.0AFFILIATED INSTITUTIONS

ANNA UNIVERSITY, CHENNAI

REGULATIONS - 2009

CURRICULUM IITO IV SEMESTERS (FULL TIME)

M.E. ENERGY ENGINEERING

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EY9321	Energy Conservation in Electrical Systems	3	0	0	3
2	TE9250	Renewable Energy Systems	3	0	0	3
3	TE9222	Instrumentation For Thermal Systems	3	0	0	3
4	E2	Elective II	3	0	0	3
5	E3	Elective III	3	0	0	3
6	E4	Elective IV	3	0	0	3
7	EY9324	Seminar	0	0	2	1
PRACTICAL						
8	EY9325	Simulation Laboratory	0	0	3	1
		TOTAL	**18**	**0**	**5**	**20**

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	E5	Elective V	3	0	0	3
2	E6	Elective VI	3	0	0	3
3	E7	Elective VII	3	0	0	3
PRACTICAL						
4	EY9331	Project work (Phase I)	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	EY9341	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 70

ELECTIVES FOR M.E ENERGY ENGINEERING

COURSE CODE	COURSE TITLE	L	T	P	C
EY9003	Energy Systems Modeling and Analysis	3	0	0	3
EY9008	Advanced Thermal Storage Technologies	3	0	0	3
EY9009	Energy Conversion Techniques	3	0	0	3
EY9010	Electrical Drives and Controls	3	0	0	3
EY9011	Power Generation, Transmission and Utilization	3	0	0	3
EY9012	Waste Management and Energy Recovery	3	0	0	3
EY9013	Clean Development Mechanism	3	0	0	3
EY9014	Solar Energy Systems	3	0	0	3
EY9015	Wind Energy Systems	3	0	0	3
EY9016	Bio Energy Conversion Techniques	3	0	0	3
EY9018	Green Buildings	3	0	0	3
EY9020	Hydrogen and Fuel Cell	3	0	0	3
EY9022	Demand Side Management Of Energy	3	0	0	3
EY9256	Design of Heat Exchangers	3	0	0	3
IC9262	**Computational Fluid Dynamics**	3	0	0	3
EY9001	Advanced Engineering Fluid Mechanics	3	0	0	3
EY9002	Cogeneration and Waste Heat Recovery Systems	3	0	0	3
TE9223	Environmental Engineering and Pollution Control	3	0	0	3
TE9252	Turbomachines	3	0	0	3
TE9258	Nuclear Engineering	3	0	0	3
TE9270	Advanced Power Plant Engineering	3	0	0	3
TE9271	Steam Generator Technology	3	0	0	3
TE9272	Fluidized Bed Systems	3	0	0	3

EY 9321 ENERGY CONSERVATION IN ELECTRICAL SYSTEMS L T P C
3 0 0 3

AIM:

This course is intended to study the ways and means of electrical energy conservation in lighting systems and rotating machineries.

OBJECTIVES:

- To study the concepts of power factor, harmonics and load management.
- To study the energy monitoring and DSM techniques.
- To study the various measures for energy conservation in electrical devices

UNIT I ELECTRICAL ENERGY - INTRODUCTION 8

Introduction electric power supply system – electrical load management – kVA demand – power factor concept – electricity billing – tariff structure – penalty concept – wheeling and banking – harmonics – transformers.

UNIT II ENERGY MONITORING / TARGETING AND DEMAND SIDE MANAGEMENT 8

Definition – elements of monitoring and targeting – data and information analysis – CUSUM techniques – demand side management – case studies.

UNIT III PERFORMANCE STUDY OF UTILITIES – 1 11

Selection, identification, specification drawals – international code followed in electrically operated rotating machineries with specific reference to motors – fans & blowers – pumps and compressed air system – performance evaluation of each – scope available for energy saving – methods adopted in industries for ENCON – latest developments

UNIT IV PERFORMANCE STUDY OF UTILITIES – 2 10

Basics of air conditioning and refrigeration – COP/EER/SEC evaluation for air conditioning and refrigeration systems – selection – methods employed for energy conservation – ENCON in auxiliaries – performance study on cooling towers – application and selection – types of illumination (Indoor/Outdoor) – efficacy of lighting – specifications for luminaries - selection and application – ENCON avenues in illumination. New generation luminaries – LED – DG set – performance prediction – scope for efficiency improvements – cost of operation.

UNIT V ENERGY EFFICIENT TECHNOLOGIES / DEVICES 8

Energy Efficient Motors – soft starters – variable speed drives – automatic power factor controllers - energy efficient transformers – auto star delta star starters – occupancy sensors -energy efficient lighting.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980
2. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997.

REFERENCES:

1. Handbook on Energy Efficiency, TERI, New Delhi, 2001
2. Peters et al. Sustainable Energy, beta – test – draft
3. Kraushaar and Ristenen, Energy and Problems of a Technical Society, 1993
4. Guide book for National Certification Examination for Energy Managers and Energy Auditors

(Could be downloaded from www.energymanagertraining.com)

TE 9250 RENEWABLE ENERGY SYSTEMS L T P C
3 0 0 3

UNIT I INTRODUCTION 7

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

UNIT II SOLAR ENERGY 10

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

UNIT III WIND ENERGY 8

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

UNIT IV BIOMASS ENERGY 8

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

UNIT V OTHER RENEWABLE ENERGY SOURCES 12

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

TOTAL : 45 PERIODS

TEXT BOOKS

1. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
2. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

REFERENCE BOOKS

1. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
2. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.
3. G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.
4. L.L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.
5. Johnson Gary, L., Wind Energy Systems, Prentice Hall, New York, 1985.

TE9222 INSTRUMENTATION FOR THERMAL SYSTEMS L T P C
3 0 0 3

AIM:

To enhance the knowledge of the students about various measuring instruments, techniques and importance of error and uncertainty analysis.

OBJECTIVE:

(I) To provide knowledge on various measuring instruments.
(II) To provide knowledge on advance measurement techniques.

(III) To understand the various steps involved in error analysis and uncertainty analysis.

UNIT I MEASURMENT CHARACTERISTICS 12

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.

UNIT II MICROPROCESSORS AND COMPUTERS IN MEASURMENT 5

Data logging and acquisition – use of sensors for error reduction, elements of micro computer interfacing, intelligent instruments in use.

UNIT III MEASURMENT OF PHYSICAL QUANTITIES 10

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

UNIT IV ADVANCE MEASURMENT TECHNIQUES 8

Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

UNIT V MEASURMENT ANALYSERS 10

Orsat apparatus, Gas Analysers, Smoke meters, gas chromatography, spectrometry.

TOTAL : 45 PERIODS

TEXT BOOKS :

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988.
2. Barnery, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky, V., Measurements and Instrumentation in Heat Engineering, Vol. 1 and 2, MIR Publishers, 1980.

REFERENCES :

1. Raman, C.S., Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw-Hill, New Delhi, 1983.
2. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1958.
3. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988
4. Prebrashensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and MIR Publishers, 1980.
5. Raman, C.S. Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems,
6. Tata McGraw-Hill, New Delhi, 1983.
7. Doeblin, Measurement System Application and Design, McGraw-Hill, 1978.
8. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.

EY 9325 SIMULATION LABORATORY L T P C
0 0 3 1

1. Introduction to finite element analysis
2. Thermal analysis of a block using conduction, convection and mixed boundary conditions (steady state and transient analysis)
3. Heat transfer analysis through two walls
4. Simulation of solidification

5. Laminar and turbulent flow analysis
6. Melting a metal using element killing
7. Electromagnetic field analysis
8. Thermo mechanical analysis of a block
9. Heat transfer analysis in fins
10. Thermal analysis of a pipe joint
11. Flow analysis in a nozzle
12. Moving heat source simulation
13. Material nonlinearity

Software needed : Modelling and Analysis Software

TOTAL : 45 PERIODS

EY9003 ENERGY SYSTEMS MODELING AND ANALYSIS L T P C
3 0 0 3

AIM:

To provide a comprehensive and rigorous introduction to energy system design and optimization from a contemporary perspective.

OBJECTIVES:

- To learn to apply mass and energy balances for the systems enable to perform enthalpy
- Learn to calculate to size performance and cost of energy equipments turns modeling and simulation techniques.
- Learn to optimize the energy system for its maximum or minimum performance output.

UNIT I INTRODUCTION 9

Primary energy analysis - dead states and energy components - energy balance for closed and control volume systems - applications of energy analysis for selected energy system design - modeling overview - levels and steps in model development - examples of models – curve fitting and regression analysis.

UNIT II MODELLING AND SYSTEMS SIMULATION 9

Modeling of energy systems – heat exchanger - solar collectors – distillation - rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of non- linear algebraic equations - successive substitution - Newton Raphson method- examples of energy systems simulation.

UNIT III OPTIMISATION TECHNIQUES 9

Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency conditions.Constrained optimization - lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis.

UNIT IV ENERGY- ECONOMY MODELS 9

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation –Econometric Energy Demand Modeling - Overview of Econometric Methods - Dynamic programming - Search Techniques - Univariate / Multivariate.

UNIT V APPLICATIONS AND CASE STUDIES 9

Case studies of optimization in Energy systems problems- Dealing with uncertainty-probabilistic techniques – Trade-offs between capital and energy using Pinch analysis.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Stoecker, W.F., Design of Thermal Systems, McGraw Hill, 1989.
2. Bejan, A, Tsatsaronis, G and Moran, M., Thermal Design and Optimization, John Wiley & Sons 1996.

REFERENCES:

1. Rao, S.S., Engineering Optimization - Theory and Applications, Wiley Eastern, 2000.
2. Meier, P., Energy Systems Analysis for Developing Countries, Springer Verlag, 1984.
3. Beveridge and Schechter, Optimization Theory and Practice, McGraw Hill, 1970.
4. Jaluria, S., Design and Optimization of Thermal Systems, McGrawHill, 1997.

EY9008 ADVANCED THERMAL STORAGE TECHNOLOGIES L T P C
3 0 0 3

AIM:

This course is intended to build up the necessary background to model and analyze the various types of thermal storage systems

OBJECTIVES:

- To learn the various types of thermal storage systems and the storage materials
- To develop the ability to model and analyze the sensible and latent heat storage units
- To study the various applications of thermal storage systems

UNIT I INTRODUCTION 8

Necessity of thermal storage – types-energy storage devices – comparison of energy storage technologies - seasonal thermal energy storage - storage materials.

UNIT II SENSIBLE HEAT STORAGE SYSTEM 9

Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storage system – use of TRNSYS – pressurized water storage system for power plant applications – packed beds.

UNIT III REGENERATORS 10

Parallel flow and counter flow regenerators – finite conductivity model – non – linear model – transient performance – step changes in inlet gas temperature – step changes in gas flow rate – parameterization of transient response – heat storage exchangers.

UNIT IV LATENT HEAT STORAGE SYSTEMS 9

Modeling of phase change problems – temperature based model - enthalpy model - porous medium approach - conduction dominated phase change – convection dominated phase change.

UNIT V APPLICATIONS 9

Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.

REFERENCES

1. Schmidt.F.W and Willmott.A.J, Thermal Storage and Regeneration, Hemisphere Publishing Corporation, 1981.
2. Lunardini.V.J, Heat Transfer in Cold Climates, John Wiley and Sons 1981.

EY9009 ENERGY CONVERSION TECHNIQUES L T P C
3 0 0 3

AIM:

To detail on the different technologies in vogue for converting one form of energy to another.

OBJECTIVE:

- To analyze the pros and cons of
- Conventional energy conversion techniques
- Direct energy conversion systems
- Need and necessity of energy storage systems and their desirable characteristics
- Detail on thermodynamics and kinetics of fuel cells

UNIT I INTRODUCTION 8

Energy conversion – conventional techniques – reversible and irreversible cycles – Carnot, Stirling and Ericsson – Otto, Diesel, Dual, Lenoir, Atkinson, Brayton, rankine.

UNIT II DIRECT CONVERSION OF THERMAL TO ELECTRICAL ENERGY 8

Thermoelectric Converters – thermoelectric refrigerator – thermoelectric generator – Thermionic converters – Ferro electric converter – Nernst effect generator – thermo magnetic converter.

UNIT III CHEMICAL AND ELECTROMAGNETIC ENERGY TO ELECTRICAL ENERGY 9

Batteries – types – working – performance governing parameters – hydrogen energy – solar cells.

UNIT IV ENERGY STORAGE SYSTEMS 9

Introduction – storage of mechanical energy, electrical energy, chemical energy, thermal energy.

UNIT V FUEL CELLS 11

Basics – working advantages and drawbacks – types – comparative analysis – thermodynamics and kinetics of fuel cell process – performance of fuel cell – applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Archie.W.Culp, Principles of Energy Conversion, McGraw-Hill Inc., 1991, Singapore
2. Kordesch. K, and Simader.G, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996

REFERENCES:

1. Kettari, M.A.Direct Energy Conversion, Addison-Wesley Pub. Co 1997
2. Hart A.B and Womack, G.J.Fuel Cells: Theory and Application, Prentice Hall, Newyork Ltd., London 1989

EY9010 ELECTRICAL DRIVES AND CONTROLS L T P C
3 0 0 3

AIM:

To expose the students to the fundamentals of electrical drives and their applications in electrical machines.

OBJECTIVES:

To impart knowledge on:

- Characteristics, starting, speed control and breaking of DC and AC motors.
- Concepts of various losses and harmonics effects.
- Super conducting generators and motors, which have improved power system stability and higher efficiency, compared with conventional machines.
- Applications of solid-state devices in speed control of electrical machines.

UNIT I CONVENTIONAL MOTOR DRIVES 9

Characteristics of DC and AC motor for various applications - starting and speed control - methods of breaking.

UNIT II PHYSICAL PHENOMENA IN ELECTRICAL MACHINES 9

Various losses in motors-Saturation and Eddy current effects - MMF harmonics and their influence of leakage-stray losses - vibration and noise.

UNIT III SOLID STATE POWER CONTROLLERS 9

Power devices - Triggering Circuits – Rectifiers – Choppers - Inverters - AC Controllers.

UNIT IV SUPERCONDUCTIVITY 9

Super conducting generators-motors and magnets - Super conducting magnetic energy storage (SMES).

UNIT V SOLID STATE MOTOR CONTROLLERS 9

Single and Three Phase fed DC motor drives - AC motor drives - Voltage Control - Rotor resistance control - Frequency control - Slip Power Recovery scheme.

TOTAL: 45PERIODS

TEXT BOOKS:

1. Pillai.S.K, A First course on Electrical Drives, Wiley Eastern Limited (1982).
2. NKDE and P.K.Sen, Electrical drives, Prentice Hall of India Pvt Ltd (2001)
3. P.S.Bimbhra, Power Electronics, Khanna Publishers.

REFERENCES:

1. S.B. Devwan, G.R. Slevnon, A.Strangher, Power Stream and Control Drives, John Wiley & Sons (1984).
2. Eedam subramanyan, Thyristor Control of Electrical Drives, Tata McGraw-Hill Co.Ltd.,(1988).
3. J.M.D. Murphy, F.G. Turnbull, ;Power Electronics: Control of AC Motors-Pergamon Press(1988).
4. C.G. Say-Introduction to the Theories of Electromagnetic Machines, Pitman (1971).
5. Rakesh Dal Begamudre-Electro Mechanical Energy Conversion with Dynamics of Machines – Wiley Eastern (1988).

EY9011 POWER GENERATION, TRANSMISSION AND UTILIZATION

L	T	P	C
3	0	0	3

UNIT I CONVENTIONAL POWER GENERATION 9

Steam power plant - Selection of site - Generated Layout - coal and Ash Handling - Steam Generating Plants - Feed Make Circuit - Cooling Towers - Turbine Governing -Hydro Power Plant-Selection of Site - Classification Layout Governing of Turbines - Nuclear Power Plants - Selection of Site - Classification Layout Governing of Turbines - Nuclear Power Plants - Selection of Site - Nuclear Fuels - Nuclear reactors - Nuclear disposal - Gas Turbine Plants.

UNIT II NON CONVENTIONAL POWER GENERATION 9

Wind power generation - characteristics of wind power-design of windmills - Tidal power generation - Single and two-basin systems -Turbines for tidal power - Solar power generation - Energy from biomass, biogas and waste

UNIT III ECONOMICS OF POWER GENERATION 9

Daily load curves - load factor - diversity factor - load deviation curve - load management - number and size of generating unit, cost of electrical energy – tariff - power factor improvement

UNIT IV ELECTRICAL POWER TRANSMISSION 9

Online diagram of transmission - substation and distribution systems - comparison of systems (DC and AC) - EHVAC and HVDC transmission - layout of substations and bus bar arrangements - Equivalents circuit of short, medium and long lines - Transmission efficiency-regulation-reactive power - compensation-transmission - loss minimization

UNIT V UTILISATION OF ELECTRICAL ENERGY 9

Selection of Electrical Drives - Electrical characteristics and mechanical considerations -size, rating and cost, Transformer characteristics – illumination - laws of illumination-polar curve - incandascent-fluoroscent and vapour lamps - Design of OLTC lighting Scheme of industry-electrical welding - energy efficient aspects of devices

TOTAL: 45 PERIODS

REFERENCES:

1. C.L.Wadhwa, Generation Distribution and utilization of Electrical Energy, Wiley Eastern Ltd., India(1989)
2. V.A.Venikov and B.V. Put Yatin, Introduction of Energy Technology, Electric power Engineering, MIR Publishers, Moscow(1984)
3. M.L.Soni,P.VGupta and V.S.A.Bhatnagar, Course in Electrical Power, Dhanbat Rai & Sons, NewDelhi(1983)
4. J.W.Twidell and A.D.Weir, Renewable Energy Sources, ELBS Edition(1986)
5. A.J.Wood and B.F. Wallenberg(1986):Power Generation, Operation and Control,2nd Edition, JohnWiley &Sons, Newyork
6. E.Khan(1988):Electrical Utility Planning and Regulation, American Council for a n Energy Efficient Economy, Washington D.C

EY9012 WASTE MANAGEMENT AND ENERGY RECOVERY L T P C
3 0 0 3

AIM:

To motivate the students by highlighting the importance of waste management, high-grade energy generation from waste and hygienic waste disposal options.

OBJECTIVES:

- To provide information on various methods of waste management
- To familiarize students with recent energy generation techniques
- To detail on the recent technologies of waste disposal and
- To make student realize on the importance of healthy environment.

UNIT I SOLID WASTE – CHARACTERISTICS AND PERSPECTIVES 6

Definition - types – sources – generation and estimation. Properties: physical, chemical and biological – regulation

UNIT II COLLECTION, TRANSPORTATION AND PROCESSING TECHNIQUES 8

Onsite handling, storage and processing – types of waste collection mechanisms - transfer Stations : types and location – manual component separation - volume reduction : mechanical, thermal – separation : mechanical, magnetic electro mechanical

UNIT III ENERGY GENERATION TECHNIQUES 16

Basics, types, working and typical conversion efficiencies of composting – anaerobic digestion – RDF – combustion – incineration – gasification – pyrolysis

UNIT IV HAZARDOUS WASTE MANAGEMENT 8

Hazardous waste – definition - potential sources - waste sources by industry – impacts – waste control methods – transportation regulations - risk assessment - remediation technologies – Private public paternership – Government initiatives.

UNIT V ULTIMATE DISPOSAL 7

Landfill – classification – site selection parameters – design aspects – Leachate control – environmental monitoring system for Land Fill Gases.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Tchobanoglous, Theisen and Vigil, Integrated Solid Waste Management, 2d Ed. McGraw-Hill, New York, 1993.
2. Howard S. Peavy etal, Environmental Engineering, McGraw Hill International Edition, 1985

REFERENCES:

1. LaGrega, M., et al., Hazardous Waste Management, McGraw-Hill, c. 1200 pp., 2nd ed., 2001.
2. Stanley E. Manahan. Hazardous Waste Chemistry, Toxicology and Treatment, Lewis Publishers, Chelsea, Michigan, 1990
3. Parker, Colin and Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
4.. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997

EY9013 CLEAN DEVELOPMENT MECHANISM L T P C
3 0 0 3

AIM:

To create awareness on eco-cess, Kyoto protocol, Clean Development Mechanism,Joint Implementation and Emissions Trading

OBJECTIVE:

- To present the case of global warming, its cause and its present and foreseen impacts on human community.
- Details on the factors led to Kyoto protocol and its resolution
- Comprehensive study on clean development mechanism and its impact on Indian energy scenario.

UNIT I CLIMATE SCIENCE 10

World energy scenario - observed and modeled changes in climate - role of Aerosols - climate change scenarios - global warming – factors contributing – comparison of global warming potential of GHG - impacts

UNIT II KYOTO PROTOCOL: FORMATION 6

Historical perspectives from the industrial revolution to the United Nations framework convention on climate change and the Kyoto protocol, the intergovernmental panel on climate change (IPCC)

UNIT III KYOTO PROTOCOL 12

Article 1 through 28 - accounted GHGs in Kyoto protocol – source categorization of GHG emissions – reduction commitment of Annexe B countries – C D M, joint implementation and emissions trading

UNIT IV CLEAN DEVELOPMENT MECHANISM AND BASELINE STUDY CENARIO 10

CDM and its economic viability for renewable energy projects – advantages for developing countries – emission and efficiency scenario of different energy sources for power generation.Baseline Study – methodology – boundary conditions – base line Fixing – typical case studies.

UNIT V RECENT ADVANCEMENTS 7

Recent advancements in the CDM technologies, issues and protocols, Emission certification norms and methods

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Somerville, Richard C.J., The Forgiving Air: Understanding Environmental Change, Los Angeles: University of California Press, 1996.
2. John Houghton, Global Warming: The Complete Briefing, Cambridge University Press, and Cambridge, UK, 1997.
3. Roleff, T.L S. Barbour and K.L. Swisher, Global Warming: Opposing Viewpoints, Greenhaven Press, and San Diego, 1997.
4. Caring for Climate: a guide to the climate change convention and the Kyoto protocol - UNFCC – 2003

REFERENCES:

1. Counting Emissions and Removals Greenhouse Gas Inventories Under The UNFCCC
2. Climate Change – Information Kit: Published by UNEP and UNFCCC
3. Kyoto Protocol Reporting on Climate Change: Manual For The Guidelines On National Communications From Non-Annex I Parties
4 Understanding Climate Change: A beginner's guide to UNFCC and its Kyoto Protocol 2002

EY9014 SOLAR ENERGY SYSTEMS L T P C
3 0 0 3

AIM:

To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.

OBJECTIVES:

- To learn and study the radiation principles with respective solar energy estimation
- To learn about PV technology principles and techniques of various solar cells / materials for lister energy conversion
- To learn economical and environmental merits of solar energy for variety applications

UNIT I SOLAR RADIATION AND COLLECTORS 9

Solar angles - day length, angle of incidence on tilted surface - Sunpath diagrams - shadow determination - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - heat capacity effect - testing methods-evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

UNIT II APPLICATIONS OF SOLAR THERMAL TECHNOLOGY 9

Principle of working, types - design and operation of - solar heating and cooling systems - solar water heaters – thermal storage systems – solar still – solar cooker – domestic, community – solar pond – solar drying.

UNIT III SOLAR PV FUNDAMENTALS 9

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetro junctions - metal-semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature - efficiency measurements - high efficiency cells - preparation of metallurgical, electronic and solar grade Silicon - production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) method - Design of a complete silicon – GaAs- InP solar cell - high efficiency III-V, II-VI multi junction solar cell; a-Si-H based solar cells-quantum well solar cell - thermophotovoltaics.

UNIT IV SOLAR PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS 9

Solar cell array system analysis and performance prediction- Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - use of computers in array design - quick sizing method - array protection and trouble shooting - centralized and decentralized SPV systems - stand alone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV systems.

UNIT V SOLAR PASSIVE ARCHITECTURE 9

Thermal comfort - heat transmission in buildings- bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - radiative cooling - application of wind, water and earth for cooling; shading - paints and cavity walls for cooling - roof radiation traps - earth air-tunnel. – energy efficient landscape design - thermal comfort - concept of solar temperature and its significance - calculation of instantaneous heat gain through building envelope.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Sukhatme S P, Solar Energy, Tata McGraw Hill, 1984.
2. Kreider, J.F. and Frank Kreith, Solar Energy Handbook, McGraw Hill, 1981.
3. Goswami, D.Y., Kreider, J. F. and & Francis., Principles of Solar Engineering, 2000.

REFERENCES:

1. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
3. Alan L Fahrenbruch and Richard H Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, 1983.
4. Larry D Partain, Solar Cells and their Applications, John Wiley and Sons, Inc, 1995.
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.
6. Sodha, M.S, Bansal, N.K., Bansal, P.K., Kumar, A. and Malik, M.A.S. Solar Passive Building, Science and Design, Pergamon Press, 1986.
7. Krieder, J and Rabi, A., Heating and Cooling of Buildings: Design for

Efficiency, McGraw-Hill, 1994.

EY9015 WIND ENERGY SYSTEMS L T P C
3 0 0 3

AIM:
To understand the fundamentals of wind energy and its conversion techniques for electrical energy applications.

OBJECTIVES:
- To understand the fundamentals of wind energy and its conversion system
- To learn Geo thermal, OTEC, wave energy fundamentals energy conservation techniques, system and design methods
- To learn different classification in Hydropower sources and its energy conservation techniques along with environmental impact.

UNIT - I FUNDAMENTALS OF WIND ENERGY 9
Structure – statistics measurements and data presentation – wind turbine aerodynamics– momentum theories - basic aerodynamics – airfoils and their characteristics – HAWT - blade element theory – Prandtis lifting line theory (Prescribed wake analysis) VAWT aerodynamics - wind turbine loads – aerodynamic loads in steady operation – wind turbulence – Yawed operation and tower Shadow.

UNIT - II WIND ENERGY CONVERSION SYSTEMS (WECS) 9
Siting - rotor selection - annual energy output - horizontal axis wind turbine (HAWT) - vertical axis wind turbine - rotor design considerations - 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 energy Converters to Electrical networks – inverters - testing of WECS- WECS control system - requirements and strategies- miscellaneous topics-noise etc- other applications.

UNIT - III GEO, OTEC THERMAL ENERGY SOURCES 9
Introduction – estimates to geo thermal sources – hydro thermal resources – applications for thermal and electricity generation – prime movers – impulse and reaction turbines - small and medium scale hydro power - ocean energy - Introduction – OTEC conversion – thermal electric power generation - energy utilization – heat exchangers – site selection – potential Impacts

UNIT - IV TIDES AND WAVES ENERGY SOURCES 9
Introduction – principal of tidal power – power plants – applications - utilization of tidal energy –application - site requirements - storage systems - different methods and potential in India-waves energy – Introduction - basic concepts - wave power devices - wave energy conversion devices.

UNIT - V HYDRO POWER RESOURCES 9
Introduction - hydro electric basic concepts - hydro power plant - potential applications- potential development hydro power stations - components of hydro electric scheme- environmental aspects - potential impacts of harnessing the different renewable energy resources.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Freris, L.L., Wind Energy Conversion Systems, Prentice Hall, 1990

2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1983.

REFERENCES:

1. Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press, 1994.
2. Duffie, A and Beckmann, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, 1996.

EY9016 BIO - ENERGY CONSERVATION TECHNIQUES L T P C
3 0 0 3

AIM:

To disseminate the technologies for utilizing bio-energy and its manifold benefits compared to conventional fossil fuels.

OBJECTIVE:

- To detail on the types of biomass, its surplus availability and characteristics.
- Analyze the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.

UNIT I INTRODUCTION 8

Biomass: types – advantages and drawbacks – Indian scenario – characteristics – carbon neutrality – conversion mechanisms – fuel assessment studies

UNIT II BIOMETHANATION 8

Microbial systems – phases in biogas production – parameters affecting gas production – effect of additives on biogas yield – possible feed stocks.Biogas plants – types – design – constructional details and comparison – biogas appliances – Burner, illumination and power generation – effect on engine performance.

UNIT III COMBUSTION 10

Perfect, complete and incomplete – equivalence ratio – fixed Bed, fluid Bed – fuel and ash handling – steam cost comparison with conventional fuels. Briquetting: types of Briquetting – merits and demerits – feed requirements and preprocessing – advantages - drawbacks

UNIT IV GASIFICATION 10

Types – comparison – application – performance evaluation – economics – dual fuel engines – 100 % Gas Engines – engine characteristics on gas mode – gas cooling and cleaning train.

UNIT V PYROLYSIS AND CARBONIZATION 9

Types – process governing parameters – thermo gravimetric analysis – differential thermal analysis – differential scanning calorimetry – Typical yield rates.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.

2. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986

REFERENCES:

1. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997
2. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981
3. Best Practises Manual for Biomass Briquetting, I R E D A, 1997
4. Eriksson S. and M. Prior, The briquetting of Agricultural wastes for fuel, FAO Energy and Environment paper, 1990
5. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S

EY9018 GREEN BUILDINGS L T P C
3 0 0 3

AIM:

This course provides an introduction to the materials, theories and practices of Green building planning, design, construction, operation and deconstruction

OBJECTIVES:

- To learn green buildings concepts and ecological design concepts applicable to modern buildings
- Acquaint students with the principle theories materials, construction techniques and to create green buildings
- To provide exposure to various national and international rating systems as compliance requirements for green buildings

UNIT I GREEN BUILDING PROCESS AND ECOLOGICAL DESIGN 9

Conventional versus green building delivery systems - Green building project execution - the integrated design process - green building documentation requirements **-** design versus ecological design **-** historical perspective - contemporary ecological design - future ecological design - green design to regenerative design.

UNIT II GREEN BUILDING SYSTEMS 9

Sustainable sites and landscaping – enhancing ecosystems - building envelop – selection of green materials - products and practices - passive design strategy – internal load reduction – indoor environment quality – building water and waste management – relevance to LEED / IGBC standards.

UNIT III GREEN BUILDING IMPLEMENTATION 9

Site protection planning - health and safety planning - construction and demolition waste management - reducing the footprint of construction operations - maximizing the value of building commissioning in HVAC System, lighting and non mechanical Systems - costs and benefits relevance to LEED / IGBC standards.

UNIT IV GREEN BUILDING ASSESSMENT 9

USGBC LEED building assessment standard - LEED certification process – green globes building assessment protocol- international building assessment systems -

LEED-NC Platinum / gold / silver building case studies – trends in building rating systems – IGBC standards – ECBC compliances.

UNIT V ECONOMICS OF GREEN BUILDINGS 9

Business case for high-performance green buildings - the economics of green building - benefits - managing initial costs - cost barrier in project management - long-term environment benefits.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Jerry Yudelson, Green building A to Z, Understanding the buildings, 2008.
2. Green building guidelines: Meeting the demand for low-energy, resource-efficient homes. Washington, D.C.: Sustainable Buildings Industry Council, 2004.

REFERENCES:

1. Jerry Yudelson, Green Building through Integrated Design, McGraw Hill, 2008
2. Means, R.S., Green building: project planning & cost estimating: a practical guide for constructing sustainable buildings: cost data. Kingston, Mass., 2006.
3. Means, R.S., Green building: project planning & cost estimating: a practical guide to materials, systems and standards; green, 2nd Edition. Kingston, Mass., 2006.
4. Alex Wilson and Mark Peipkorn., Green Building Products: the GreenSpec guide to residential building materials, 2nd Edition, Gabriola Island, BC:
5. Jane Anderson, David E. Shiers, and Mike Sinclair. The green guide to specification: an environmental profiling system for building materials and components, 3rd Edition, Oxford; Malden, MA: Blackwell Science, 2002.
6. Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, 2nd Edition, Wiley, 2007.
7. ECBC 2007 Manual, Bureau of Energy Efficiency, New Delhi

EY9020 HYDROGEN AND FUEL CELLS L T P C
3 0 0 3

AIM:

To enlighten the student community on various technological advancements, benefits and prospects of utilizing hydrogen/fuel cell for meeting the future energy requirements.

OBJECTIVE:

- To detail on the hydrogen production methodologies, possible applications and various storage options
- To discuss on the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics
- To analyze the cost effectiveness and eco-friendliness of Fuel Cells

UNIT I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES 9

Hydrogen – physical and chemical properties, salient characteristics.Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass

conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II HYDROGEN STORAGE AND APPLICATIONS 9

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons.Hydrogen transmission systems.Applications of Hydrogen.

UNIT III FUEL CELLS 9

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell

UNIT IV FUEL CELL - TYPES 9

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma (2005)
2. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK (2005)

REFERENCES:

1. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany (1996).
2. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork Ltd., London (1989)
3. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA (2002).
4. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press (2006)

EY9022 DEMAND SIDE MANAGEMENT OF ENERGY L T P C
3 0 0 3

AIM:

To understand the concept and methods of demand side management and load control both utility side and area side

OBJECTIVES:

- To provide in-depth load management techniques for shifting / leveling the load To analyze the impact system load shape, cost benefit and feasibility study of DSM program.
- To learn economic utilization of energy resources

UNIT I CONCEPTS AND METHODS OF DSM, LOAD CONTROL 9

Load control - energy efficiency - load management - DSM planning – design – marketing - impact assessment – direct – distributed - and local control - interruptible load - configuration of control system for load control - assessment of impact on load shape.

UNIT II STRATEGIC CONSERVATION AND LOAD MANAGEMENT TECHNOLOGIES 9

Strategic conservation via improving building envelope - air-conditioning – lighting - electric motor - and other industrial processes and equipment - load shifting and load leveling through thermal energy storage.

UNIT III ASSESSMENT OF IMPACT ON SYSTEM LOAD SHAPE 9

Energy audit and assessment of customers load shape for different customer groups - impact of DSM programs on load shapes in customer groups - categorized in economic sub sectors and by geographical location.

UNIT IV COST / BENEFIT ANALYSIS AND FEASIBILITY OF DSM PROGRAM 9

DSM program costing and Load Shape Impact on system - DSM program cost/benefit and feasibility - environmental benefits - type of customer incentives and programs - program design - use of analytic hierarchical process for assessment of customer acceptance and program penetration.

UNIT V INTEGRATED ELECTRIC UTILITY SERVICE UNDER DEREGULATED SITUATION 9

Institutional – legal - and political environments and the stages of development of electric utility Service - the mechanism of competition and development of the financial environment for economic utilization of resources for electric service.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Gellings, C.W. and Chamberlin, J. H., Demand-Side Management: Concepts & Methods, Firmont Press, 1993.
2. Gellings, C.W. and Chamberlin, J. H., Demand-Side Management Planning, Firmont Press, 1993.

REFERENCES:

1. Limaye, D. R and Rable, V., International Load Management: Methods to Practice, Firmont Press, 1988.
2. Hiroshi, Demand-Side Management of the Electric Power Industry in Japan, Central Research Institute of Electric Power Industry, 1998.
1. Bjork, C.O., Industrial Load Management: Theory, Practice and Simulations, Amsterdam, 1989.

EY9256 DESIGN OF HEAT EXCHANGERS LT P C
3 0 0 3

AIM:

The course is intended to build up necessary background for the design of the various types of heat exchangers.

OBJECTIVE:

- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.

UNIT II FLOW AND STRESS ANALYSIS 9

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures.

UNIT III DESIGN ASPECTS 9

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers.

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters - limitations.

UNIT V CONDENSERS AND COOLING TOWERS 9

Design of surface and evaporative condensers – cooling tower – performance characteristics.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Sadik Kakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002

REFERENCES

1. Arthur. P Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
2. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.
3. Hewitt.G.F, Shires.G.L and Bott.T.R, Process Heat Transfer, CRC Press, 1994.

IC 9262 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

AIM

This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

OBJECTIVE :

- To develop finite difference and finite volume discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

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 Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 10

Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM 10

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.

UNIT V TURBULENCE MODELS 5

Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL : 45 PERIODS

TEXT BOOKS :

2. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
3. Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
4. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
5. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K., 1981.
6. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA,1984.
7. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.
8. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
9. Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

EY 9001 ADVANCED ENGINEERING FLUID MECHANICS L T P C
3 0 0 3

AIM:

To introduce the advanced concepts of fluid mechanics and aerodynamics with the emphasis on practical applications.

OBJECTIVES:

- To understand the laws of fluid flow for ideal and viscous fluids.
- To represent the real solid shapes by suitable flow patterns and to analyze the same for aerodynamics performances.
- To understand the changes in properties in compressible flow and shock expansion.

UNIT I BASIC EQUATIONS OF FLOW 6

Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy and their engineering applications.

UNIT II POTENTIAL FLOW THEORY 12

Rotational and irrorational flows - circulation – vorticity - stream and potential functions for standard flows and combined flows – representation of solid bodies by flow patters.Pressure distribution over stationery and rotating cylinders in a uniform flow - magnus effect - Kutta – Zhukovsky theorem.Complex potential functions.Conformal transformation to analyze the flow over flat plate, cylinder, oval body and airfoils.Thin airfoil theory – generalized airfoil theory for cambered and flapped airfoils.

UNIT III VISCOUS FLOW THEORY 9

Laminar and turbulent Flow - laminar flow between parallel plates - Poiseuille's equation for flow through circular pipes.Turbulent flow - Darcy Weisbach equation for flow through circular pipe - friction factor - smooth and rough Pipes - Moody diagram – losses during flow through pipes.Pipes in series and parallel – transmission of power through pipes.

UNIT IV BOUNDARY LAYER CONCEPT 9

Boundary Layer - displacement and momentum thickness - laminar and turbulent boundary layers in flat plates - velocity distribution in turbulent flows in smooth and rough boundaries - laminar sub layer.

UNIT- V COMPRESSIBLE FLUID FLOW 9

One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – fundamentals of supersonics – normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Houghten, E.L. and Carruthers, N.B., Aerodynamics for Engineering Students, Arnold Publishers, 1993.
2. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill, Boston, 2001.

REFERENCES:

1. Streeter, V.L., Wylie, E.B., and Bedford, K.W., Fluid Mechanics, WCB McGraw Hill, Boston, 1998.
2. Munson, B.R., Young, D.F. and Okiisi, T.H., Fundamentals of Fluid Mechanics, John Wiley and Sons Inc., NewYork, 1990
3. Kumar, K.L., Engineering Fluid Mechanics, Eurasia Publishing House, New Delhi, 2002
4. Bansal, R.K., Fluid Mechanics, Saurabh and Co., New Delhi, 1985.

EY 9002	COGENERATION AND WASTE HEAT RECOVERY SYSTEMS	L T P C 3 0 0 3

AIM:

To detail on the importance of Total Energy Concept, its advantages and cost effectiveness

OBJECTIVE:

- To analyze the basic energy generation cycles
- To detail about the concept of cogeneration, its types and probable areas of applications
- To study the significance of waste heat recovery systems and carryout its economic analysis

UNIT I INTRODUCTION 9

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

UNIT II COGENERATION TECHNOLOGIES 9

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

UNIT III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES 9

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

UNIT IV WASTE HEAT RECOVERY SYSTEMS 9

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

UNIT V ECONOMIC ANALYSIS 9

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.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987.

2. Institute of Fuel, London, Waste Heat Recovery, Chapman and Hall Publishers, London, 1963

REFERENCES:

1. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001
3. Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
4. De Nevers, Noel, Air Pollution Control Engineering, McGrawHill, New York, 1995.

TE9223 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL L T P C 3 0 0 3

AIM:

To create awareness among the student community on anthropogenic degradation of environment and technologies available to limit the degradation.

OBJECTIVES:

- To impart knowledge on the atmosphere and its present condition, global warming and eco-legislations.
- To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
- To elaborate on the technologies available for generating energy from waste.

UNIT I INTRODUCTION 9

Global atmospheric change – green house effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations.

UNIT II AIR POLLUTION 9

llutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

UNIT III WATER POLLUTION 9

Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

UNIT IV WASTE MANAGEMENT 9

Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

UNIT V OTHER TYPES OF POLLUTION FROM INDUSTRIES 9

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. G. Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003
2. Peavy, H.S. and D.R. Rowe, G.Tchobanoglous: Environmental Engineering - McGraw- Hill BookCompany, NewYork, 1985

REFERENCES

1. Ludwig, H. W.Evans: Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J, 1991
2. Arcadio P Sincero and G. A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002

TE9252 TURBOMACHINES L T P C
3 0 0 3

AIM:

To instil the working principles, performance and applications of Turbomachines in the minds of the students.

OBJECTIVES:

- To introduce the energy transfer process in Turbomachines and governing equations of various forms.
- To understand the structural and functional aspects of major components of Turbomachines.
- To understand the applications of Turbomachines to gas turbine power plants and aerospace propulsion.

UNIT I INTRODUCTION 12

Basics of isentropic flow – diffuser and nozzle configurations - static and stagnation properties – area ratio – mass flow rate – critical properties - operating characteristics of diffuser and Nozzle. Various types of subsonic and supersonic inlets.Basics of Fanno and Rayleigh flow.Basics of normal and oblique shock waves.Use of gas tables.Energy transfer between fluid and rotor velocity triangles for a generalized turbomachine - methods of representing velocity diagrams - Euler turbine equation and its different forms - degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, polytropic etc.

UNIT II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS 9

Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio.Axial flow compressor – geometry and working – velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves.

UNIT III COMBUSTION CHAMBER 6

Basics of combustion and chamber – chamber arrangements - flame stability – fuel injection nozzles. Swirl for stability - cooling of combustion chamber.

UNIT IV AXIAL AND RADIAL FLOW TURBINES 9

Elementary theory of axial flow turbines - stage parameters- multi-staging - stage loading and flow coefficients - degree of reaction - stage temperature and pressure ratios – single and twin spool arrangements – performance.Matching of components. Blade Cooling.Radial flow turbines.

UNIT V GAS TURBINE AND JET ENGINE CYCLES 9

Gas turbine cycle analysis – simple and actual – Reheater, Regenerator and Intercooled cycles.Working principles of Turbojet, Turbofan, Turboprop, Ramjet, Scarmjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, sfc, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Khajuria P.R and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
2. Ganesan, V. Gas Turbines, Tata McGrawHill, 1999.

REFERENCES:

1. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiely, 5th Edition 2001.
2. Hill P G and Peterson C R, Mechanics and Thermodynamics of Propulsion, Addition-Wesley, 1970.
3. Mattingly J D, Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition. 1997.

TE9258 NUCLEAR ENGINEERING L T P C
3 0 0 3

AIM:

To provide in-depth knowledge on Nuclear reaction materials reprocessing techniques and also to understand nuclear waste disposal techniques and radiation protection aspects.

OBJECTIVES:

- To describe fundamental study of nuclear reactions
- To learn nuclear fuels cycles, characteristics. Fundamental principles governing nuclear fission chain reaction and fusion
- To discuss future nuclear reactor systems with respect to generation of energy, fuel breeding, incineration of nuclear material and safety.

UNIT I NUCLEAR REACTIONS 9

Mechanism of nuclear fission - nuclides - radioactivity – decay chains - neutron reactions - the fission process - reactors - types of fast breeding reactor - design and construction of nuclear reactors - heat transfer techniques in nuclear reactors - reactor shielding.

UNIT II REACTOR MATERIALS 9

Nuclear Fuel Cycles - characteristics of nuclear fuels - Uranium - production and purification of Uranium - conversion to UF4 and UF6 - other fuels like Zirconium, Thorium - Berylium.

UNIT III REPROCESSING 9

Nuclear fuel cycles - spent fuel characteristics - role of solvent extraction in reprocessing - solvent extraction equipment.

UNIT IV SEPARATION OF REACTOR PRODUCTS 9

Processes to be considered - 'Fuel Element' dissolution - precipitation process – ion exchange - redox - purex - TTA - chelation -U235 - Hexone - TBP and thorax Processes - oxidative slaging and electro - refinng - Isotopes - principles of Isotope separation.

UNIT V WASTE DISPOSAL AND RADIATION PROTECTION 9

Types of nuclear wastes - safety control and pollution control and abatement - international convention on safety aspects - radiation hazards prevention.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, 3rd Edition, Von Nostrand, 1984.
2. Duderstadt, J.J. and Hamilton, L.J., Nuclear Reactor Analysis, John Wiley, 1976.

REFERENCES:

1. Lamarsh, J.R., Introduction to Nuclear Reactor Theory, Wesley, 1996.
2. Walter, A.E. and Reynolds, A.B., Fast Breeder Reactor, Pergamon Press, 1981.
3. Winterton, R.H.S., Thermal Design of Nuclear Reactors, Pergamon Press, 1981.

TE9270 ADVANCED POWER PLANT ENGINEERING L T P C
3 0 0 3

AIM:

To introduce the advances in operations and applications of different types of power plants.

OBJECTIVE:

- To understand the energy scenario and the environmental issues related to the power plants.
- To understand the various improvements possible in steam turbine, gas turbine and combined cycle power plants.
- To study the advances in nuclear and MHD power plants.

UNIT I INTRODUCTION 6

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

UNIT II STEAM AND GAS TURBINE POWER PLANTS 12

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

UNIT III ADVANCED POWER CYCLES 10

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

UNIT IV NUCLEAR AND MHD POWER PLANTS 10

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

UNIT V ENVIRONMENTAL ISSUES 7

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

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Nag, P.K., Power Plant Engineering, Tata Mcgraw Hill Publishing Co Ltd, New Delhi, 1998.
2. Arora and Domkundwar, A course in power Plant Engineering, Dhanpat Rai and CO, 2004.

REFERENCES:

1. Haywood, R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.
2. Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York,1984.
3. Gill, A.B., Power Plant Performance, Butterworths, 1984.
4. Lamarsh, J.R., Introduction to Nuclear Engg.2nd edition, Addison-Wesley, 1983.

TE9271 STEAM GENERATOR TECHNOLOGY L T P C
3 0 0 3

AIM:

To understand the types, working of steam generator and their major components, along with design principles and calculations.

OBJECTIVES:

- To educate the students on the types of boilers with their constructional and functional significance.
- To understand the working and design of coal preparation units and boilers.
- To introduce the concept of heat transfer surfaces and the boiler design.

UNIT I INTRODUCTION 10

Boilers – components - classification – general design considerations - boiler specifications.Fuel stoichiometry calculations – enthalpy calculation of air and combustion products – heat balance.

UNIT II COAL PREPARATION SYSTEM OF BOILERS 8

Pulverizing properties of coal – air system for pulverization – size - reducing machines.Design of coal preparation system for PC Boilers – fuel-feeding arrangements

UNIT III DESIGN OF BURNERS 8

Design of oil supply system - tangential fired burners - oil atomizers - air registers - design principles of oil fired boilers

UNIT IV BOILER FURNACE DESIGN 9

General design Principles – flame Emissivity – heat transfer calculation for PC Boiler furnace – water wall arrangement – furnace emissivity – distribution of heat load in furnace.Fluidized bed boilers - major features of fluidized bed boilers – basic design principles.

UNIT V DESIGN OF CONVECTIVE HEAT TRANSFER SURFACE 10

Design of economizer – superheater – reheater – air preheater.Temperature control in superheaters and reheaters.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Prabir Basu, Cen Kefa and Louis Jestin, Boilers and Burners: Design and Theory, Springer 2000.
2. Ganapathy, V., Industrial Boilers and Heat Recovery Steam Generators, Marcel Dekker Ink 2003

REFERENCES:

1. David Gunn and Robert Horton, Industrial Boilers, Longman Scientific and Technical Publication, 1986
2. Carl Schields, Boilers: Type, Characteristics and Functions, McGraw Hill Publishers, 1982
3. Howard, J.R., Fluidized Bed Technology: Principles and Applications, Adam Hilger, NewYork, 1983.

TE9272 FLUIDIZED BED SYSTEMS L T P C
3 0 0 3

AIM:

To inspire the students with the theories of fluidization, heat transfer and design for various applications.

OBJECTIVES:

- To introduce the concepts of fluidization and heat transfer in fluidized beds.
- To understand the design principles and apply the same for industrial applications.

UNIT I FLUIDIZED BED BEHAVIOUR 12

Characterization of bed particles - comparison of different methods of gas - solid contacts.Fluidization phenomena - regimes of fluidization – bed pressure drop curve.Two phase and well-mixed theory of fluidization.Particle entrainment and elutriation – unique features of circulating fluidized beds.

UNIT II HEAT TRANSFER 6

Different modes of heat transfer in fluidized bed – bed to wall heat transfer – gas to solid heat transfer – radiant heat transfer – heat transfer to immersed surfaces.Methods for improvement – external heat exchangers – heat transfer and part load operations.

UNIT III COMBUSTION AND GASIFICATION 6

Fluidized bed combustion and gasification – stages of combustion of particles – performance - start-up methods.Pressurized fluidized beds.

UNIT IV DESIGN CONSIDERATIONS 9

Design of distributors – stoichiometric calculations – heat and mass balance – furnace design – design of heating surfaces – gas solid separators.

UNIT V INDUSTRIAL APPLICATIONS 12

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing.Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission Control.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Howard,J.R.,Fluidized Bed Technology:Principles and Applications,Adam Hilger, NewYork, 1983.
2. Geldart, D., Gas Fluidization Technology, John Willey and Sons, 1986.

REFERENCES:

1. Kunii, D and Levespiel, O., Fluidization Engineering, John Wiley and Son Inc, New York, 1969.
2. Howard, J.R. (Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, NewYork, 1983.
3. Botteril, J.S.M., Fluid Bed Heat Transfer, Academic Press, London, 1975.
4. Yates, J.G.Fundamentals of Fluidized bed Chemical Processes, Butterworths, 1983.