ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2013

M.E. ENERGY ENGINEERING

I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA7169	Advanced Numerical Methods	3	1	0	4
2	EY7101	Fluid Mechanics and Heat Transfer	3	1	0	4
3	EY7102	Thermodynamic Analysis of Energy Systems	3	1	0	4
4	EY7103	Energy Resources	3	0	0	3
5	EY7104	Energy Conservation in Thermal Systems	3	0	0	3
6		Elective I	3	0	0	3
PRACTICAL						
7	EY7111	Energy Laboratory	0	0	3	2
		TOTAL	**18**	**3**	**3**	**23**

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EY7201	Energy Conservation in Electrical Systems	3	0	0	3
2	EY7202	Design and Analysis of Turbomachines	3	0	0	3
3	EY7203	Measurement and Control for Energy Systems	3	0	0	3
4		Elective II	3	0	0	3
5		Elective III	3	0	0	3
6		Elective IV	3	0	0	3
PRACTICAL						
7	EY7211	Seminar	0	0	2	1
8	EY7212	Simulation Laboratory	0	0	3	2
		TOTAL	**18**	**0**	**5**	**21**

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1		Elective V	3	0	0	3
2		Elective VI	3	0	0	3
3		Elective VII	3	0	0	3
PRACTICAL						
4	EY7311	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	EY7411	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 71

ELECTIVES FOR M.E ENERGY ENGINEERING

SEMESTER I (Elective I)

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	EY7001	Energy Systems Modeling and Analysis	3	0	0	3
2	TE7001	Design of Heat Exchangers	3	0	0	3
3	EB7071	Electrical Drives and Controls	3	0	0	3
4	EY7002	Power Generation, Transmission and Utilization	3	0	0	3
5	PX7301	Power Electronics for Renewable Energy Systems	3	0	0	3
6	EY7003	Hydrogen and Fuel Cell Technologies	3	0	0	3

SEMESTER II (Elective II, III & IV)

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	EY7004	Energy Conversion Techniques	3	0	0	3
2	EY7005	Solar Energy Technologies	3	0	0	3
3	EY7006	Wind Energy Technologies	3	0	0	3
4	EY7007	Bio Energy Conversion Techniques	3	0	0	3
5	EY7008	Nuclear Engineering	3	0	0	3
6	EY7009	Computational Fluid Dynamics for Energy Systems	3	0	0	3

SEMESTER III (Elective V, VI & VII)

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	TE7010	Advanced Power Plant Engineering	3	0	0	3
2	EY7010	Steam Generator Technology	3	0	0	3
3	EY7011	Fluidized Bed Systems	3	0	0	3
4	EY7012	Advanced Energy Storage Technologies	3	0	0	3
5	EY7013	Waste Management and Energy Recovery	3	0	0	3
6	EY7014	Energy Efficient Buildings	3	0	0	3
7	TE7203	Environmental Engineering and Pollution Control	3	0	0	3
8	EY7015	Energy forecasting, Modeling and Project Management	3	0	0	3

MA7169 **ADVANCED NUMERICAL METHODS** **L T P C**
3 1 0 4

AIM:

OBJECTIVES:
To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS (9+3)
Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS (9+3)
Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION (9+3)
Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme- Stability of above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS (9+3)
Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD (9+3)
Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

TOTAL (L – 45 + T – 15): 60 PERIODS

OUTCOME:
It helps the students to get familiarized with the numerical methods which are necessary to solve numerically the problems that arise in engineering.

REFERENCES

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 1995
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009.
4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , "Computational Methods for Partial Differential Equations", New Age Publishers,1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.

EY7101 FLUID MECHANICS AND HEAT TRANSFER **L T P C**
3 1 0 4

AIM:
This Course is intended to buildup necessary fundamentals of fluid Mechanics and Heat transfer relevant to Energy applications

OBJECTIVES:
- To understand the laws of fluid flow and Heat transfer
- To develop the skills to correlate the Physics with applications

UNIT I BASIC EQUATION, POTENTIAL FLOW THEORY AND BOUNDARY LAYER CONCEPT 9+3
Three dimensional continuity equation – differential and integral forms – equations of mass, momentum and Energy and their engineering applications. Rotational and irrotational flows – circulation – vorticity – stream and potential functions. Boundary Layer - displacement and momentum thickness – laminar and turbulent boundary layers in flat plates – circular pipes.

UNIT II INCOMPRESSIBLE AND COMPRESSIBLE FLOWS 9+3
Laminar and turbulent flow between parallel plates – flow through circular pipe – friction factor – smooth and rough pipes – Moody diagram – looses during flow through pipes. Pipes in series and parallel – transmission of power through pipes. One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers

UNIT III CONDUCTION AND RADIATION HEAT TRANSFER 12+3
Governing Equation and Boundary conditions, Extended surface Heat Transfer, Transient conduction – Use of Heisler's charts, Conduction with moving boundaries, Radiation Heat Transfer, Gas Radiation

UNIT IV TURBULENT FORCED CONVECTIVE HEAT TRANSFER 8+3
Turbulence theory – mixing length concept – turbulence model – k Є model – analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube – high speed flows.

UNIT V PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 7+3
Condensation on bank of tubes – boiling – pool and flow boiling, Heat exchanger – Є – NTU approach and design procedure – compact heat exchangers

TOTAL: 45+15 = 60 PERIODS

OUTCOME
Student will be able to use the concepts of Heat Transfer and fluid flow in the field of energy applications.

TEXT BOOK:

1. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill, Boston, 2001.
2. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985.

REFERENCES

1. Streeter, V.L., Wylie, E.B., and Bedford, K.W., Fluid Mechanics, WCB McGraw Hill, Boston, 1998.
2. Bansal,R.K., Fluid Mechanics, Saurabh and Co., New Delhi, 1985.
3. Holman.J.P., Heat Transfer, Tata Mc Graw Hill, 2002.
4. Ghoshdastidar.P.S., Heat Transfer, Oxford University Press, 2004

EY7102 THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS **L T P C**
3 1 0 4

AIM:
To introduce and apply advanced concepts of thermodynamics to engineering systems

OBJECTIVES:
- To understand and apply the concept of availability
- To understand the and calculate the behavior of real gases
- To predict the condition of systems and analyse them by the criteria of equilibrium
- To apply the concepts of advanced thermodynamics to combustion systems

UNIT I AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATION **10+3**
Reversible work - availability – irreversibility. 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 - C_p and $C_{V.}$ Clausius Clayperon equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations

UNIT II REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS **10+3**
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. Ideal and real gas mixtures. Equilibrium in multi phase systems

UNIT III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM **10+3**
First and second law analysis of reacting systems - Adiabatic flame temperature - entropy change of reacting systems. Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures and evaluation of equilibrium composition.

UNIT IV COMBUSTION CHEMISTRY **8+3**
Combustion of Hydrocarbon Fuels. Heat of reaction, combustion and formation. Stoichiometric, fuel rich and oxygen rich reactions. Heating value of fuels. Application of energy equation to the combustion process. Explosion limits, flames and flammability limits. Diffusion and premixed flames.

UNIT V COMBUSTION PROCESS and COMBUSTION CHAMBERS **7+3**
Combustion in IC Engines and Gas turbines. Knocking and Detonation and control. Design principles of combustion chambers for IC Engines and Gas turbine. Arrangements of gas turbine combustion chambers for power and comparative analysis.

TOTAL: 45+15 = 60 PERIODS

OUTCOME:
Students will able to
- Calculate the availability of the systems and cycles
- Analyse the engineering systems to improve and optimize its performance
- Understand the working and design principles of combustion systems

REFERENCES

1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
2. Kuo, K.K., Principles of Combustion, John Wiley and Sons, 2005
3. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGrew – Hill Inc., 1995.
4. Winterbone D E, Advanced Thermodynamics for Engineers, Arnold, 1997.
5. Ganesan, V., Gas Turbines, Tata McGrawHill, 2011.
6. Ganesan,V., Internal Combustion Engines, Tata McGrawHill, 2006.

7. Khajuria P.R and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
8. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiely, 5th Edition 2001.

EY7103 ENERGY RESOURCES **L T P C**
3 0 0 3

AIM:
To introduce and apply advanced concepts of thermodynamics to engineering systems To understand types and applications of various form of energy sources and its environmental impacts.

OBJECTIVES:
- To explain concept of various forms of Non-renewable and renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications
- To analysis the environmental and cost economics of using renewable energy sources compared to fossil fuels.

UNIT I COMMERCIAL ENERGY 9
Coal, Oil, Natural Gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

UNIT II SOLAR ENERGY 9
Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT III WIND ENERGY 9
Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

UNIT IV BIO-ENERGY 9
Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT V OTHER TYPES OF ENERGY 9
Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro - geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.

TOTAL: 45 PERIODS

OUTCOME:

- Understanding of commercial energy and renewable energy sources
- Knowledge in working principle of various energy systems
- Capability to do basic design of renewable energy systems

REFERENCES

1. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 1984.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986.
3. Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi, 2012
4. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill,2007
5. Kreith, F and Kreider, J. F., Principles of Solar Engineering, McGraw-Hill, 1978.
6. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford
7. University Press, U.K, 1996.
8. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1990
9. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, 1980.
10. Bridgurater, A.V., Thermochemical processing of Biomass, Academic Press, 1981.
11. Bent Sorensen , Renewable Energy, Elsevier, Academic Press, 2011

EY7104 ENERGY CONSERVATION IN THERMAL SYSTEMS L T P C
3 0 0 3

AIM:

This course is intended to introduce principles of energy auditing and to provide measures for energy conservation in thermal utilities

OBJECTIVES:

- To learn the present energy scenario and the need for energy conservation
- To understand the monitoring / targeting aspects of Energy
- To study the different measures for energy conservation and financial implications of various thermal utilities

UNIT I INTRODUCTION 7

Indian Energy Scenario – Types & Forms of Energy - Primary / Secondary Energy Sources – Energy Conservation – Need – EC Act 2003 : Salient Features – Energy Intensive Industries – Barriers - Roles & Responsibility of Energy Managers – Energy Auditing : Preliminary & Detailed - Benchmarking .

UNIT II ENERGY MONITORING & TARGETING 9

Data & Information Analysis – Cost / Energy Share Diagram – Data Graphing – Break Even Analysis – Depreciation – Financial Analysis Techniques – CUSUM Technique – ESCO Concept – ESCO Contracts.

UNIT III PERFORMANCE STUDY OF THERMAL UTILITIES – 1 11

Boiler – Stoichiometry – Combustion Principles – Heat Loss Estimation – Steam Traps – Steam Piping & Distribution – Thermic Fluid Heaters – Furnaces – Insulation & Refractories

UNIT IV PERFORMANCE STUDY OF THERMAL UTILITIES – 2 11

Cogeneration – Principles & Operation – Power Ratio - Economics of Cogeneration Scheme – Case Study on Cogeneration – WHR – Sources & Grades – Types (Heat Wheel, Recuperators, Regenerators ,Heat Pipe etc) – Scheme Evaluation – Economics of WHR Systems – Thermal Energy Storage – Basics & Concepts as an ENCON scheme

UNIT V PERFORMANCE STUDY OF THERMAL UTILITIES – 3 7

Basics of R & A/C – COP / EER / SEC Evaluation – Psychometric Chart Analysis – Types & Applications of Cooling Towers – Basics – Performance Analysis – DG Set – Performance Prediction – Cost of Power Generation – Scope for Energy Conservation in all these

TOTAL: 45 PERIODS

OUTCOME:

1. Students will be familiar with Energy Conservation scenario in general and will be mastering the thermal energy auditing technologies / procedures
2. Financial aspects also will be made clear to them as far as Energy Conservation Schemes are concerned. In short, students will become knowledgeable on techno – economic aspects of Energy Conservation

REFERENCES

1 Smith, CB Energy Management Principles, Pergamon Press, NewYork, 1981
2 Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980
3 Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
4 Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington, 1988
5 Diamant, RME, Total Energy, Pergamon, Oxford, 1970
6 Handbook on Energy Efficiency, TERI, New Delhi, 2001
7 Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)

EY7111 ENERGY LABORATORY L T P C
0 0 3 2

AIM:

To make the student to feel/understand the magnitude of numbers being used in the energy sector

OBJECTIVES:

- Acquainting the students on the SOP adopted for quantification of various parameters
- Inculcate the habit of analyzing the numbers resulting from experimentation
- Create awareness on actual performance limits of renewable energy gadgets/ industrial utilities

Session 1 RENEWABLE ENERGY 18

1. Performance testing of Solar Hot Water Collector
2. Characteristics of Solar photovoltaic devices
3. Testing of biomass Gasifier in updraught/downdraught mode
4. Testing of biogas plant
5. Fuel characterization
   (proximate analysis, calorific value, viscosity, specific gravity etc.,)
6. Solar Radiation measurement

Session 2 ENERGY CONSERVATION 18

1. Boiler efficiency testing using direct and indirect method
2. Testing of steam turbine efficiency
3. Motor efficiency testing

4. Computation of pump & pumping system characteristics (pump curve, system curve and BEP)
5. Analysis of various luminaries and computation of their efficacy
6. Analysis on Blowers/fans characteristic curves
7. Comparison of discharge control techniques in rotating machineries using VFD, throttling, bypass, parallel/series operation, impeller trimming
8. Heat Exchangers
9. Effect of superheating, sub-cooling, condenser temperature and evaporator temperature on the COP of an AC system

Session 3 ALTERNATE ENERGY SYSTEMS 9

1. Fuel Cell
2. Synthesis of biodiesel
3. Performance evaluation of engine on biodiesel
4. Thermal Energy Storage Systems

TOTAL: 45 PERIODS

OUTCOME

- Students will be knowledgeable on the
- Procedure to be adopted for performance analysis and optimization of energy utilities
- Methodology to be adopted for the quantification of performance governing parameters

EQUIPMENTS REQUIRED

1. Solar water heater – 100 LPD
2. SPV Educational Kit
3. 20 kW_e flexible draught gasifier
4. Biogas plant (fixed dome or floating drum)
5. Bomb calorimeter
6. Junker's gas calorimeter
7. Viscometer
8. Hydrometer
9. Flash and fire point apparatus
10. Proximate analyser (Muffle furnace and micro weigh balance)
11. Solar Radiation Meters
12. Non-IBR boiler
13. Simple impulse steam turbine
14. 5 HP motor efficiency test rig
15. Pump efficiency test rig
16. Blower/fan efficiency test rig
17. Heat Exchangers (plate, pipe-in-pipe, shell and tube)
18. Vapour Compression Refrigeration Test Rig
19. Fuel cell – Educational Kit
20. Biodiesel synthesizing kit
21. 5 hp air or water cooling engine
22. PCM based energy storage system

EY7201 ENERGY CONSERVATION IN ELECTRICAL SYSTEMS L T P C
3 0 0 3

AIM:

This course is intended to study the basics of electrical energy usage and means of electrical energy conservation in all utilities including rotating machineries / Illumination.

OBJECTIVES:

- To study the concepts of power factor, load management etc.
- To study the various measures for energy conservation in electrical devices both static & rotating machineries
- To study the emission related aspects & also a couple of case studies related to ENCON

UNIT I BASICS OF ELECTRICAL ENERGY USAGE 9

Fuel to Power : Cascade Efficiency – Electricity Billing : Components & Costs – kVA – Need & Control – Determination of kVA demand & Consumption – Time of Day Tariff – Power Factor Basics – Penalty Concept for PF – PF Correction – Demand Side Management (a brief)

UNIT II TRANSFORMERS & MOTORS 9

Transformer – Basics & Types – AVR & OLTC Concepts – Selection of Transformers – Performance Prediction - Energy Efficient Transformers - Motors : Specification & Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding & Oversizing - Energy Efficient Motors - ENCON Scope

UNIT III FANS / PUMPS / COMPRESSORS 11

Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods (General & Latest) adopted for effecting ENCON – Economics of ENCON adoption in all the 3 utilities

UNIT IV ILLUMINATION & ENERGY EFFICIENCY DEVICES 8

Specification of Luminaries – Types – Efficacy – Selection & Application – ENCON Avenues & Economic Proposition - New Generation Luminaries (LED / Induction Lighting) -
Soft Starters / Auto Star – Delta – Star Starters / APFC / Variable Speed & Frequency Drives –
Time Sensors – Occupancy Sensors

UNIT V CASE STUDIES & CO_2 MITIGATION 8

Case Study Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO_2 Mitigation & Energy Conservation & Cost Factor

TOTAL: 45 PERIODS

OUTCOME:

1. Basics of Electrical Energy Conservation would be the major outcome of this.
2. In addition, technical aspects of Rotating Machineries (Pumps / Fans / Compressors) will be made clear to them enabling them to work on energy savings
3. Typical industrial case studies will make them to realize the economic potential of energy conservation

REFERENCES

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
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001
4. Peters et al. Sustainable Energy, beta – test – draft
5. Kraushaar and Ristenen, Energy and Problems of a Technical
6. Society, 1993
7. Guide book for National Certification Examination for Energy
8. Managers and Energy Auditors (Could be downloaded from
9. www.energymanagertraining.com)

EY7202 DESIGN AND ANALYSIS OF TURBOMACHINES

L	T	P	C
3	0	0	3

AIM:
To design and analyse the performance of Turbo machines for engineering applications.

OBJECTIVES:
- To understand 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 design various Turbomachines for power plant and aircraft applications

UNIT I INTRODUCTION 12
Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations - area ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbomachines - velocity diagrams. Euler's equation for turbomachines and its different forms. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytropic

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 and losses

UNIT III COMBUSTION CHAMBER 6
Basics of combustion. Structure and working of combustion chamber – combustion chamber arrangements - flame stability – fuel injection nozzles. Flame stabilization - 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. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scarmjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, specific fuel consumption, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS

OUTCOME:
When a student completes this subject, he / she can
- Understand the design principles of the turbomachines
- Analyse the turbomachines to improve and optimize its performance

REFERENCES

1. Ganesan, V., Gas Turbines, Tata McGrawHill, 2011.
2. Khajuria P.R and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003
3. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiely, 5th Edition 2001.
4. Hill P G and Peterson C R, Mechanics and Thermodynamics of Propulsion, Addition-Wesley, 1970.
5. Mattingly J D, Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition. 1997

EY7203 MEASUREMENT AND CONTROL FOR ENERGY SYSTEMS **L T P C**
3 0 0 3

AIM:
To impart the student on measurement and control techniques applicable to Energy systems

OBJECTIVES:
- To understand the principle and use of sensors for measurement of different thermal and electrical parameters.
- To understand the concept of control systems, modes, design and their applications

UNIT I MEASUREMENT CHARACTERISTICS 5
Introduction to measurements, Errors in measurements, Statistical analysis of data, Regression analysis, correlation, estimation of uncertainty and presentation of data, design of experiments – Experimental design factors and protocols

UNIT II MEASURMENTS IN ENERGY SYSTEMS 15
Basic Electrical measurements, Transducers and its types, Signal conditioning and processing - Measurement of temperature, pressure, velocity, flow rate, thermo-physical and transport properties of solids liquids and gases, radiation properties of surfaces, vibration and noise - Computer assisted data acquisition, data manipulation and data presentation

UNIT III CONTROL SYSTEMS 7
Introduction, Open and closed loop control systems, Transfer function. Types of feedback and feedback control system characteristics – Effect of disturbances – dynamic characteristics

UNIT IV CONTROL COMPONENTS AND CONTROLLER 9
Process characteristics, Control system parameters – DC and AC servomotors, servo amplifier, potentiometer, synchro transmitters, synchro receivers, synchro control transformer, stepper motors - Continuous, Discontinuous and Composite control modes – Analog and Digital controllers

UNIT V DESIGNING OF MEASUREMENT AND CONTROL SYSTEMS 9
Designing of temperature, pressure, flow and liquid level measurement and control system – Performance – Steady state accuracy – Transient response – Frequency response – Fault finding – Computer based controls

TOTAL: 45 PERIODS

OUTCOME:
1. Students will be familiar with various measurement techniques useful for the evaluation of Energy Conservation Schemes.
2. Control aspects also will be made clear to them as far as Energy Conservation Schemes are concerned.
3. In short, students will become knowledgeable on the design of measurement and control systems for thermal / electrical energy systems

REFERENCES

1. Holman, J.P. Experimental methods for Engineers, McGraw – Hill, 2008
2. W. Bolten, Industrial Control and Instrumentation, University Press, 2004
3. Alan S Morris, Reza Langari, Measurements and Instrumentation – Theory and Application, Elsevier Inc, 2012.
4. S.P. Venkateshan, Mechanical Measurements, Ane Books Pvt Ltd, 2010
5. Curtis D Johnson, Process Control Instrumentation Technology, PHI Learning Private Limited, 2011.

EY7211 **SEMINAR** **L T P C**
0 0 2 1

OBJECTIVES:

- During the seminar session each student is expected to prepare and present a topic on Energy related issues / technology, for a duration of about 30 minutes.
- In a session of three periods per week, 4 students are expected to present the seminar.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models.

TOTAL: 30 PERIODS

EY7212 **SIMULATION LABORATORY** **L T P C**
0 0 3 2

FOCUS: USE OF STANDARD APPLICATION SOFTWARE FOR SOLVING HEAT TRANSFER PROBLEMS

1. Heat exchanger analysis – NTU method
2. Heat exchanger analysis – LMTD method
3. Convection heat transfer analysis – Velocity boundary layer
4. Convection heat transfer analysis – Internal flow
5. Radiation heat transfer analysis – Emissivity
6. Critical radius of insulation
7. Lumped heat transfer analysis
8. Conduction heat transfer analysis
9. Condensation heat transfer analysis

DYNAMIC LINKING OF MAT LAB AND REF PROP SOFTWARE
SIMPLE CFD PROBLEMS FOR PRACTICE

NOTE: The above exercises are only guidelines to maintain the standard for teaching and conduct of examination.

SIMULATION LAB – REQUIREMENT:

1. Software - Modeling software like ProE, Gambit, Ansys etc
   Analysis software like Ansys, fluent, CFX, etc
   Equation solving software like Matlab, Engg equation solver

1. Every students in a batch must be provided with a terminal
2. Hardware are compatible with the requirement of the above software.

TOTAL: 45 PERIODS

EY7001 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 and to optimize the energy system.

UNIT I INTRODUCTION 9
Primary energy analysis - 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 - New generation optimization techniques – Genetic algorithm and simulated annealing - examples

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

OUTCOME:
1. Student will be able do to Simulation and Modeling of typical energy system
2. Able to analysis effect of constraints on the performance of energy systems
3. Has a potential to do design HEN net work and perform Energy-Economic Analysis for a typical applications

REFERENCES

1. Bejan, A, Tsatsaronis, G and Moran, M., Thermal Design and Optimization, John Wiley & Sons 1996
2. Stoecker, W.F., Design of Thermal Systems, McGraw Hill, 2011.
3. Yogesh Jaluria, Design and Optimization of Thermal Systems, CRC Press INC, 2008
4. C. Balaji, Essentials of Thermal System Design and Optimization, Aue Books, 2011

TE7001 **DESIGN OF HEAT EXCHANGERS** **L T 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

OBJECTIVES:
- 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

OUTCOME
Able to design the heat exchanger based on the information provided for a particular application and do the cost economic analysis

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.

EB7071 **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 understand the principle of conventional motor drives, concepts of various losses and harmonics effects in motors and superconductivity theory.
- To understand the concept of Solid State motor controllers and their applications

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 – Single Phase and Three Phase with R, RL and Freewheeling Diode, Choppers - Type-A, Type-B, Type C and Type D, Inverters - Single Phase and Three Phase with R, RL and Freewheeling Diode, AC Voltage Controllers

UNIT IV SUPERCONDUCTIVITY 9

Principle of Super conductivity, 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: 45 PERIODS

OUTCOME:

The student will be able to understand

(i) The principle of conventional motor drives, concepts of various losses and harmonic effects in motors and superconductivity theory.
(ii) The concept of Solid State motor controllers and their applications.

REFERENCES

1. Subrahmanyam, Electric Drives : Concepts & Applications 2/E, Tata McGraw-Hill Education, 2011
2. Robert A. Huggins, Energy Storage , Springer(2010)
3. Rene Husson, Modelling and Control of Electrical machines, Elsevier Science Ltd, 2009
4. D.Singh, K.B.Khanchandani, Power Electronics, Tata McGraw-Hill Education Ltd, 2006
5. Austin Hughes, Electric Motor & Drives, Newnes, 2006.

EY7002 POWER GENERATION, TRANSMISSION AND UTILIZATION **L T P C**
3 0 0 3

AIM:

To expose the student to the different types of power generation techniques, electrical power transmission systems, characteristic and utilization of electrical drives

OBJECTIVES:

- To impart knowledge on Conventional Power Plants (Steam, Hydro, Nuclear and Gas Turbine plants) and Renewable Energy Power generation.
- To understand the Economics of Power generation and Utilization of Electrical Energy for Various applications.

UNIT I CONVENTIONAL POWER GENERATION 12

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 - 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 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 IV 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 – incandescent - fluoroscent and vapour lamps - Design of OLTC lighting Scheme of industry-electrical welding - energy efficient aspects of devices

UNIT V ECONOMICS OF POWER GENERATION 6

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

TOTAL: 45 PERIODS

OUTCOME:

The student will be able to understand

(i) The Operation of Conventional Power Plants (Steam, Hydro, Nuclear and Gas Turbine plants) and concepts of Renewable Energy Power generation.
(ii) The Economics of Power generation and Utilization of Electrical Energy for Various applications.

REFERENCES

1. S.N.Singh, Electrical Power generation, Transmission and Distribution 2nd Edition, PHILearning Private Limited, 2010
2. C.L.Wadhwa, Generation Distribution and utilization of Electrical Energy, New Age International, 2012
3. J.W.Twidell and A.D.Weir, Renewable Energy Sources, Taylor and Francis, 2006.
4. Mohammed E. El Hawary, Introduction to Electrical Power Systems, John Wiley & Sons, 2008.
5. R. Krishnan, Electric Motor Drives, Prentice hall, 2001.

PX7301 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS **L T P C**
3 0 0 3

OBJECTIVES :

- To Provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION 9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems : operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system : line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing.

Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV- Maximum Power Point Tracking (MPPT).

TOTAL : 45 PERIODS

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electricaal Systems”, Oxford University Press, 2009
2. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
3. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
4. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
5. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
6. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company,New Delhi.

EY7003 HYDROGEN AND FUEL CELLS TECHNOLOGIES

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

AIM:

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

OBJECTIVES:

- 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. Safety and management of hydrogen. 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

OUTCOME:

- Fundamentally strong understanding on the working of various fuel cells, their relative advantages / disadvantages and hydrogen generation/storage technologies

REFERENCES

1. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press (2006)
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma (2005
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK (2005)
4. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany (1996)
5. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork Ltd., London (1989)
6. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA (2002).

EY7004 ENERGY CONVERSION TECHNIQUES **L T P C**
3 0 0 3

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

OBJECTIVES:
To analyze the working principle, pros and cons of
- Conventional energy conversion techniques
- Direct energy conversion systems
- Need and necessity of energy storage systems and their desirable characteristics & Fuel cells

UNIT I CONVENTIONAL ENERGY CONVERSION CYCLES 8
Reversible and irreversible cycles – Thermodynamics analysis of Carnot – Stirling – Ericsson – Otto – Diesel – Dual – Lenoir – Atkinson – Brayton - Rankine.

UNIT II DIRECT CONVERSION OF THERMAL TO ELECTRICAL ENERGY 8
Thermoelectric Converters –Thermionic converters – MHD – Ferro electric converter – Nernst effect generator

UNIT III CHEMICAL & ELECTROMAGNETIC ENERGY TO ELECTRICAL ENERGY 9
Batteries – types – working – performance governing parameters – hydrogen energy – solar photovoltaic cells

UNIT IV ENERGY STORAGE SYSTEMS 9
Energy Storage Technologies - Mechanical energy, Electrical energy, Chemical energy, Thermal energy

UNIT V FUEL CELLS 11
Basics – types – working - comparative analysis – thermodynamics and kinetics of fuel cell process – performance of fuel cell – applications - advantages and drawbacks

TOTAL: 45 PERIODS

OUTCOME:
Awareness on the existence of various mechanisms for conversion and storage of energy, their merits, constraints and drawbacks

REFERENCES

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

EY7005 SOLAR ENERGY TECHNOLOGIES **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 – Sun path diagrams – Radiation - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - 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 SOLAR THERMAL TECHNOLOGIES 9

Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – 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 – Solar thermo-photovoltaics.

UNIT IV SPV 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 - 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 - 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

TOTAL: 45 PERIODS

OUTCOME:

1. Able to suggest and design a solar thermal based applications for a community
2. Will become expert in the design of solar photovoltaic based power systems for both domestic and industrial applications
3. Have the potential to apply the concept of utilization of solar energy for the said application in a economical way.

REFERENCES

1. Goswami, D.Y., Kreider, J. F. and & Francis., Principles of Solar Engineering, Taylor and Francis, 2000
2. Chetan Singh Solanki, Solar Photovoltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited, 2011
3. Sukhatme S P, J K Nayak, Solar Energy – Principle of Thermal Storage and collection, Tata McGraw Hill, 2008.
4. Solar Energy International, Photovoltaic – Design and Installation Manual – New Society Publishers, 2006
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2010.

EY7006 WIND ENERGY TECHNOLOGIES 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 gear coupled generator wind turbine components
- To learn modern wind turbine control & monitoring

UNIT I WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS 9

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis

UNIT II AERODYNAMICS THEORY & WIND TURBINE TYPES 9

Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator

UNIT III GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION 9

Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Sysnchronisation System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing

UNIT IV DIRECT ROTOR COUPLED GENERATOR (MULTIPOLE) [VARIABLE SPEED VARIABLE FREQ.] 9

Excited Rotor Synch.Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up / Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits

UNIT V MODERN WIND TURBINE CONTROL & MONITORING SYSTEM 9

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maitenance for Product Life Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.

TOTAL: 45 PERIODS

OUTCOME:

- Knowledge in conversion techniques of wind energy
- Learning of wind turbine components and their construction
- Understating of modern wind turbine control & monitoring

REFERENCES
1. Freris, L.L., Wind Energy Conversion Systems, Prentice Hall, 1990
2. Kaldellis J.K, Stand – alone and Hybrid Wind Energy Systems, CRC Press, 2010
3. Mario Garcia –Sanz, Constantine H. Houpis, Wind Energy Systems,CRC Press 2012
4. Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press, 1994.
5. Duffie, A and Beckmann, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
6. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, 1996.
7. Anna Mani : Wind Energy Data for India
8. C-Wet : Wind Energy Resources Survey in India VI
9. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1983
10. John D Sorensen and Jens N Sorensen, Wind Energy Systems, Woodhead Publishing Ltd, 2011

EY7007 BIO - ENERGY CONVERSION 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.

OBJECTIVES:
- 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 7
Biomass: types – advantages and drawbacks – Indian scenario – characteristics – carbon neutrality – conversion mechanisms – fuel assessment studies – densification technologies – Comparison with coal – Proximate & Ultimate Analysis - Thermo Gravimetric Analysis – Differential Thermal Analysis – Differential Scanning Calorimetry

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, luminaries and power generation – effect on engine performance

UNIT III COMBUSTION 10
Perfect, complete and incomplete combustion - stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems – steam cost comparison with conventional fuels

UNIT IV GASIFICATION, PYROLYSIS AND CARBONISATION 12
Chemistry of gasification - types – comparison – application – performance evaluation – economics – dual fuelling in IC engines – 100 % Gas Engines – engine characteristics on gas mode – gas cooling and cleaning systems - Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization Techniques – merits of carbonized fuels

UNIT V LIQUIFIED BIOFUELS 8

History of usage of Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel health effects / emissions / performance. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL: 45 PERIODS

OUTCOME:

- A practical understanding on the various biomass energy conversion technologies and its relevance towards solving the present energy crisis.

REFERENCES

1. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981
2. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
4. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997
5. Best Practises Manual for Biomass Briquetting, I R E D A, 1997
6. Eriksson S. and M. Prior, The briquetting of Agricultural wastes for fuel, FAO Energy and Environment paper, 1990
7. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S

EY7008 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 UF_4 and UF_6 - 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 HOURS : 45 PERIODS

OUTCOME:

- Understanding fundamentals of nuclear reactions
- Knowledge in nuclear fission chain reaction and fusion
- Awareness about reprocessing of spent fuel and waste disposal

REFERENCES

1. Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, 3rd Edition, Von Nostrand, 1984.
2. J. Kenneth Shultis, Richard E, Faw, Richard E. Faw, Fundamentals of Nuclear Science and Engineering, CRC Press, 2008
3. Tatjana Tevremovic, Nuclear Principles in Engineering, Springer, 2008
4. Kenneth D. Kok, Nuclear Engineering, CRC Press, 2009
5. Cacuci, Dan Gabriel, Nuclear Engineering Fundamentals, Springer, 2010
6. Lamarsh, J.R., Introduction to Nuclear Reactor Theory, Wesley, 1996.
7. Lalter, A.E. and Reynolds, A.B., Fast Breeder Reactor, Pergamon Press, 1981.
8. Winterton, R.H.S., Thermal Design of Nuclear Reactors, Pergamon Press, 1981.
9. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.

EY7009 COMPUTATIONAL FLUID DYNAMICS FOR ENERGY SYSTEMS **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

OBJECTIVES:

1. To understand the method of modelling the flow and heat transfer phenomenon.
2. To develop finite difference and finite volume discretized forms of the CFD equations.
3. To understand the various numerical schemes to solve convection and diffusion equations.

UNIT I INTRODUCTION 10

Numerical simulation – Advantages, Methods of classification of PDE's, Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions, Discretisation Methods, Finite Difference Expressions from Taylor's series, Uniform and non-uniform Grids - Numerical Errors, Grid Independence Test.

UNIT II CONSERVATION EQUATION 10

Mass, Momentum and Energy Equation three dimensions, Eulerian and Lagrangian Approach, Equation of State, Navier's Strokes equation, Differential and Integral form of general transport equations.

UNIT III CONDUCTION HEAT TRANSFER 10

Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems - Finite difference and Finite Volume approach

UNIT IV INCOMPRESSIBLE FLUID FLOW 10

Stream Function – Vorticity methods, Finite volume methods for Convection and diffusion problem – Central difference scheme, Upwind scheme, Hybrid scheme – Assessment of each scheme - Solution algorithm for pressure – velocity – coupling in steady flows - SIMPLE Procedure of Patankar and Spalding, SIMPLER and PISO Algorithm.

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

OUTCOME:

Student will be able to apply the concept of computational fluid dynamics in the Energy systems to predict the actual performance

REFERENCES

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

TE7010 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

OBJECTIVES

- To make the students to understand the energy scenario and the environmental issues related to the power plants
- Creating awareness to the students on the various utilities in the power plants and the avenues for optimizing them

UNIT I INTRODUCTION 5

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

UNIT II STEAM POWER PLANTS 9

Basics of typical power plant utilities - Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system - Rankine Cycle – thermodynamic analysis. Cycle improvements – Superheat, Reheat, Regeneration

UNIT III DIESEL AND GAS TURBINE POWER PLANTS 9

I.C Engine Cycles - Otto, Diesel & Dual –Theoretical vis-à-vis actual – Typical diesel power plant – Types – Components - Layout - Performance analysis and improvement - Combustion in CI engines - E.C cycles – Gas turbine & Stirling - Gas turbine cycles – thermodynamic analysis – cycle improvements - Intercoolers, Re heaters, regenerators.

UNIT IV ADVANCED POWER CYCLES 12

Cogeneration systems – topping & bottoming cycles - Performance indices of cogeneration systems – Heat to power ratio - Thermodynamic performance of steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems- Binary Cycle - Combined cycle – IGCC – AFBC / PFBC cycles – Thermionic steam power plant. MHD – Open cycle and closed cycle- Hybrid MHD & steam power plants

UNIT V HYDROELECTRIC & NUCLEAR POWER PLANTS 10

Hydroelectric Power plants – classifications - essential elements – pumped storage systems – micro and mini hydel power plants

General aspects of Nuclear Engineering – Components of nuclear power plants - Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor - nuclear safety – Environmental issues

TOTAL: 45 PERIODS

OUTCOME:

Possible mitigation of anthropogenic emissions by optimizing the power plant cycles/utilities

REFERENCES

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

EY7010 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 fuel preparation units and boilers.
- To introduce the concept of boiler design, emission aspects

UNIT I BASICS 8

Steam Cycle for Power Generation – Fuel Stoichiometry - Boiler Classification & Components – Specifications - Boiler Heat Balance – Efficiency Estimation (Direct & Indirect) – Sankey Diagram

UNIT II FUELS & BOILER TYPES 8

Solid Fuel : Coal Preparation – Pulverization – Fuel feeding arrangements , Fuel Oil : Design of oil firing system – components – Air regulators , Types of Boiler – Merits & Limitations – Specialty of Fluid Bed Boilers – Basic design principles (Stoker, Travelling Grate etc)

UNIT III COMPONENTS' DESIGN 12

Furnace – Water Wall – Steam Drum – Attemperator - Superheaters – Reheaters – Air Preheaters – Economisers - Steam Turbines : Design Aspects of all these

UNIT IV AUXILIARY EQUIPMENTS – DESIGN & SIZING 10

Forced Draft & Induced Draft Fans – PA / SA Fans – Water Pumps (Low Pressure & High Pressure) – Cooling Towers – Softener – DM Plant

UNIT V EMISSION ASPECTS 7

Emission Control – Low NO_x Burners– Boiler Blow Down - Control & Disposal : Feed Water Deaeration & Deoxygenation – Reverse Osmosis - Ash Handling Systems Design – Ash Disposal– Chimney Design to meet Pollution std – Cooling Water Treatment & Disposal

TOTAL: 45 PERIODS

OUTCOME:

1. Familiarization with Boiler cycles, components and will have specialized knowledge in steam boiler performance evaluation
2. Emission related aspects in terms of CO_2 NOx emission, mitigation etc will make them to realize the impact of Coal / fuel burning in the society

REFERENCES

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

EY7011	**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

OUTCOME:

When a student completes this subject, he / she can

- Understand the working principles, merits and limitations of fluidized bed systems
- Apply fluidized bed systems for a specific engineering applications
- Analyse the fluidized bed systems to improve and optimize its performance

REFERENCES

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

EY7012 ADVANCED ENERGY 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 energy storage systems

OBJECTIVES:

- To develop the ability to understand / analyse the various types of energy storage.
- To study the various applications of energy storage systems

UNIT I INTRODUCTION 9

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

UNIT II THERMAL STORAGE SYSTEM 9

Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of Transys

UNIT III ELECTRICAL ENERGY STORAGE 10

Fundamental concept of batteries – measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and modern batteries for example (i) zinc-Air (ii) Nickel Hydride, (iii) Lithium Battery

UNIT IV FUEL CELL 9

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantage and drawback of each type.

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES 12

Flywheel , Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications

TOTAL HOURS : 45 PERIODS

OUTCOME:

Able to anlayse various types of energy storage devices and perform the selection based on techno-economic view point

REFERENCES

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002
2. Fuel cell systems Explained, James Larminie and Andrew Dicks, Wiley publications, 2003.
3. Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012

EY7013 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 CHARACTERISTICS AND PERSPECTIVES 9

Sources – Types – Composition – Generation – Estimation Techniques – Characterization – Types of Collection System – Transfer Stations – Transfer Operations – Material Recycle / Recovery Facilities

UNIT II UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES 8

Separation & Processing : Size Reduction – Separation through Density Variation, Magnetic / Electric Field : Densification - Physical, Chemical and Biological Properties and Transformation Technologies – Selection of Proper Mix of Technologies

UNIT III WASTE DISPOSAL 9

Landfill Classification – Types – Siting Considerations – Landfill Gas (Generation, Extraction, Gas Usage Techniques) – Leachates Formation, Movement, Control Techniques – Environmental Quality Monitoring – Layout, Closure & Post Closure Operation – Reclamation

UNIT IV TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION 10

Physical Transformation : Component Separation & Volume Reduction : Chemical Transformation – Combustion / Gasification / Pyrolysis : Energy Recovery - Biological Transformation – Aerobic Composting – Anaerobic Digestion

UNIT V HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING 9

Definition – Sources – Classification – Incineration Technology - Incineration vs Combustion Technology – RDF / Mass Firing – Material Recycling : Paper / Glass / Plastics etc., - Disposal of White Goods & E-Wastes

TOTAL: 45 PERIODS

OUTCOME:

1. Waste characterization ,Segregation, Disposal etc will be made known
2. Technologies that are available for effective waste disposal along with pros / cons will become clearer to students
3. First hand information on present day waste related problems (Hazardous Waste, Pharma Waste, Biomedical Waste etc) that will be taught in this programme will make them understand the problem in a much sensible & realistic manner.

REFERENCES

1. Tchobanoglous, Theisen and Vigil, Integrated Solid Waste Management, 2d Ed. Mc Graw-Hill, New York, 1993.
2. Howard S. Peavy etal, Environmental Engineering, McGraw Hill International Edition, 1985
3. LaGrega, M., et al., Hazardous Waste Management, McGraw-Hill, c. 1200 pp., 2nd ed.,2001.
4. Stanley E. Manahan. Hazardous Waste Chemistry, Toxicology and Treatment, Lewis Publishers, Chelsea, Michigan, 1990
5. Parker, Colin and Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
6. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997

EY7014 ENERGY EFFICIENT BUILDINGS L T P C
3 0 0 3

AIM:

This course provides the concept of introducing energy efficient practices in building design and construction

OBJECTIVES:

- To learn the green buildings concepts applicable to modern buildings
- Acquaint students with the principle theories materials, construction techniques and to create energy efficient buildings

UNIT I INTRODUCTION 9

Conventional versus Energy Efficient buildings – Historical perspective - Water – Energy – IAQ requirement analysis – Future building design aspects – Criticality of resources and needs of modern living

UNIT II LANDSCAPE AND BUILDING ENVELOPES 9

Energy efficient Landscape design - Micro-climates – various methods – Shading, water bodies- Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools.

UNIT III HEATING, VENTILATION AND AIR-CONDITIONING 9

Natural Ventilation, Passive cooling and heating - Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid Methods – Energy Conservation measures, Thermal Storage.

UNIT IV ENERGY EFFICIENCY IN ELECTRICAL SYSTEM 9

Introduction of electrical power supply system – Demand side Management – Conservation measures in building : Lighting, DG sets, Energy efficient motors - Electronic devices: Power consumption pattern, saving methods

UNIT V RENEWABLE SOURCES INTEGRATION 9

Introduction of renewable sources in buildings, Solar water heating, small wind turbines, stand alone PV systems, Hybrid system – Economics.

TOTAL: 45 PERIODS

OUTCOME:

Student will be able to do

(a) the energy audit in any type for buildings and suggest the conservation measures.
(b) Provide the renewable energy systems for the buildings

REFERENCES

1. Krieder, J and Rabi, A., Heating and Cooling of buildings : Design for Efficiency, Mc Graw Hill, 1994.
2. Ursala Eicker, “Solar Technologies for buildings”, Wiley publications, 2003.
3. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)

TE7203	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

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

REFERENCES

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

EY7015	ENERGY FORECASTING, MODELING AND PROJECT MANAGEMENT	L T P C 3 0 0 3

AIM:

To impact knowledge on energy prediction for the future and to develop skills on the development of optimization model to meet the future energy demand

OBJECTIVES:

- To develop forecasting models and optimization models for energy planning.
- To equip the students in writing project proposals and making project cost estimation.
- To evaluate the limit cost of energy for various renewable energy systems

UNIT I ENERGY SCENARIO 10

Role of energy in economic development and social transformation: Energy & GDP,GNP and its dynamics - Energy Sources and Overall Energy demand and Availability - Energy Consumption in various sectors and its changing pattern - Status of Nuclear and Renewable Energy: Present Status and future promise

UNIT II FORECASTING MODEL 10

Forecasting Techniques - Regression Analysis - Double Moving Average - Double Experimental Smoothing - Triple Exponential Smoothing – ARIMA model - Validation techniques – Qualitative forecasting – Delphi technique - Concept of Neural Net Works

UNIT III OPTIMIZATION MODEL 10

Principles of Optimization - Formulation of Objective Function - Constraints - Multi Objective Optimization – Mathematical Optimization Software – Development of Energy Optimization Model - Development of Scenarios – Sensitivity Analysis - Concept of Fuzzy Logic.

UNIT IV PROJECT MANAGEMENT 10

Project Preparation – Feasibility Study – Detailed Project Report - Project Appraisal – Social-cost benefit Analysis - Project Cost Estimation – Project Risk Analysis - Project Financing – Financial Evaluation

UNIT V ENERGY POLICY 5

National & State Level Energy Issues - National & State Energy Policy - Energy Security - National solar mission - state solar energy policy - Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs)

TOTAL: 45 PERIODS

OUTCOME:

- Knowledge in Energy prediction using various forecasting techniques
- Ability to develop optimization model for energy planning
- Understanding of National and state energy policies

REFERENCES

1. S. Makridakis, Forecasting Methods and applications. Wiley 1983
2. Yang X.S. Introduction to mathematical optimization: From linear programming to Metaheuristics, Cambridge, Int. Science Publishing, 2008
3. Austin H. Church, centrifugal pumps and blowers, John Wiley and sons, 1980.
4. Fred Luthans, Organisational Behaviour, McGraw Hill, Inc, USA, 1992.
5. Armstrong, J.Scott (ed.) Principles of forecasting: a hand book for researchers and practitioners, Norwell, Masschusetts:Kluwer Academic Publishers.2001
6. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press,2006
7. Sukhvinder Kaur Multani, Energy Security in Asia Current Scenario, The ICFAI University Press, 2008