KUMARAGURU COLLEGE OF TECHNOLOGY

(Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM

(REGULATIONS 2015)

I to IV Semester

ME-Energy Engineering

Mechanical Engineering

Department of Mechanical Engineering

Vision

To be a pioneer in the Field of Mechanical Engineering Education, research and services that contributes to the advancement of scientific knowledge leading to social development.

Mission

The Department is committed to provide quality education and training with emphasis on engineering fundamentals and applications to the students to be competent professionals with ethics. The department will execute research and provide services for sustainable development.

Kumaraguru College of Technology
Coimbatore – 641 049
Regulation 2015

CBCS – PG Curriculum

Name of the PG Programme: ENERGY ENGINEERING

Foundation Courses(FC)

S. No.	Course Code	Course Title	Periods/Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15MAT104	Applied Mathematics for Energy Engineering	3	1	0	4	1

Professional Core(PC)

S. No.	Course Code	Course Title	Periods /Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15EE*T*101	Advanced Thermodynamics	3	1	0	4	1
2.	P15EE*T*102	Solar Energy Systems	3	1	0	4	1
3.	P15EE*T*103	Bio Energy Conversion Techniques	3	0	0	3	1
4.	P15EE*T*104	Fuels and Combustion Technology	3	1	0	4	1
5.	P15EE*T*105	Energy Conversion Systems	3	0	0	3	1
6.	P15EE*P*101	Energy Technology Laboratory	0	0	3	1	1
7.	P15EE*T*201	Co-generation and Waste Heat Recovery Systems	3	0	0	3	2
8.	P15EE*T*202	Environmental Engineering and Pollution Control	3	0	0	3	2
9.	P15EE*T*203	Instrumentation for Thermal Systems	3	0	0	3	2
10.	P15EE*T*204	Wind Energy Conversion Systems	3	0	0	3	2
11.	P15EE*P*201	Simulation Laboratory	0	0	3	1	2

Professional Electives(PE)

S. No.	Course Code	Course Title	Periods /Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15EE*T*E01	Boiler Technology	3	0	0	3	2
2.	P15EE*T*E02	Project Management	3	0	0	3	2
3.	P15EE*T*E03	Energy System Modelling and Analysis	3	0	0	3	2
4.	P15EE*T*E04	Energy Economics & Cost Estimation	3	0	0	3	2
5.	P15EE*T*E05	Energy Conservation in Buildings and HVAC	3	0	0	3	2

6.	P15EE*T*E06	Clean Development Mechanism	3	0	0	3	2
7.	P15EE*T*E07	Design of Heat Exchangers	3	0	0	3	2
8.	P15EE*T*E08	Energy Storage systems	3	0	0	3	3
9.	P15EE*T*E09	Advanced Fluid Mechanics	3	0	0	3	3
10.	P15EE*T*E10	Computational Fluid Dynamics	3	0	0	3	3
11.	P15EE*T*E11	Waste Management	3	0	0	3	3
12.	P15EE*T*E12	Global Warming and Climate change Mitigation	3	0	0	3	3
13.	P15EE*T*E13	Energy conservation in Industrial processes and Equipment	3	0	0	3	3
14.	P15EE*T*E14	Energy Information Systems	3	0	0	3	3
15.	P15EE*T*E15	Unit Operations in Chemical Engineering	3	0	0	3	3
16.	P15EE*T*E16	Solar Architecture	3	0	0	3	3
17.	P15EE*T*E17	Fluidized Bed System	3	0	0	3	3
18.	P15EE*T*E18	Nuclear Engineering	3	0	0	3	3
19.	P15EE*T*E19	Energy Management	3	0	0	3	3
20.	P15EE*T*E20	Electrical Drives and Control	3	0	0	3	3
21.	P15EE*T*E21	Power Generation Transmission and Utilization	3	0	0	3	3

Employability Enhancement Courses(EEC)

S. No.	Course Code	Course Title	Periods /Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15EE*P*301	Project work – Phase I	0	0	12	6	3
2.	P15EE*P*401	Project work – Phase II	0	0	24	12	4
3.	P15EE*P*202	Technical Seminar	0	0	3	1	2
4.	P15EEIN01	Wind Mill Design	1	0	0	1	1
5.	P15EEIN02	Solid Waste Disposal and Management	1	0	0	1	1
6.	P15EEIN03	Team Dynamics	1	0	0	1	1
7.	P15EEIN04	Implementation of Statistical Process control	1	0	0	1	1

SEMESTER I								
S.No	**Course Code**	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	P15MAT104	Applied Mathematics for Energy Engineering	FC	4	3	1	0	4
2.	P15EE*T*101	Advanced Thermodynamics	PC	4	3	1	0	4
3.	P15EE*T*102	Solar Energy Systems	PC	4	3	1	0	4
4.	P15EE*T*103	Bio Energy Conversion Techniques	PC	3	3	0	0	3
5.	P15EE*T*104	Fuels and Combustion Technology	PC	4	3	1	0	4
6.	P15EE*T*105	Energy Conversion Systems	PC	3	3	0	0	3
Practical's								
7.	P15EE*P*101	Energy Technology Laboratory	PC	3	0	0	3	1
Total Credits								
				25	**18**	**4**	**3**	**23**

SEMESTER II								
SNo	**Course Code**	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	P15EE*T*201	Co-generation and Waste Heat Recovery Systems	PC	3	3	0	0	3
2.	P15EE*T*202	Environmental Engineering and Pollution Control	PC	3	3	0	0	3
3.	P15EE*T*203	Instrumentation for Thermal Systems	PC	3	3	0	0	3
4.	P15EE*T*204	Wind Energy Conversion Systems	PC	3	3	0	0	3
5.		Elective – 1	PE	3	3	0	0	3
6.		Elective – 2	PE	3	3	0	0	3
Practical's								
7.	P15EE*P*201	Simulation Laboratory	PC	3	0	0	3	1
8.	P15EE*P*202	Technical Seminar	EEC	3	0	0	3	1

Total Credits								
				24	**18**	**0**	**6**	**20**
SEMESTER III								
SNo	**Course Code**	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	E3	Elective – 3	PE	3	3	0	0	3
2.	E4	Elective – 4	PE	3	3	0	0	3
3.	E5	Elective – 5	PE	3	3	0	0	3
4.	E6	Elective – 6 (Self Study Course)	PE	0	3	0	0	3
Practical's								
5.	P15EE*P*301	Project work – Phase I	EEC	12	0	0	12	6
Total Credits								
				21	**12**	**0**	**12**	**18**
SEMESTER IV								
1.	P15EE*P*401	Project work – Phase II	EEC	24	0	0	24	12
Total Credits								
				24	**0**	**0**	**24**	**12**
ELECTIVES								
SNo	**Course Code**	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
1.	P15EE*T*E01	Boiler Technology	PE	3	3	0	0	3
2.	P15EE*T*E02	Project Management	PE	3	3	0	0	3
3.	P15EE*T*E03	Energy System Modelling and Analysis	PE	3	3	0	0	3
4.	P15EE*T*E04	Energy Economics & Cost Estimation	PE	3	3	0	0	3
5.	P15EE*T*E05	Energy Conservation in Buildings and HVAC	PE	3	3	0	0	3
6.	P15EE*T*E06	Clean Development Mechanism	PE	3	3	0	0	3
7.	P15EE*T*E07	Design of Heat Exchangers	PE	3	3	0	0	3
8.	P15EE*T*E08	Energy Storage systems	PE	3	3	0	0	3

9.	P15EETE09	Advanced Fluid Mechanics	PE	3	3	0	0	3
10.	P15EETE10	Computational Fluid Dynamics	PE	3	3	0	0	3
11.	P15EETE11	Waste Management	PE	3	3	0	0	3
12.	P15EETE12	Global Warming and Climate change Mitigation	PE	3	3	0	0	3
13.	P15EETE13	Energy conservation in Industrial processes and Equipment	PE	3	3	0	0	3
14.	P15EETE14	Energy Information Systems	PE	3	3	0	0	3
15.	P15EETE15	Unit Operations in Chemical Engineering	PE	3	3	0	0	3
16.	P15EETE16	Solar Architecture	PE	3	3	0	0	3
17.	P15EETE17	Fluidized Bed System	PE	3	3	0	0	3
18.	P15EETE18	Nuclear Engineering	PE	3	3	0	0	3
19.	P15EETE19	Energy Management	PE	3	3	0	0	3
20.	P15EETE20	Electrical Drives and Control	PE	3	3	0	0	3
21.	P15EETE21	Power Generation Transmission and Utilization	PE	3	3	0	0	3

DEPARTMENT OF MECHANICAL ENGINEERING
ENERGY ENGINEERING
SYLLABUS
REGULATIONS 2015

P15MAT104 /APPLIED MATHEMATICS FOR ENERGY ENGINEERING

L	T	P	C
3	1	0	4

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Compute problems in Fourier transforms and PDE.
CO 2: Outline the applications of Euler’s equation in calculus of variations
CO 3: Translate boundaries using conformal mapping
CO 4: Solve algebraic, transcendental and partial differential equations numerically.

Pre-requisites:

1. Knowledge in Fourier transforms and PDE

Course Content

FOURIER TRANSFORMS 9+3Hours

Fourier Transforms – Complex, Sine and Cosine Transforms – Finite Fourier transform – One dimensional heat conduction problem – Laplace Equation, Poisson Equation.

CALCULUS OF VARIATIONS 9+3Hours

Euler’s equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several dependent variables – Some applications – Direct method: Ritz method.

CONFORMAL MAPPING AND APPLICATIONS 9+3Hours

Schwarz – Christoffel transformation – Transformation of boundaries in parametric form – Physical applications – Application to fluid flow – Application to heat flow.

NUMERICAL SOLUTION OF EQUATIONS ANDEIGEN VALUE PROBLEMS 9+3Hours

Method of false position – Newton Raphson method – Iteration method – Solution of linear system by Gaussian elimination and Gauss-Jordon methods- Iterative methods: Gauss Jacobi and Gauss-Seidel methods – Eigen values of a matrix by Power method.

NUMERICAL SOLUTION OF PDE **9+3Hours**

Solution of Laplace and Poisson equation on a rectangular region by Leibmann's method – Diffusion equation by the explicit and Crank Nicolson implicit methods – Solution of wave equation by explicit scheme.

Theory: 45HrsTutorial:15Hrs **Total Hours: 60**

References:

1. SankaraRao K., "Introduction to Partial differential equations", Prentice-Hall of India, New Delhi 2006.
2. Grewal. B.S., "Higher Engineering Mathematics", Khanna Publishers, 40th Edition 2007.
3. Spiegel M.R., "Theory and Problems of complex variables with an introduction to Conformal mapping and its applications, Schaum's outline series", McGraw Hill Book Co., 1998.
4. Grewal. B.S., "Numerical Methods", Khanna Publishers, 40th Edition 2007.
5. Sneddon I.N., "Elements of partial differential equations", Dover Publications 2006.
6. Elsgolts L., "Differential equation and calculus of variations", University Press of Pacific, 2003.
7. Luther. H and Wilkes. J. Carnahan B, Applied Numerical Methods, Wiley and Sons, 1976.

P15EET101 / ADVANCED THERMODYNAMICS

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Analyze the availability and to relate the various thermodynamic properties of the system
CO 2: Calculate mixture properties for real gas
CO 3: Apply first and second law of thermodynamic for reacting system
CO 4: Interpret the heat and work in statistical approach
CO 5: Explain the concept of thermoelectric phenomena of the system

Pre-requisites:

1. Knowledge in Engineering Thermodynamics

Course Content

AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTYRELATIONS **10+3Hours**

Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-state Control Volume. Availability Analysis of Simple Cycles. Thermodynamic Potentials, Maxwell relations, Generalized relation for changes in Entropy, Internal Energy and Enthalpy, Generalized Relations for C_p and C_v, ClausiusClaypeyron Equation, Joule-Thomson Coefficient, Bridgman Tables for thermodynamic relations.

REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS **10+3Hours**

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 prosperities, Real gas mixtures, Ideal solution of real gases and liquids, Equilibrium in multi-phase systems, Gibbs phase rule for non-reactive components.

CHEMICAL THERMODYNAMICS AND EQUILIBRIUM **10+3Hours**

Thermo chemistry, first Law analysis of reacting systems, Adiabatic Flame temperature, Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion for reaction equilibrium composition.

STATISTICAL THERMODYNAMICS **8+3Hours**

Microstates and Macro states, Thermodynamic probability, Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Partition function, Calculation of the Microscopic properties from partition functions.

IRREVERSIBLE THERMODYNAMICS **7+3Hours**

Conjugate Fluxes and Forces, Entropy Production, Onsager's Reciprocity relations, thermoelectric phenomena and formulations.

Theory : 45Hrs Tutorial : 15Hrs **Total Hours: 60**

References:

1. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 1985
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 2006.
3. Holman, J.P., Thermodynamics, Fourth Ediction, McGraw-Hill Inc., 2012
4. Smith, J.M and Van Ness., H.C., Introduction to chemical Engineering
5. Thermodynamics, Fourth Edition, McGraw-Hill Inc., 2005.
6. Sonntag, R.E., and Vann Wylen, G, Introduction to Thermodynamics, Classical and
7. Statistical, third Edition, John Wiley and Sons, 2009.
8. Sears, F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, third Edition, Narosa Publishing House, New Delhi, 1999
9. DeHoft, R.T. Thermodynamics in Materials Science, McGraw-Hill Inc., 1998.
10. Rao, Y.V.C., Postulational and Statistical thermodynamics, Allied Publisher Limited,New Delhi, 1997.

P15EET102 / SOLAR ENERGY SYSTEMS

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Estimate solar radiation for specific location
CO 2: Illustrate the working principle of solar radiation measuring devices
CO 3: Predict the performance characteristics of flat plate collectors
CO 4: Appraise the design of concentrating collectors
CO 5: Illustrate the applications of solar energy system

Pre-requisites:

1. Knowledge in Renewable energy

Course Content

INTRODUCTION **9+3Hours**

Different types of Renewable Energy Sources – Sun as a Source of Energy – Solar Radiation– Extra-terrestrial at earth's surface – Horizontal, tilted surface – Estimation of Radiation –hourly, daily and monthly average – Alternation of Solar radiation by atmosphere – Effect of orientation of receiving surface.

MEASUREMENT OF SOLAR RADIATION **9+3Hours**

Measurement of solar radiation – Radiation characteristics of opaque materials – Radiation transmission through covers and absorption of collectors.

FLAT PLATE COLLECTORS **9+3Hours**

Theory of Flat plate collectors – Liquid and air flat plate collectors – design, performance and testing – other types of flat plate collectors.

CONCENTRATING COLLECTORS **9+3Hours**

Theory of concentrating collectors – Modes of tracking – Cylindrical parabolic collector – compound parabolic collector – Central receiver collector – Fixed reflector and tracking absorber collector – Design, performance and testing.

APPLICATIONS **9+3Hours**

Thermal Energy Storage – Various methods and applications, Solar Ponds – Thermal applications – Thermal Power Conversion, Solar cooling and heating – Solar desalination – Drying – Solar pumping.

Theory : 45Hrs Tutorial : 15Hrs **Total Hours: 60**

References:

1. Sukhatme S.P., Solar Energy – Principles of Thermal Collection & Storage, TataMcGraw Hill Publishing Co., 2008
2. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley,London, 2006.
3. Kreith F and Kreider J.F., 'Principles of Solar Engineering', McGrawhill Book Co., 2000.
4. Garg, H.P., 'Treatise on Solar Energy', Volume 1, 2 & 3, John Wiley and Sons, 2006.
5. Seshadriet.al., "Climatological and Solar Data for India", SaritaPrakashan, 1969

P15EET103 / BIO - ENERGY CONVERSION TECHNIQUES

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Explain the various bio energy conversion techniques
CO 2: Illustrate various phase in Bio methanation process
CO3: Compare various combustion techniques
CO 4: Explain the gasification process
CO 5: Analyze fuel sample using different scanning calorimeter

Pre-requisites:

1. Knowledge in Non- Conventional Energy sources

Course Content

INTRODUCTION **8Hours**

Biomass: Types – Advantages & Drawbacks – Indian Scenario – Characteristics – Carbon Neutrality – Conversion Mechanisms – Fuel Assessment Studies

BIOMETHANATION **8Hours**

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 & comparison – Biogas appliances– Burner, Illumination & Power Generation – Effect on Engine Performance.

COMBUSTION **10Hours**

Perfect, Complete & Incomplete – Equivalence ratio – Fixed Bed, Fluid Bed – Fuel & Ash handling – Steam Cost comparison with conventional fuels.
Briquetting: Types of Briquetting – Merits & Demerits – Feed requirements &Preprocessing – Advantages – Drawbacks.

GASIFICATION **10Hours**

Types – Comparison – Application – Performance Evaluation – Economics – Dual fuel engines – 100 % Gas Engines – Engine characteristics on gas mode – Gas Cooling &cleaning train.

PYROLYSIS & CARBONISATION **9Hours**

Types – process governing parameters – Thermo gravimetric analysis – Differential thermal analysis – Differential scanning calorimetry – Typical yield rates.

Theory : 45Hrs **Total Hours: 45**

References:

1. Rai, G D “Non Conventional Energy Sources”, Khanna Publishers, New Delhi 2011
2. 2.David Boyles, “Bio Energy Technology Thermodynamics and costs”, Ellis Hoknood, Chichester, 2006
3. Khandelwal KC, Mahdi SS, “Biogas Technology – A Practical Handbook”, Tata McGrawHill, 2008
4. Mahaeswari, R.C. “Bio Energy for Rural Energisation”, Concepts Publication, 1997
5. Tom B Reed, Biomass Gasification – Principles & Technology, Noyce Data Corporation, 1981
6. Best Practises Manual for Biomass Briquetting, I R E D A, 1997
7. Eriksson S. & Prior, M. “The briquetting of Agricultural wastes for fuel”, FAO Energy &Environment paper, 1990
8. Iyer PVR et al, “Thermochemical Characterization of Biomass”, M N E S.1981

P15EET104 / FUELS AND COMBUSTION TECHNOLOGY

Course Outcomes

After successful completion of the course, the students should be able to

L	T	P	C
3	0	0	3

CO 1: Estimate the Gross and Net Calorific value of solid, liquid and gaseous fuels
CO 2: Define and calculate the properties of the Solid, liquid and gaseous fuels
CO 3: Analyze the calorific value of various fuel
CO 4: Estimate the excess air circulation for flue gas composition
CO 5: Illustrate the working principle of combustion equipment

Pre-requisites:

1. Knowledge in chemical characteristics of fuels and combustion phenomenon.

Course Content

CHARACTERIZATION **8+3Hours**

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value -Gross & Net Calorific Values - Calorimetry - DuLong’s Formula for CV Estimation – Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

SOLID FUELS & LIQUID FUELS **10+3Hours**

Solid fuels: Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Wash ability - Coking & Caking Coals - Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels – Manufactured Solid Fuels.

Liquid fuels: Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc., - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

GASEOUS FUELS **7+3Hours**

Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG -Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas -Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas -Digesters - Reactions - Viability - Economics.

COMBUSTION: STOICHIOMETRY & KINETICS **12+3Hours**

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes - Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion Explosive Combustion.

Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion – Flame Propagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature -Theoretical, Adiabatic & Actual - Ignition Limits - Limits of In flammability.

COMBUSTION EQUIPMENTS **8+3Hours**

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing – Fixed Bed& Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers -Sprinkler Stokers, Traveling Grate Stokers. Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners – Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

Theory : 45Hrs Tutorial : 15Hrs **Total Hours: 60**

References:

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2. Bhatt, Vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 2004
3. BlokhAG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988
4. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 2000
5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 2000.

P15EET105 / ENERGY CONVERSION SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the basic concepts of air standard cycles
CO 2: Outline the direct conversion methods of thermal to electrical energy
CO 3: Illustrate the direct conversion methods of chemical & electromagnetic energy to electrical energy
CO 4: Outline the mechanical, electrical, chemical and thermal energy storage systems
CO 5: Explain the working principle of fuel cells

Pre-requisites:

1. Knowledge in Thermal Engineering

Course Content

INTRODUCTION **8Hours**

Energy Conservation – Conventional Techniques – Reversible & Irreversible Cycles –Carnot, Stirling & Ericsson – Otto, Diesel, Dual, Lenior, Atkinson, Brayton, Rankine.

DIRECT CONSERVATION OF THERMAL TO ELECTRICAL ENERGY **8Hours**

Thermoelectric Converters – Thermoelectric refrigerator – Thermoelectric Generator – Thermionic Converters – Ferro Electric Converter – Nernst Effect Generator – Thermo Magnetic Converter.

CHEMICAL & ELECTROMAGNETIC ENERGY TO ELECTRICAL ENERGY **9Hours**

Batteries – Types – Working – Performance Governing Parameters – Hydrogen Energy –Solar Cells.

ENERGY STORAGE SYSTEMS **9Hours**

Introduction – Storage of Mechanical Energy, Electrical Energy, Chemical Energy, Thermal Energy.

FUEL CELLS **11Hours**

Basics – Working Advantages & Drawbacks – Types – Comparative Analysis – Thermodynamics & Kinetics of fuel cell process – Performance of fuel cell – Applications.

Theory : 45Hrs **Total Hours: 45**

References:

1. Archie.W.Culp, Principles of Energy Conversion, McGraw-Hill Inc., (1991), Singapore
2. K.Kordesch, G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany (1996)
3. Kettari, M.A. Direct Energy Conservation, Addision – Wesley Pub.Co (2009)
4. Hart A.B.and Womack, G.J.Fuel Cells: Theory and Application, Prentice Hall, Newyork, Ltd., London, 1995.

L	T	P	C
0	0	3	1

P15EEP101 / ENERGY TECHNOLOGY LABORATORY

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Test the performance of refrigeration and air conditioning systems
CO 2: Test the performance of solar water heater and gasifier
CO 3: Test the performance of heat exchanger
CO 4: Determine properties of fuel oil and biogas
CO 5: Demonstrate the application of thermal energy storage and earth energy

Course Content

Renewable Energy

1. Performance testing of solar water heater
2. Characteristics of Solar photovoltaic devices
3. Testing of Gasifier
4. Study of biogas plant
5. Testing of Properties of fuel oils, biomass, biogas
6. Testing of VFD Drives
7. Testing of Heat Exchangers
8. Testing of Refrigeration and Air conditioning systems
9. Solar Radiation measurement

Energy Conservation

1. Boiler efficiency testing
2. Motor and pump efficiency testing
3. Energy consumption measurement of lighting systems

Study of Advanced Energy Systems

1. Fuel Cell
2. Earth Energy
3. Thermal Storage Systems

Practical: 45Hrs **Total Hours: 45**

P15EET201 / CO-GENERATION AND WASTE HEAT RECOVERY SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to
CO 1: Analyze the performance of co-generation cycles
CO 2: compare the performance of various cogeneration systems
CO 3: Illustrate the applications of cogeneration technologies
CO 4: Design waste heat recovery systems
CO 5: Analyze the economic aspects of cogeneration system

Pre-requisites:
1. Knowledge in Principles of thermodynamic cycles

Course Content

INTRODUCTION 9Hours
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.

CONGENERATION TECHNOLOGIES 9Hours
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.,

ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES 9Hours
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.

WASTE HEAT RECOVERY SYSTEMS 9Hours
Selection criteria for waste heat recovery technologies – Recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems.

ECONOMIC ANALYSIS 9Hours
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.

Theory : 45Hrs Total Hours: 45

References:

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.11.
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001.
3. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987.
4. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
5. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
6. De Nevers, Noel, Air Pollution Control Engineering, McGrawHill, New York, 2000.

P15EET202 / ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the causes for global atmospheric change
CO 2: Explain the various environmental legislations
CO 3: Identify the sources, effects and control methods of air and water pollution
CO 4: Illustrate the sources, characteristics and energy recovery of solid waste
CO 5: Outline the environmental impact assessment for various projects.

Pre-requisites:

1. Knowledge in Environmental Engineering

Course Content

INTRODUCTION **9Hours**

Global atmospheric change – Greenhouse effect –Ozone Depletion - Natural Cycles -Mass and Energy Transfer – Material balance – Environmental chemistry and biology –Impacts – Environmental legislations, ISO14000.

AIR POLLUTION **9Hours**

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.

WATER POLLUTION **9Hours**

Water resources - Water Pollutants - Characteristics – Quality - Water Treatment systems – Wastewater treatment - Treatment, Utilization and Disposal of Sludge – Monitoring compliance with Standards.

WASTE MANAGEMENT **9Hours**

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

OTHER TYPES OF POLLUTION FROM INDUSTRIES **9Hours**

Noise Pollution and its impact - Oil Pollution - Pesticides - Instrumentation for EIA test -Water Pollution from Tanneries and other Industries and their control – Environment Impact assessment for various projects – Case studies.

Theory : 45Hrs **Total Hours: 45**

References:

1. H.S.Peavy, D.R.Rowe, G.Tchobanoglous: Environmental Engineering - McGraw-Hill Book Company, New York. 2003.
2. G.Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi. 2003
3. H.Ludwig, W.Evans: Manual of Environmental Technology in Developing Countries,. International Book Company, Absecon Highlands, N.J. 2002
4. Arcadio P Sincero and G. A. Sincero.: Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi. 2004

P15EET203 / INSTRUMENTATION FOR THERMAL SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes
After successful completion of the course, the students should be able to

CO 1: Illustrate the static and dynamic measurement characteristics of instruments
CO 2: Demonstrate the applications of intelligent instruments in measuring systems
CO 3: Explain the measurement of thermo - physical quantities by various instruments
CO 4: Review the flow visualization techniques
CO 5: Demonstrate the use of gas analyzer and chromatography

Pre-requisites:
1. Knowledge in Measurement and Instrumentation

Course Content

MEASUREMENT CHARACTERISTICS **12Hours**
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.

MICROPROCESSORS AND COMPUTERS IN MEASUREMENT **5Hours**
Data logging and acquisition use of intelligent instrument for error reduction, elements of micro-computer interfacing, intelligent instruments in use.

MEASUREMENT OF PHYSICAL QUANTITIES **10Hours**
Measurement of thermo-physical properties, instruments for measuring temperature pressure and flow, use of intelligent instruments for the physical variables.

FLOW VISUALIZATION **8Hours**
Techniques, shadow graph, Schileren, interferometer, Laser Doppler anemometer, hear flux measurement, Telemetry in engines.

MEASUREMENT ANALYSIS **10Hours**
Chemical Thermal, magnetic and optical gas analyzers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

Theory : 45Hrs **Total Hours: 45**

References:

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 2012.
2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1998.
3. Prebrashensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and 2MIR Publishers, 1980.
4. Raman, C.S. Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw-Hill, New Delhi, 1997.
5. Doeblin, Measuent System Application and Design, McGraw-Hill, 2010.
6. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.

P15EET204 / WIND ENERGY CONVERSION SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Describe the parameters of wind energy conversion systems
CO 2: Illustrate the terminologies involved in wind turbine technology
CO 3: Explain the functions of wind turbine parts
CO 4: Discuss the siting, operation and maintenance of wind turbines
CO 5: Outline the environmental benefits of wind turbines

Pre-requisites:

1. Knowledge in Renewable energy

Course Content

INTRODUCTION TO WIND **9Hours**

Power and Energy in wind- Applications of wind -How To Use The Wind- Wind Data- -Sources of Wind Data in India-Surveying a Site -Measuring the Wind-Wind Speed Units-Beaufort Scale-Power in the Wind-Power Density -Air Density -Calculating Swept Area-Wind Speed Distributions- Frequency Distributions-Wind Speed, Power and Height- Wind Shear- Estimating the Height of Obstructions-Measuring Instruments-Anemometer Towers-Survey Duration-Data Analysis.

WIND TURBINE TECHNOLOGY **9Hours**

Size of wind turbines- Evaluating the Technology-Orientation-Vertical Axis-Horizontal Axis-Tail Vanes-Passive Yaw-Active Yaw-Ducted or Augmented Turbines-Lift and Drag-Aerodynamics-Apparent Wind and the Angle of Attack-Twist and Taper-Solidity-Betz's Limit-Drag Force and Thrust -One-Bladed Wind Turbines-Blade Number-Self Starting-Tip Vanes and Tip Torpedoes-Blade materials Micro Hybrid Power System -AC and DC Systems-Sizing -Inverters-Batteries-Backup Generators- Stand-Alone Economics-Other Stand-Alone Power Systems- Telecommunications- -Village Electrification-Water Pumping -Mechanical Wind Pumps- Pumping Head-Estimating Farm Windmill Pumping Capacity-New Technology for Mechanical Wind Pumps-Farm Windmill Conversion-Electrical Wind Pumps- Estimating Water Use.

WIND TURBINE PARTS AND FUNCTIONS **9Hours**

Blades-Hubs-Drive-Trains-Generators-Alternators-Variable-orConstant-Speed Operation-Induction (Asynchronous) Generators-Dual Generators-Rotor Controls-Horizontal Furling-Vertical Furling-Coning-Changing Blade Pitch-Pitch to Feather-Pitch to Stall-Aerodynamic Stall-Mechanical Brakes-Aerodynamic Brakes-Small Turbines-Medium-Sized Turbines-Towers-Height and types.

SITING, OPERATION AND MANITENANCE OF WIND TURBINES **9Hours**

Physical Restrictions-Exposure and Turbulence-Power Cable Routing-Property Values-Planning Permission -Building Permits-Height Restrictions-Obstruction Marking-Public Safety-Attractive Nuisance-Aesthetics-Noise Propagation-TV and Radio Interference-Shadow Flicker and the

Disco Effect-Birds -Case Studies Small Wind Turbine -Interconnected Wind Systems-Battery-Charging Wind Systems-Monitoring Performance -Small Wind Turbines-Reading a Kilowatt hour Meter- Medium size Wind Turbines-Blade and Tower Cleaning-Painting-Cost of Maintenance-Small Wind Turbines-Medium- Life Expectancy.

WIND TURBINE SAFETY, ECONOMICS AND ENVIRONMENT BENEFITS 9Hours
Fatal Accidents-Hazards-Falls-Spinning Rotors-Dynamic Braking of Small Turbines-Electrical-Construction-Analysis-Tower Safety and Climbing Gear-Work Belts and Full-Body Harnesses-Lanyards and Anchorages-Snap Hooks, Carabineers, and Slings-Fall-Arresting Systems-Work Platforms Economics-Cost of Energy and Payback-Economic Factors-Residential Economics Wind Farm and Business Economics-Visual Design -Community Acceptance -Impact on Flora and Fauna -Impact on People -Impact on Land -Benefits –reduction of air pollution-energy balance-employment and tourism

Theory : 45Hrs **Total Hours: 45**

References:

1. Freris, L.L.Wind Energy Conversion Systems, Prentice Hall, 1990
2. Wind Energy Conversion Systems, Prentice Hall, New York2001
3. Spera, D.A.Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.1998

P15EEP201 / SIMULATION LABORATORY

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to
CO 1: Analyze Heat Exchanger using NTU and LMTD method
CO 2: Analyze Convection heat transfer for external and internal flow
CO 3: Determine temperature distribution in concentric pipe
CO 4: Predict temperature distribution in solar dryer, collector and thermal storage system
CO 5: Demonstrate temperature distribution in condenser

Course Content

List of experiments:
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. Simulation of thermal equipments such as Condenser and Radiator
8. Simulation of Solar collector
9. Simulation of Solar Dryer
10. Simulation of thermal storage system

Practicals : 45Hrs **Total Hours: 45**

P15EETE01/ BOILER TECHNOLOGY

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Recall the basic concepts involved in boiler design
CO 2: Compute the enthalpy calculation of air and combustion products
CO 3: Explain the various methods involved in coal preparation and handling
CO 4: Demonstrate boilers, burners and furnace
CO 5: Design of Economizer, super heater and reheater

Pre-requisites:

1. Knowledge in Thermal engineering

Course Content

INTRODUCTION **9Hours**

Boilers – Classification – Basic Design Steps – Fuel Stoichiometry calculations – Enthalpy calculation of air & combustion products – Heat Balance.

COAL PREPARATION SYSTEM OF BOILERS **9Hours**

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

DESIGN OF BURNERS **9Hours**

Tangential fired burners – Basics & Design Methods Oil Burners – Design of supply system – Oil Atomizer – Air Register – Design Principles

BOILER FURNACE DESIGNING **9Hours**

General Design Principles – Flame Emissivity – Heat Transfer calculation for PC Boiler furnace – water wall arrangement – Furnace Emissivity – Distribution of heat load in furnace.

DESIGN OF CONVECTIVE HEAT TRANSFER SURFACE **9Hours**

Design of: Economizer – Super heater – Reheater – Air Preheater, Temperature Control in Super heater &Reheater

Theory : 45Hrs **Total Hours: 45**

References:

1. Ganapathy, V Industrial Boilers & Heat Recovery Steam Generators, Marcel Dekker Ink - 2003
2. PrabirBasu, Cen Kefa et.al, Boilers & Burners – Design & Theory, Springer – 2000
3. David Gunn, Robert Horton, Industrial Boilers – Longman Scientific & Technical Publication, 1989
4. Carl Schields, Boilers – Type, Characteristics and Functions, McGraw Hill Publishers,1995

P15EETE02 / PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the application of management principles in project management
CO 2: Discuss the steps involved in planning and implementation of project
CO 3: Analyze the projects using PERT & CPM techniques.
CO 4: Identify the sequence involved in recruitment process
CO 5: Explain the procedures involved in project termination

Pre-requisites:

1. Knowledge in Principles of Management

Course Content

INTRODUCTION **9Hours**

Introduction – Definitions – classifications – project risk – scope -Project management – definitions – overview – project plan – management-principles applied to project management – project management life cycles -and uncertainty.

PROJECT PLANNING AND IMPLEMENTATION **9Hours**

Scope – problem statement – project goals – objectives –success criteria – assumptions –risks – obstacles – approval process –projects and strategic planning- Project -implementation – project resource requirements – types of resources– men – materials –finance.

PROJECT MONITORING & PROJECT TEAM MANAGEMENT **7Hours**

Evaluation – control – project network technique –planning for monitoring and evaluation – project audits – project management information system – project scheduling – PERT &CPM – project communication – post project reviews.

RECRUITMENT **10Hours**

Organizing – human resources – team operating rules – project organization – various forms of project organizations – project organization charting – project contracts – principles – compilation of contracts – practical aspects – legal aspects – global tender – negotiations – insurance.

PROJECT TERMINATION **10Hours**

Closing the project – types of project termination – strategic implications –project in trouble – termination strategies – evaluation of termination-possibilities –termination procedures, Project inventory management – nature of project inventory –supply and transportation of materials – use of PERT & CPM techniques.

Theory : 45Hrs **Total Hours: 45**

References:

1. Project Management – for 21st Centrury-Beenet P Lientz, KathynPrea- Academic Press, 1995.
2. Project Management –Denislok.
3. Project management - David I Cleland - Mcgraw Hill, International Edition, 1999
4. Project Management – Gopalakrishnan – McMillan India Ltd.
5. Project Management-Harry-Maylor-Peason Publication

P15EETE03 / ENERGY SYSTEMS MODELLING & ANALYSIS

L	T	P	C
3	0	0	3

Course Outcomes
After successful completion of the course, the students should be able to

CO 1: Review the modelling concept for energy system
CO 2: Develop model for energy system using Newton Raphson
CO 3: Solve the equation using LPP and simplex method
CO 4: Demonstrate the energy economy models
CO 5: Demonstrate the optimization of energy system models

Pre-requisites:
1. Knowledge in thermodynamics

Course Content

INTRODUCTION **9 Hours**
Primary energy analysis - Dead states and energy components-Exergy balance for closed and control volume systems-applications of exergy analysis for selected energy system design - Modelling overview- levels and steps in model development - examples of models– Curve fitting and regression analysis

MODELLING AND SYSTEMS SIMULATION **9 Hours**
Modelling of energy systems – Heat Exchanger, Solar collectors, Distillation, Rectifications, turbo machinery components, refrigeration systems - information flow diagram, solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson. Examples of energy systems simulation

OPTIMIZATION **9Hours**
Objectives-constraints, problem formulation - Unconstrained problems - Necessary and Sufficiency conditions. Constrained Optimization- Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis.

ENERGY- ECONOMY MODELS **9Hours**
Multiplier Analysis - Energy and Environmental Input / Output Analysis – Energy Aggregation – Econometric Energy Demand Modeling - Overview of Econometric Methods-Dynamic programming - Search Techniques - Univariate / Multivariate.

APPLICATIONS AND CASE STUDIES **9Hours**
Case studies of optimization in Energy systems problems- Dealing with uncertainty probabilistic techniques - Trade-offs between capital and energy using Pinch Analysis.

Theory : 45Hrs **Total Hours: 45**

References:

1. Stoecker W.F. Design of Thermal Systems, Mcgraw Hill, 1989
2. Bejan, A. TsatsaronisG.and Moran M.: Thermal Design and Optimization John Wiley & Sons, 1999
3. Rao, S.S.Optimisation theory and applications, Wiley Eastern, 2013
4. Sastry, S.S. Introductory methods of numerical Analysis, Prentice Hall, 2005
5. Meier, P. Energy Systems Analysis for Developing Countries, Springer Verlag, 1984
6. De Neufville, R.Applied Systems Analysis, Mcgraw Hill, International Edition, 2011

P15EETE04 / ENERGY ECONOMICS AND COST ESTIMATION

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the principles of financial accounting
CO 2: Identify the various elements of costs, costing systems and variance analysis.
CO 3: Relate the inventory variable method in capital budgeting, inventory, cash valuable methods.
CO 4: Explain the significance of capital budgeting
CO 5: Estimate the economic cost of standalone power supply systems

Pre-requisites:

1. Knowledge in Cost Estimation and planning

Course Content

FINANCIAL ACCOUNTING **9Hours**

Accounting Principles-Basic records depreciation-Depreciation methods-Preparation and interpretation of profit and loss statement-Balance sheets-Fixed assets-Current assets.

COSTING **9Hours**

Elements of cost -Cost Classification-Material cost-Labour costs-Overheads-Costs of a product-Costing systems- Cost determination-Process costing-Allocation of overheads-Standard costing-Variance analysis.

WORKING CAPITAL MANAGEMENT **9Hours**

Current assets and Liability decisions-Estimation of working capital requirements-Management of accounts receivable-Inventory-cash- inventory valuable methods.

CAPITAL BUDGETING **9Hours**

Significance of capital budgeting-payback period-Present value method-Accounting rate of return method.

ECONOMICS OF STANDALONE POWER SUPPLY SYSTEMS **9Hours**

Solar Energy - Biomass Energy - Wind Energy and other Renewable Sources of Energy - Economics of Waste Heat Recovery and Cogeneration - Energy Conservation Economics.

Theory : 45Hrs **Total Hours: 45**

References:

1. JAMES, C., VANHORN, “Fundamentals of Financial management” , PHI 1997.
2. CHARLES T.HOMGREN, “Cost accounting ", PHI 1993.
3. MAHESWARI,S.N."Management Accounting and Financial Control ", Sultanchand, 2014
4. Munasinghe, M. and P.Meier: Energy Policy Analysis and Modeling, Cambridge University Press. 1996
5. Donnelly, W.A.: The Econometrics of Energy Demand: A Survey of Applications, New York. 1999
6. Pindyck, S and Daniel L.Rubinfeld: Econometrics Models and Economic Forecasts, 3rd edition MC Graw -Hill, New York. 1990.
7. UN-ESCAP: Sectoral Energy Demand Studies: Application of the END-USE Approach to Asian Countries, New York. 1991
8. Makridakis, S., Wiley: Forecasting Methods and Applications. 1998

P15EETE05 / ENERGY CONSERVATION IN BUILDINGS AND HVAC

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the thermal properties and energy content of building materials
CO 2: Estimate the cooling load calculation of buildings
CO 3: Design the efficient day lighting system
CO 4: Identify the requirement of indoor environmental conditions
CO 5: Estimate the energy conservation in air-conditioning systems

Pre-requisites:

1. Knowledge in Thermal engineering

Course Content

CLIMATES AND BUILDINGS 9Hours

Thermal Properties and Energy content of Building materials - Psychrometry-Comfort conditions – Air conditioning Systems.

ESTIMATION OF BUILDING LOADS 9Hours

Steady state method-Network method- Numerical method-correlations-computer packages for carrying out thermal design of buildings and predicting performance.

EFFICIENT LIGHTING AND DAYLIGHTING 9Hours

Lighting and Visual ability-Light sources and Luminaries - Lighting System Design-Day lighting-Lighting Economics and aesthetics-Impacts of Lighting efficiency.

INDOOR ENVIRONMENTAL REQUIREMENT AND MANAGEMENT 9Hours

Thermal comfort-Ventilation and air quality-Air conditioning requirement- visual perception– illumination Requirement-Auditory requirement-Energy Management Options-Energy Audit and Energy Targeting- Technological Options for Energy Management.

ENERGY CONSERVATION IN AIR CONDITIONING SYSTEMS 9Hours

Cycles-Energy Conservation in pumps/fan/blowers-Refrigerating machines -Heat Rejection Equipment-Energy efficient motors-insulation.

Theory : 45Hrs Total Hours: 45

References:

1. KriederJ.and Rabi A: Heating and Cooling of Buildings: Design for Efficiency, McGraw-Hill. 1994
2. M.S.Sodha, N.K. Bansal,P.K.Bansal, A.Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press, 1986.
3. Williams, J.R., Passive Solar Heating, Ann Arbar Science, 1983.
4. Jones R.W., Balcomb J.D., Kosiewiez C.E., Lazarus, G.S. McFarland R.D.andWaray W.O. ,Passive Solar Design Handbook,Vol 3,Report of U.S. Department of Energy (DOE/CS-0127/3) 1982
5. Thrilkeld, J.L.Thermal Environmental Engineering, Prentice Hall. (1993):
6. Thumann: Lighting Efficiency Applications, Fairmont Press. 1992
7. http ://www.climat.arch.ucl.ac.be
8. http ://www.21design.com
9. http ://www.ashrae.org
10. www.log-one.com

P15EE*T*E06 / CLEAN DEVELOPMENT MECHANISM

L	T	P	C
3	0	0	3

Course Outcomes
After successful completion of the course, the students should be able to

CO 1: Remember the climate change scenarios and impacts
CO 2: Understand the Kyoto protocol formation, implementation & emission trading.
CO 3: Explain the clean development mechanism.
CO 4: Categorize various emissions based on Kyoto protocol
CO 5: Illustrate the certification programs, policies in clean development.

Pre-requisites:
1. Knowledge in Environmental engineering and pollution control

Course Content

CLIMATE SCIENCE **10Hours**
World Energy Scenario - Observed and modelled changes in Climate - Role of Aerosols - Climate Change Scenarios - Global Warming – Factors contributing – Comparison of Global warming potential of GHG – Impacts.

KYOTO PROTOCOL: FORMATION **6Hours**
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).

KYOTO PROTOCOL **12Hours**
Article 1 through 28 - accounted GHGs in Kyoto protocol – Source categorization of GHG emissions – Reduction commitment of Annexes B countries – C D M, Joint Implementation& Emissions Trading.

CLEAN DEVELOPMENT MECHANISM & BASELINE STUDY SCENARIO **10Hours**
Green and red industries, CDM and its economic viability for Renewable Energy Projects – Advantages for Developing Countries – Emission & Efficiency Scenario of different energy sources for power generation. Baseline Study – Methodology – Boundary Conditions– Base Line fixing – Typical Case Studies.

RECENT ADVANCEMENTS **7Hours**
Certification program – Emission trade – Policy and implications

Theory : 45Hrs **Total Hours: 45**

References:

1. Somerville, Richard C.J., the Forgiving Air: Understanding Environmental Change, Los
2. Angeles: University of California Press, 1998
3. John Houghton, Global Warming: The Complete Briefing, Cambridge University Press,
4. Cambridge, UK, 2004.
5. T.L Roleff, S. Barbour & K.L. Swisher, Global Warming: Opposing Viewpoints, Green
6. haven Press, San Diego, 2002.

P15EETE07 / DESIGN OF HEAT EXCHANGERS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Discuss the components of heat exchanger
CO 2: Analyze the heat exchanger for flow and strength
CO 3: Appraise the design aspects of different heat exchangers
CO 4: Design and develop a solution for compact and plate heat exchanger
CO 5: Predict the performance characteristics of condensers and cooling towers

Pre-requisites:

1. Knowledge in Heat transfer

Course Content

CONSTRUCTIONAL DETAILS AND HEAT TRANSFER 8Hours

Types – Shell and Tube Heat Exchangers – Regenerators and Recuperators –Industrial Applications – Temperature Distribution and its Implications – Analysis of Heat Exchangers– LMTD and Effectiveness method.

FLOW AND STRESS ANALYSIS 9Hours

Effect of Turbulence – Friction Factor – Pressure Loss – Stress in Tubes – Header sheet sand Pressure Vessels – Thermal Stresses, Shear Stresses, Types of Failures.

DESIGN ASPECTS 9Hours

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.

COMPACT AND PLATE HEAT EXCHANGERS 9Hours

Types – Merits and Demerits – Design of Compact Heat Exchangers, Plate Heat Exchangers– Performance Influencing Parameters, Limitations.

CONDENSERS & COOLING TOWERS 9Hours

Design of Surface and Evaporative Condensers – Cooling Tower – Performance Characteristics.

Theory : 45Hrs Total Hours: 45

References:

1. Taborek, T. Hewitt G.F.andAfgan, N.Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.
2. Walker, Industrial Heat Exchangers – A Basic Guide, McGraw Hill Book Co. 1980.
3. Nicholas Cheremistoff, Cooling Tower, Ann Arbor Science Pub 1981.
4. Arthur. P. Frass, Heat Exchanger Design, John Wiley & Sons, 1985.

P15EETE08 / ENERGY STORAGE SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Compare the thermal energy storage systems
CO 2: Analyze the sensible heat storage system
CO 3: Illustrate the working principle of regenerators
CO 4: Identify the types of latent heat storage medium
CO 5: Outline the applications of thermal energy storage systems

Pre-requisites:

1. Knowledge in Thermal energy storage systems

Course Content

INTRODUCTION **5Hours**

Necessity of Thermal Storage – Energy Storage Devices – Comparison of Energy Storage Technologies, Seasonal Thermal Energy Storage.

SENSIBLE HEAT STORAGE SYSTEM **10Hours**

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.

REGENERATORS **10Hours**

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.

LATENT HEAT STORAGE SYSTEMS **10Hours**

Storage materials modelling of phase change problems – Temperature based model, Enthalpy model, Porous medium approach - Conduction dominated phase change – Convection dominated phase change.

APPLICATIONS **10Hours**

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.

Theory : 45Hrs **Total Hours: 45**

References:

1. Schmidt . F.W. and Willmott, A.J. Thermal Storage and Regeneration, Hemisphere
2. Publishing Corporation (1981).
3. Lunardini, V.J. Heat Transfer in Cold Climates, D.VanNostrand, Reinhold, N.Y (1994).
4. Thermal Energy Storage Systems and Applications, Ibrahim Dincer and Mark A. Rosen,
5. John Wiley & Sons Ltd (2002).

P15EETE09 / ADVANCED FLUID MECHANICS

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

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Apply the Navier - Stokes equation for flat plate and cylinder
CO 2: Analyze the 2D fluid flow using the Kelvin's theorem
CO 3: Solve the turbulent flow models
CO 4: Explain the compressible flow through, nozzle and ducts
CO 5: Analyze the 2D shock wave through wind tunnel

Pre-requisites:

1. Knowledge in Fluid mechanics

Course Content

INTRODUCTION **9Hours**

Ideal and non-ideal flows, general equations of fluid motion, Navier - stokes equations and their exact solutions. Boundary layer theory, wedge flows, laminar flow over plates and through cylinders

TWO DIMENSIONAL FLOW **9Hours**

Subsonic flow, physical significance of irrotational motion – Kelvin's theorem – Differential equation in terms of velocity Potential and stream function – Flow with small purtubaration – flow past a wave shaped wall – Gothert's rule –PrandtlGlanert rule – Hodograph method.

TURBULENT FLOW **9Hours**

Turbulence, models and flow equations: steady and unsteady turbulent boundary layers.

COMPRESSIBLE FLOW THROUGH DUCTS **9Hours**

Introduction to compressible viscous flow, governing equations, flow with friction flow with heat transfer-- flow though nozzle and diffuses.

SHOCK WAVE **9Hours**

Normal and oblique shocks – Prandtl – Meyer expansion – Rankine – Hugnoit relation, Application of method of characteristics applied to two dimensional cases – simple supersonic wind tunnel -Design of supersonic wind tunnel and nozzle.

Theory : 45Hrs **Total Hours: 45**

References:

1. Shapiro A F The Dynamics of Compressible flow Vd 1, The Ronald Press company, 1963.
2. Radhakrishnan T Gas Dynamics Prentice Hall, New Delhi, 1995
3. Mohanty A K Fluid Mechanics, Prentice Hall of India, 2002
4. Shames, Mechanics of Fluids, MC grow Hill 1962 Book Company 2002
5. Schlichting H Boundary layer theory MC Grow Hill Book Company 2000

P15EETE10 / COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Develop governing equations, using finite difference method
CO 2: Solve the 1-D, 2-D steady and transient state problems in conduction mode of heat transfer
CO 3: Formulate the governing equation using finite volume method for incompressible fluid flow
CO 4: Apply the finite volume and finite element method in convection method of heat transfer
CO 5: Solve the various turbulence models

Pre-requisites:

1. Knowledge in Heat transfer and fluid mechanics

Course Content

GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10Hours

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.

CONDUCTION HEAT TRANSFER 10Hours

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

INCOMPRESSIBLE FLUID FLOW 10Hours

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.

CONVECTION HEAT TRANSFER AND FEM 10Hours

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

TURBULENCE MODELS 5Hours

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

Theory : 45Hrs **Total Hours: 45**

References:

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2011
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, 1997
4. Taylor, C and Hughes, J.B. “Finite Element Programming of the Navier Stock 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, 1988
7. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics 2”, Specific Techniques for Different Flow Categories, Springer – Verlag, 1991.
8. Bose, T.X., “Numerical Fluid Dynamics”, Narosa Publishing House, 1997.

P15EETE11 / WASTE MANAGEMENT

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Estimate the physical, chemical and biological properties of solid waste
CO 2: Illustrate the collection, transportation and processing techniques of solid waste
CO 3: Discuss the various energy generation techniques.
CO 4: Illustrate the control methods of hazardous waste
CO 5: Outline the design aspects of landfill

Pre-requisites:

1. Knowledge in Environmental Engineering

Course Content

SOLID WASTE – CHARACTERISTICS & PERSPECTIVES 6Hours

Definition - Types – Sources – Generation & Estimation - Properties: Physical, Chemical &Biological – Regulation

COLLECTION, TRANSPORTATION & PROCESSING TECHNIQUES 8Hours

Onsite Handling, Storage & Processing – Types of Waste Collection Mechanisms – Transfer Stations: Types & location – Manual Component Separation - Volume Reduction: Mechanical, Thermal – Separation: Mechanical, Magnetic & Electro Mechanical

ENERGY GENERATION TECHNIQUES 16Hours

Basics, Types, Working & typical conversion efficiencies of Composting – Anaerobic Digestion – RDF – Combustion – Incineration – Gasification – Pyrolysis.

HAZARDOUS WASTE MANAGEMENT 8Hours

Hazardous Waste – Definition - Potential Sources - Waste Sources By Industry – Impacts – Waste Control Methods – Transportation regulations - Risk Assessment – Remediation Technologies.

ULTIMATE DISPOSAL 7Hours

Landfill – Classification – Site Selection Parameters – Design Aspects – Leachate Control – Environmental Monitoring System for Land Fill Gases.

Theory : 45Hrs **Total Hours: 45**

References:

1. Tchobanoglous, Theisen and Vigil, Integrated Solid Waste Management, 2d Ed.McGraw-Hill, New York, 1999.
2. Howard S. Peavy et.al, 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 & Roberts, Energy from Waste – An Evaluation of Conversion technologies, Elsevier Applied Science, London, 1991
6. ManojDatta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.

P15EETE12 / GLOBAL WARMING & CLIMATE CHANGE MITIGATION

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Infer the basic knowledge about the climate change.
CO 2: Outline the climate change mitigation and adaptation
CO 3: Explain the climate change impact on economy
CO 4: Illustrate the policies and recommendations in climate change studies.
CO 5: Develop the case studies on climate change mitigation.

Pre-requisites:

1. Knowledge in Environmental engineering and Pollution control

Course Content

CLIMATE CHANGE INTRODUCTION 9Hours

Earth's natural greenhouse effect-Greenhouse gases-CO2 Emissions-Earths carbon reservoirs-Carbon cycling-Climate and weather-Global wind systems-Global ocean circulation-El Nino-Rising Sea Level-Melting Ice sheets.

CLIMATE CHANGE MITIGATION AND ADAPTATION 9Hours

Kyoto Protocol-GHG intensity - Approaches to reduce CC problems – Mitigation Options and Practices -Land Use Change and Forestry-The Energy Sector-The Agriculture Sector-Grassland Management- Peatl and Management and Restoration of Organic Soils-Restoration of Degraded Lands- Agroforestry, Land Use Change -Livestock Management and Manure Management - Economics of mitigation – Trade able permits – IPCC- Mitigation Options in the Energy Sector - Marginal Abatement Cost Curves.

ASSESSMENT OF CLIMATE CHANGE IMPACT ON ECONOMY 9Hours

Economic issues –Public goods, externalities, uncertainty, sustainability, inter gen. equity, cost-benefit analysis -Scope of Assessment -Regional, national, and international. Scenario and economy wide assessments. Time frame of assessment -Socio-Economic Scenarios Population, income, demand, employment etc. Climate Change Scenario –Impact Assessment Methodologies.

CLIMATE CHANGE POLICY AND RECOMMENDATIONS 9Hours

Introduction- National Policy and Actions- Global and Regional Initiatives- Financing Climate Change Mitigation and Adaptation Activities-Adaptation toward enhanced climate resilience Mitigation toward a low-carbon economy- Funding, Technology Transfer, and International/Regional Cooperation- Strengthening Government Policy Coordination-Undertaking more research on climate change-related issues-Turning the economic crisis into an opportunity.

CLIMATE CHANGE MITIGATION CASE STUDIES **9Hours**

Successful case studies of climate change mitigation.

Theory : 45Hrs **Total Hours: 45**

References:

1. John Houghton, Global Warming: The Complete Briefing, Cambridge University Press, Cambridge, UK, 1997.
2. http://earthguide.ucsd.edu/virtualmuseum/climatechange1/cc1syllabus.shtml.
3. http://www.adb.org/documents/books/economics-climate-change-sea/default.asp.

P15EETE13 / ENERGY CONSERVATION IN INDUSTRIAL PROCESSES AND EQUIPMENT

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Carry out various energy consumption analysis
CO 2: Evaluate heat transfer co efficient for industrial equipments
CO 3: Demonstrate the working of energy recovery system
CO 4: Explain the working of various process equipments
CO 5: Estimate the effectiveness of various types of cooling towers.

Pre-requisites:

1. Knowledge in HVAC

Course Content

INTRODUCTION **9Hours**

Material and energy balances of different manufacturing industries, major process equipments and their characteristics,, performance evaluation, specific energy consumption analysis.

HEAT TRANSFER SYSTEMS AND EQUIPMENTS **9Hours**

Heat transfer principles and coefficient evaluation, evaluation of jacketed pan, heating coils immersed in liquids, refrigeration cycles and refrigerant, mechanical equipments, freezing and cold storage systems.

ABSORPTION AND ADSORPTION **9Hours**

Theory of absorption, extraction and washing equipments, performance evaluation, Desiccant and adsorption systems in vehicles, energy recovery systems, chemical dehumidification, cold storage.

CRYSTALLIZATION AND MECHANICAL SEPARATION **9Hours**

Theory and types of crystallization, membrane separation, chiller equipments, performance evaluation. Cyclones, centrifuges, filters, size reduction equipments, mixers, chemical reactors and bio-reactors, performance evaluation.

COOLING TOWERS **9Hours**

Cooling tower system, types, performance parameters – range, approach, cycles of concentration, effectiveness, cooling tower losses, factors affecting performance, flow control strategies, energy saving opportunities, performance improvement.

Theory : 45Hrs **Total Hours: 45**

References:

1. Royce N Brown, “Compressors: Selection and Sizing” Third Edition”, Gulf Professional Publishing, 2011
2. .James R Couper, W Roy Penney and James R Fair, “Chemical Process Equipment: Selection and Design”, Stan Walas Gulf Professional Publishing, 2005
3. .Ernest E Ludwig, “Applied Process Design for Chemical and Petrochemical Plants”, Vol. 3, Gulf Professional Publishing, 2001.
4. Ernest E Ludwig, “Applied Process Design for Chemical and Petrochemical Plants”, Vol. 1, Gulf Professional Publishing, 2001.

P15EETE14 / ENERGY INFORMATION SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Recall the basic concepts of programming languages

CO 2: Summarize the time sharing concepts in intelligent based system.

CO 3: Discover the scope of software engineering in network models.

CO 4: Illustrate the applications of data acquisition system in energy management area.

CO 5: Perceive the computer monitoring and compile the online control system.

Pre-requisites:

1. Knowledge in Energy Management

Course Content

INTRODUCTION TO COMPUTER APPLICATION 9Hours

Programming languages - Introduction to Visual C++, C-Programming Design – Computer Organization

INTRODUCTION TO COMPUTER BASED INFORMATION SYSTEM 9Hours

Types of CBIS - Relationship among CBIS system concepts and CBIS - general systems theory - Energy Management concepts and CBIS.

DATA BASE MANAGEMENT SYSTEM 9Hours

Intelligence based system - energy data bases - networking - time sharing concepts.

SOFTWARE ENGINEERING 9Hours

The need for the scope of software engineering - survey of software life cycle models-Transform theory of software performance - network model of structured programs.

COMPUTER BASED MONITORING AND ONLINE CONTROL SYSTEM 9Hours

Data acquisition systems - expert based systems for energy management – Parallel Processing Concepts - Typical applications in energy management area.

Theory : 45Hrs **Total Hours: 45**

References:

1. Herbert Schildt-C/C++ Programmer's reference, McGraw-Hill, New York. 2000
2. David McMahon, Rapid Application Development with Visual C++(1999), McGraw-Hill, New York.
3. GerritBlaauw, Frederick Brooks, Computer Architecture: Concepts and Evolution, Addison Wesley. 1997.
4. Ian Sommerville, Software Engineering, 5/e, University of Lancaster, England (1996), Addison Wesley.
5. Peter Jackson, Introduction to Expert Systems, 3/e, addisonWesley(1998).
6. Peter Rob, Databases: Design, Development and Deployment with student CD (Pkg),

P15EETE15 / UNIT OPERATIONS IN CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the methods of size separation of solid particles
CO 2: Apply various technologies in crushing, grinding and conveying
CO 3: Discuss the mixing and filtration methods of solid particles
CO 4: Summarize the evaporation and humidification process
CO 5: Explain the mechanism of drying and distillation methods

Pre-requisites:

1. Knowledge in Powder Metallurgy

Course Content

SIZE SEPERATION **9Hours**

Introduction - Characterization of solid particles - Standard Screens - Screen Analysis -Types of screening Equipments - Air Separation Methods - Cyclone and Bag Filters – Size Separation by Setting - Laws of Setting -Classifiers - Material Separation by difference in Density - Hindered Setting - working of a Thickener.

CRUSHING, GRINDING AND CONVEYING **9Hours**

Various Laws of Crushing - Classification of Crushing and Grinding Machinery – coarse Crushers – Intermediate Crushers - fine Grinder - Jaw Crusher - Gyrator Crusher – Crushing Rolls - Hammer Mills - Ball and Tube Mills - Ultra Fine Grinders - closed circuits Grinding - Grindability Index - conveyors.

MIXING & FILTERATION **9Hours**

Introduction - Mixing of Liquids/Liquids, Liquids/Gases, Liquids/Solids - Types of Mixers - Various Mixing Equipments - Power Requirements for an Impeller Mixer - Theory of Industrial Filtration - Constant Pressure and Constant Rate Filtration - Filter Aids –Filtration Equipments classification - Filter Presses - Heat Filters Rotary Drum Filter -Centrifuges.

EVAPORATION & HUMIDIFICATION **9Hours**

Introduction - Diihrings Chart - Boiling Point Elevation - Capacity and Economy of Evaporators – Evaporators Classification - Short Tube and Long Tube Evaporators – Forced Circulation Evaporators - Forced Circulation Evaporators, Climbing and Falling Film Evaporators - Multiple Effect Evaporators - Evaporator Accessories - Definition – Adiabatic Saturation Temperature Humidity Chart - Wet Bulb Temperature and Measurement of Humidity - Spray Ponds and cooling Tower Design.

DRYING & DISTILLATION **9Hours**

Introduction - Drying Theory - Equilibrium Moisture Content - Bound, Unbound, Free Moisture - Drying rate Curves - Constant Drying Rate - Falling Rate Period – Classification of Dryers - Tray Dryers - Rotary Dryer - Turbo Dryer - Cylinder Dryer - Festoon Dryer -Drum Dryer -

Spray Dryer - Fluid Bed Dryer – Distillation Methods - Minimum Reflux Ratio - Total Reflux - Optimum Reflux Ratio - Steam Distillation Calculations – Ideal Plate- Actual Plate - Plate Efficiency Distillation column internals - Concept of Azeotropic and Extractive Distillation - Enthalpy Balance for a Continuous Distillation - Enthalpy Balance for a Continuous Distillation column(for Binary Systems).

Theory : 45Hrs **Total Hours: 45**

References:

1. W.L.M.C. CABE and JC.SMITH - " Unit Operation of Chemical Engg. " – McGrawHill, 1980.
2. BADGER V.A.and BANCHERO, JT." Introduction to Chemical Engg. ", McGraw Hill,1955.
3. COULSON V.A.and RICHARDSON J.F.- " Chemical Engg., Vol.2 and Vol.3 ", Oxford,1996.
4. ALAN S.FOUST - “Principles of Unit Operations ", John Wiley, 1980.
5. http://www.Chemisoft.on
6. http://www.Chemicalonline.com

P15EETE16 / SOLAR ARCHITECTURE

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the concept of green building technology
CO 2: Explain the significance of passive heating and cooling of buildings
CO 3: Analyze the thermal comfort for human being
CO 4: Identify the various load acting in the buildings
CO 5: Illustrate the passive solar design of buildings

Pre-requisites:

1. Knowledge in Energy conservation in buildings and HVA

Course Content

INTRODUCTION 9Hours

Bio-climatic classification of India, Passive Solar Passive Building and Green Building Concepts, National Building Code, Energy Star Rating , Policies on Energy Efficient and Green buildings.

PASSIVE HEATING & COOLING CONCEPTS 9Hours

Passive heating concepts: Direct heat gain, indirect heat gain, isolated gain and sunspaces, Solar Green Houses, Solar Wall, Solar Trombe wall. Evaporative cooling, radioactive cooling, Application of wind, water and earth for cooling, Shading, paints and cavity walls for cooling, Roof radiation traps, Earth air-tunnel systems for cooling.

THERMAL ANALYSIS AND DESIGN FOR HUMAN COMFORT 9Hours

Thermal comfort, Criteria and various parameters, Psychometric chart, Thermal indices, Climate and comfort zones, Concept of sol-air temperature and its significance, Calculation of instantaneous heat gain through building envelope, Calculation of solar radiation on buildings, Building orientation, Introduction to design of shading devices, Overhangs, Factors that affect energy use in buildings, Ventilation and its significance, Air-conditioning systems.

HEAT TRANSMISSION IN BUILDINGS 9Hours

Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows, Heat transfer due to ventilation/infiltration, internal heat transfer, solar temperature, Decrement factor, Phase lag, Day lighting, Estimation of Building loads: Steady state method, network method, numerical method, correlations.

PASSIVE SOLAR DESIGNS OF BUILDING 9Hours

Thumb rules for design of buildings and building codes, typical design of selected buildings in various climatic zones, Simulation Software's for carrying out thermal design of buildings and predicting performance.

Theory : 45Hrs Total Hours: 45

References:

1. David Findley, Solar Power for Your Home, McGraw-Hill Professional, 2010
2. Jan F. Kreider, P Curtiss, Ari Rabl, Heating and cooling of buildings: design for efficiency, 2nd Edition, CRC Press, 2010.
3. Sue Reed , Energy-Wise Landscape Design, New Society Publishers, 2010
4. S Roaf , M Fuentes, S Thomas, Ecohouse: a design guide,3rd Edition, Architectural Press, 2007
5. Climatology, DS Lal, ShardaPustakBhawan, Allahabad, 2003
6. Christian Schittich, Solar architecture: strategies, visions, concepts, Edition Detail, 2003
7. Daniel D. Chiras , The solar house: passive heating and cooling, Chelsea Green Publishing, 2002

P15EETE17 / FLUIDIZED BED SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the concept of FBC system
CO 2: Compute the heat transfer in fluidized bed systems
CO 3: Discuss the stages of combustion in fluidized bed
CO 4: Analyze the design of distributors, furnace and gas solid separators
CO 5: Outline the industrial applications of fluidized bed systems

Pre-requisites:

1. Knowledge in Heat transfer

Course Content

FLUIDIZED BED BEHAVIOUR 12Hours

Characterization of bed Particles - Fluidization Phenomena - Regimes of Fluidization – Bed pressure drop curve – Two Phase and Well Mixed Theory of Fluidization - Solids Mixing - Particle Entrainment and Elutriation – Features of circulating fluidized beds - Comparison of different methods of gas-solid contacts.

HEAT TRANSFER 6Hours

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.

COMBUSTION AND GASIFICATION 6Hours

Fluidized Bed Combustion and Gasification – Stages of combustion of particles –Performance - Start-up Methods - Pressurized Fluidized Bed Systems – Combustion in CFB boilers.

DESIGN CONSIDERATIONS 9Hours

Design of Distributors – Stoichiometric calculations – Heat and mass balance – Furnace design – design of heating surfaces – gas solid separators.

INDUSTRIAL APPLICATIONS 12Hours

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing; Principles of Synthesis reactions, Cracking and Reforming of hydrocarbons, Carbonization and gasification, Calcining and Clinkering and Gas solid reactions - Sulphur Retention and Oxides of Nitrogen Emission Control.

Theory : 45Hrs Total Hours: 45

References:

1. Yates, J.G.Fundamentals of Fluidized bed Chemical Processes, Butterworths, 1983.

2. Howard, J.R., Fluidized Bed Technology: Principles and Applications, Adam Hilger, New York, 1983.
3. Kunii, D and Levespiel, O., Fluidization Engineering, John Wiley & Son Inc, New York,
4. 1969.
5. Geldart, D, Gas Fluidization Technology, John Wiley & Sons, New York, 1986.
6. Howard, J.R. (Ed), Fluidized Beds: Combustion and Applications, Applied Science
7. Publishers, NewYork, 1983.
8. Botteril, J.S.M., Fluid Bed Heat Transfer, Academic Press, London, 1975.
9. Basu, P. and Fraser, S.A., Circulating Fluidized Bed Boilers, Butterworth-Heinemann,
10. Boston, 1991.
11. Reed, T.B., Biomass Gasification: Principles and Technology, Noyes Data Corporation,
12. New Jersey, 1981.

P15EE*T*18 / NUCLEAR ENGINEERING

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

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the working principle of nuclear reactor and its components
CO 2: Explain the characteristics of nuclear reactor materials and fuel cycles
CO 3: Discuss the reprocessing techniques
CO 4: Describe the processes to be considered for preparation of reactor products.
CO 5: Identify the types of nuclear wastes

Pre-requisites: Knowledge in

1. Nuclear Engineering

Course Content

NUCLEAR REACTIONS **9Hours**

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.

REACTOR MATERIALS **9Hours**

Nuclear Fuel Cycles - Characteristics of Nuclear Fuels - Uranium - Production and Purification of Uranium - Conversion to UF4 and UF6 - Other Fuels like Zirconium, Thorium - Beryllium.

REPROCESSIG **9Hours**

Nuclear Fuel Cycles - Spent Fuel Characteristics - Role of Solvent Extraction in Reprocessing - Solvent Extraction Equipment.

PREPARTION OF REACTOR PRODUCTS **9Hours**

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.

WASTE DISPOSAL AND RADIATION PROTECTION **9Hours**

Types of Nuclear Wastes - Safety Control and Pollution Control and Abatement -International Convention on Safety Aspects - Radiation Hazards Prevention.

Theory : 45Hr **Total Hours: 45Hr**

References:

1. Glasstone S. and Sesonske, A.Nuclear Reactor Engineering (3 rd Edition), Von Nostrand, 1983.
2. Arsh, Introduction to Nuclear Reactor Theory, Wesley, 1966
3. Duderstadt and L.J.Hamiition, Nuclear Reactor Analysis - John Wiley 1976

4. Alter and A.B.Reynolds Fast Breeder Reactor, Pergamon Press - 1981
5. Winterton, Thermal Design of Nuclear Reactors - Pergamon Press - 1981.

P15EE*T*19 / ENERGY MANAGEMENT

L	T	P	C
3	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Identify the different energy sources & energy storage systems.
CO 2: Explain the forecasting techniques of energy demand
CO 3: Discuss the biochemical cycles
CO 4: Explain the working of various components of petro chemical systems.
CO 5: Discuss about various renewable energy sources

Pre-requisites: Knowledge in

1. Energy conservation and Management

Course Content

ENERGY SOURCES **9Hours**

Energy sources; coal oil, natural gas; nuclear energy; hydro electricity, other fossil fuels; geothermal; supply and demand; depletion of resources; need for conservation; uncertainties; national and international issues.

FORECASTING TECHNIQUES **9Hours**

Forecasting techniques; energy demand; magnitude and pattern; input and output analysis; energy modeling and optimal mix of energy sources. Energy; various forms; energy storage; structural properties of environment.

BIOCHEMICAL CYCLES **9Hours**

Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution; growth and change; patterns of consumption in developing and advances countries; commercial generation of power requirements and benefit.

CHEMICAL INDUSTRIES **9Hours**

Chemical industries; classification; conservation in unit operation such as separation; cooling tower; drying; conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries, chloro alkali industries; conservation using optimization techniques.

CONTINUOUS POWER SOURCES **9Hours**

Sources of continuous power; wind and water; geothermal; tidal and solar power; MHD, fuel cells; hydrogen as fuel. Cost analysis; capacity; production rate; system rate; system cost analysis; corporate models; production analysis and production using fuel inventories; input-output analysis; economics; tariffs.

Theory : 45Hr **Total Hours: 45 Hr**

References:

1.Krentz, J. H., Energy Conservation and Utilisation, Allyn and Bacur Inc., 1976.
2.Gramlay, G. M., Energy, Macmillan Publishing Co., New York, 1975.
3.Rused, C. K., Elements of Energy Conservation, McGraw-Hill Book Co., 1985.

P15EE*T*20 / ELECTRICAL DRIVES AND CONTROLS

L	T	P	C
3	0	0	3

Course outcomes

After successful completion of the course, the students should be able to
CO 1: Explain the characteristics of DC and AC motors
CO 2: Illustrate the various losses in electric motors
CO 3: Discuss the working principle of solid state power controllers
CO 4: Illustrate the concept of superconductivity in generators and motors
CO 5: Analyze the solid state motor controllers

Pre-requisites: Knowledge in
1. Electrical drives and control

Course Content

REVIEW OF CONVENTIONAL MOTOR DRIVES 10Hours
Characteristics of DC and AC motors for various applications-starting and speed control methods of breaking.

PHYSICAL PHENOMENA IN ELECTRICAL MACHINES 10Hours
Various losses in motors-Saturation and Eddy current effects-mmf harmonics and their influence of leakage-stray losses-vibration and noise.

INTRODUCTION TO SOLID STATE POWER CONTROLLERS 10Hours
Power devices-Triggering Circuits-Rectifiers-Choppers-Inverters-AC Controllers

SUPERCONDUCTIVITY 9Hours
Super conducting generators-motors and magnets-Super conducting magnetic energy storage (SMES).

SOLID STATE MOTOR CONTROLLERS 6Hours
Single and Three Phase fed DC motor drives-AC motor drives-Voltage Control-Rotor resistance control-Frequency control-Slip Power Recovery scheme.

Theory : 45Hr Total Hours: 45 Hr

References:

1. Pillai, S.K. A First Course on Electrical Drives, Wiley Eastern Ltd, 1989
2. Devwan, S.B. Slevnon, G.R..Strangher, A , Power Stream and Control Drives, JohnWiley& Sons, 1991.
3. Eedamsubramanyan, Thyristor Control of Electrical Drives, Tata McGraw-HillCo.Ltd.,(1997).
4. Murphy, J.M.D. Turnbull, F.G.;Power Electronics: Control of AC Motors-PergamonPress, 2002.

5. Say C.G. -Introduction to the Theories of Electromagnetic Machines, Pitman, 1998.
6. Rakesh Dal Begamudre-Electro Mechanical Energy Conversion with Dynamics of Machines – Wiley Eastern (1988).
7. http://www.ascorinc.com
8. http://wwwsoltek.ca
9. http://www.siemens.com

P15EE*T*21 / POWER GENERATION, TRANSMISSION AND UTILIZATION

L	T	P	C
3	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the conventional power generation methods
CO 2: Explain the non conventional power generation methods
CO 3: Apply load curves and power factor improvement methods
CO 4: Discuss the electrical power transmission
CO 5: Illustrate the utilization of electrical energy

Pre-requisites: Knowledge in

1. Power plant engineering

Course Content

CONVENTIONAL POWER GENERATION 9Hours

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.

NON CONVENTIONAL POWER GENERATION 9Hours

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

ECONOMICS OF POWER GENERATION 9Hours

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.

ELECTRICAL POWER TRANSMISSION 9Hours

Online diagram of transmission-sub transmission 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 large lines-Transmission efficiency regulation-reactive power-compensation-transmission-loss minimization.

UTILIZATION OF ELECTRICAL ENERGY 9Hours

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

Theory : 45Hr **Total Hours: 45 Hr**

References:

1. Wadhwa, C.L. Generation Distribution and utilization of Electrical Energy, Wiley Eastern Ltd., India, 1989.
2. Venikov V.A. and Put Yatin, B.V. Introduction of Energy Technology, Electric power Engineering, MIR Publishers, Moscow, 1984.
3. Soni, M.L. Gupta P.V and Bhatnagar, V.S.A. Course in Electrical Power, DhanbatRai&Sons, New Delhi, 1983.
4. Twidell J.W. and Weir, A.D. Renewable Energy Sources, ELBS Edition, 2000
5. Wood A.J. and Wallenberg B.: Power Generation, Operation and Control, 2ndEdition, JohnWiley&Sons, Newyork, 1986.
6. E.Khan:Electrical Utility Planning and Regulation, American Council for an Energy Efficient Economy, Washington D.C. 1988.

L	T	P	C
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P15EEIN01 WIND MILL DESIGN

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Explain the design of wind power systems

Pre-requisite:

1. Basic Knowledge in wind energy techniques

Course Content

Basics of wind power, introduction to windmills, basics of power production using windmill, design of a windmill and introduction to costing.

This course introduces students to wind systems, including wind generator theory, operation, site evaluation, installation, service and safety. It will be a combination of classroom training, hands-on exercises, and field experience that provides students a broad and solid foundation in wind energy.

Total: 15 Hrs.

P15EEIN02 SOLID WASTE DISPOSAL AND MANAGEMENT

L	T	P	C
1	0	0	1

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand the Implementation of statistical process and control

Pre-requisite:

1. Knowledge in Environmental pollution and control methods

Course Content

Introduction to Solid Waste Management, Hazardous Waste, Management Environmental policies and Legislation, Sustainable techniques in municipal solid waste management, Management of urban waste services

Total: 15 Hrs.

P15EEIN03 **TEAM DYNAMICS**

L	T	P	C
1	0	0	1

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand the concepts of Team dynamics

Pre-requisite:

1. Nil

Course Content

In this course the main text and lectures will cover theories and findings on topics that students will also explore through group exercises in class. Two tests will assess learning of the basic concepts and findings. Students will also demonstrate their ability to apply what they are learning by writing two essays analyzing case studies. One recounts the story of a group expedition to Antarctic (intra group dynamics); the other is a first-person account of ethnic conflict in Bosnia (intergroup dynamics). Finally, class groups will each focus in depth on a particular topic and read primary articles reporting empirical studies. Groups will give a short presentation to the class on this topic and turn in a review paper. An optional final exam will give students who are unhappy with their grades on the tests a chance to improve their scores.

Total: 15 Hrs.

P15EEIN04 IMPLEMENTATION OF STATISTICAL PROCESS CONTROL

L	T	P	C
1	0	0	1

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand the Implementation of statistical process control

Pre-requisite:

1. Nil

Course Content

1. Introduction to SPC
2. Basic statistical concepts
3. Types of Control Chart
4. Calculating Control Limits
5. Variables Control Charts
6. Uses of Control Charts
7. Process Capability
8. Process Control v Process Capability
9. Attribute Control Charts
10. Example of SPC software (Minitab)
11. Process Capability and Six Sigma
12. Company Implementation

Total: 15 Hrs