – Pressurized water reactors – Boiling water reactors – Gas – cooled reactors – Advanced design – Advanced boiling water reactors – Modular pressurized – heavy water reactors – Advanced passive reactors – Gas turbine modular helium reactor – Breeder reactors – Commercial design – Comparison of nuclear plants with thermal plants.

UNIT III HYDROLOGY AND HYDRO – ELECTRIC POWER PLANTS**9**

Rainfall and its measurements – Hydrographs – Flow duration curve – Mass curve and storage – Site selection for hydroelectric power plants – Environmental aspects of site selection – Classification of hydro – electric power plants – Storage type hydro-electric plant and its operation – Advantage and disadvantages of hydro-electric power plant.

