Master of Technology

(Two Year Full Time Post Graduate Degree Program)

SYLLABUS

(M.Tech Energy Systems, First & Second Year)

School of Energy Management

Shri Mata Vaishno Devi University Katra

(June 2019)

	ABBREVIATIONS / CODES / NOMENCLATURE
Course Code Convention	
SCT – LSAY Example EML 9101 EMP 9102	Course Code for various Courses / Subjects SC: School Code T: Course Type Code (Lecture/Studio/Practical/Project etc.) L: Course Level (1, 2, 3, 4 & 5 for First, Second years …) SA: Study Area / Sub Area Y: Semester Wise Course Number
EM	School Code (SoEM)
L	Lecture
P	Practical
E	Elective
C	Colloquium
D	Project Based
T	Training
S	Self Study
N	Non Credit
V	Special Lecture Topic
Teaching Scheme Convention	
L	Lecture
T	Tutorial
P	Practical
C	Course Credit
Evaluation Scheme Convention	
Minor	(Mid Term Exams / Tests) I & II
Major	Semester End Examination (ESE)
FFCS	Fully Flexible Credit System
CBCS	Choice Based Credit System

Teaching & Examination Scheme

M.Tech. Semester-I (Fall), First Year

			Teaching & Credit Scheme						Evaluation & Examination Scheme					
S. No.	Subject Code	Title of the subject	L	T	P	S	Total Periods/ week	C	Minor E Duration (Hours)	Major E Duration (Hours)	Internal Marks (Assignment)	Minor (I+II) Marks	Major ESE Marks	Total Marks
1	EML 6011	Non-Conventional Energy Sources	3	0	0	-	3	3	1.5	3	10	40	50	100
2	EML 6012	Fuel Technology	3	0	0	-	3	3	1.5	3	10	40	50	100
3	EML 6013	Energy Economics and Planning	3	0	0	-	3	3	1.5	3	10	40	50	100
4	EML 6015	Thermal Science and Engineering	3	0	0	-	3	3	1.5	3	10	40	50	100
5	EME XXXX	School Elective-I	3	0	0	-	3	3	1.5	3	10	40	50	100
6	EML 6026	Research Methodology	3	1	0	-	4	4	1.5	3	10	40	50	100
7	EMP 6011	Energy Laboratory-I	0	0	6	-	3	3	1.5	3	-	40	60	100
8	EML 6025	Basic Electrical and Mechanical Engineering	1	0	0		1	1	1.5	3	10	40	50	100
		SUB TOTAL	19	1	3	-	23	23			70	320	410	800

M.Tech, Semester-II (Winter), First Year

S. No.	Subject Code	Title of the subject	Teaching & Credit Scheme						Evaluation & Examination Scheme					
			L	T	P	S	Total Periods / week	C	Minor E Duration (Hours)	Major E Duration (Hours)	Internal Marks (Assignment)	Minor (I+II) Marks	Major ESE Marks	Total Marks
1	EML 6016	Energy Auditing	3	1	0	-	4	4	1.5	3	10	40	50	100
2	EML 6024	Solar Energy Utilization and System Design	3	1	0	-	4	4	1.5	3	10	40	50	100
3	EME XXXX	School Elective-II	3	0	0	-	3	3	1.5	3	10	40	50	100
4	EME XXXX	School Elective-III	3	0	0	-	3	3	1.5	3	10	40	50	100
5	EML 6023	Disaster Management	2	0	0	-	2	2	1.5	3	10	40	50	100
6	PCN 7067	Discourse on "Universal Human Values : Understanding Harmony and Ethical Conduct	3	0	0	-	0	0	1.5	3	10	40	50	100
7	EMP 6012	Energy Laboratory-II	0	0	6	-	3	3	1.5	3	-	40	60	100
		SUB TOTAL	14	2	6	-	19	19			60	280	360	700

M.Tech, Semester-I (Fall) Second Year

S. No.	Subject Code	Title of the subject	Teaching & Credit Scheme						Evaluation & Examination Scheme					
			L	T	P	S	Total Periods / week	C	Minor E Duration (Hours)	Major E Duration (Hours)	Internal Marks (Assignment)	Minor (I+II) Marks	Major ESE Marks	Total Marks
1	EME XXXX	School Elective-IV	3	0	0	-	3	3	1.5	3	10	40	50	100
2		Open Elective	3	0	0	-	3	3	1.5	3	10	40	50	100
3	EMD 7011	Major project phase-I	0	0	20	-	5	10	-	-	-	40	60	100
4	EMC 6011	Seminar	-	-	6	-	3	3	-	-	-	40	60	100
5	LNL 6414	Communication Skills and Project Presentation	1	0	0		1	1	1.5	3	10	40	50	100
		SUB TOTAL	7	3	13	-	15	20			30	200	270	500

M.Tech, Semester-II (Winter) Second Year

			Teaching & Credit Scheme						Evaluation & Examination Scheme					
S. No.	Subject Code	Title of the subject	L	T	P	S	Total Periods / week	C	Minor E Duration (Hours)	Major E Duration (Hours)	Internal Marks/ Mid Term Evaluation	Marks with Supervisor	Major External Evaluation Marks	Total Marks
1	EMD 7012	Major project phase-II	0	0	40	-	10	20	-	-	10	30	60	100
		SUB TOTAL	0	0	40	-	10	20			30	160	60	100

LIST OF SCHOOL ELECTIVES I						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EME 6011	Materials for Solar Photovoltaics	3	0	0	3
2	EME 6012	Environmental Impact of Energy Sources	3	0	0	3
3	EME 7016	Pollution Control in Power Plants and Automobiles	3	0	0	3
4	EME 7026	Energy Scenario and Energy Policy	3	0	0	3
5	EME 6013	Solar Energy for Industrial Process Heat	3	0	0	3
6	EME 6014	Solar Thermal Power Generation	3	0	0	3
7	EME 6015	Generation, Transmission, Distribution and Utilization of Power	3	0	0	3
LIST OF SCHOOL ELECTIVES II & III						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EME 6016	Solar Photovoltaic Power Plants: Planning & Design	3	0	0	3
2	EME 6020	Biomass and Bio Energy Systems	3	0	0	3
3	EME 6021	Industrial Energy Systems	3	0	0	3
4	EME 7012	Wind Energy Systems	3	0	0	3
5	EME 7013	Small Hydro Systems	3	0	0	3
6	EME 7014	Solar Passive Architecture	3	0	0	3
7	EME 7022	Instrumentation and Control in Energy Systems	3	0	0	3
8	EME 7024	Fuel Cell & Hydrogen Energy	3	0	0	3
9	EME 7025	Solar Refrigeration and Air-Conditioning	3	0	0	3
LIST OF SCHOOL ELECTIVES IV						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EME 7011	Energy Efficiency in Buildings	3	0	0	3
2	EME 7015	Decentralized Generation Systems	3	0	0	3
3	EME 7023	Energy Storage	3	0	0	3
4	EME 7027	Smart Grid Technologies	3	0	0	3
5	EME 7021	Demand Side Management & Integration of Energy	3	0	0	3
6	EME 7028	Electric Vehicles	3	0	0	3
LIST OF OPEN ELECTIVES						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EME 7017	Cogeneration & Energy Efficiency	3	0	0	3
2	EME 7031	Waste to Energy	3	0	0	3
3	EME 7032	IC Engines and Alternative Fuels	3	0	0	3
4	EME 7033	Integrated Energy Systems	3	0	0	3
5	EME 7034	Rural Electrification & its Management	3	0	0	3
6	EME 7035	Renewable Energy Technologies and Grid Integration	3	0	0	3
7	EME 7036	Heating, Ventilating and Air-Conditioning	3	0	0	3

EML 6011			**Non Conventional Energy Sources**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the fundamental for Non Conventional Energy Sources.
2. Design and optimization of Solar Energy based technologies and applications
3. Learn Fundamentals and calculations for biogas and biomass based power generation systems.
4. Scientific overview the wind and hydro power systems and its associated problems.
5. Fundamentally understand Tidal, Geothermal and Nuclear Energy based systems and its Applications

COURSE CONTENTS

Unit-I: (07 Contact Periods)

Conventional Energy Sources, Non Conventional Energy Sources, Renewable Energy Potential, World Energy Scenario, Indian Energy Scenario, Renewable Energy Polices of India, Indian Solar Energy Mission.

Unit-II: (08 Contact Periods)

Solar Energy, Solar radiation Availability, Instruments for measurement of Solar Radiation, Solar angles, Atmospheric phenomena, Solar Collectors (FPC, ETC and PTC), Solar thermal and PV applications: water heating application, Solar Dryer, Solar distillation, Solar refrigeration and Fundamental of Photovoltaic..

Unit-III: (08 Contact Periods)

Hydropower Energy, Present status of Hydro Power, Magneto-hydro-dynamic (MHD) system, Ocean thermal energy conversion (OTEC), Tidal energy conversion, Spring and neap tides, Single and double basin system, Geothermal Energy, Types of geothermal energy sites, Geothermal power plants.,

Unit-IV: (06 Contact Periods)

Biomass availability, Bio-Energy Scenario, Technologies for Bioenergy conversion, Global and Indian Bio Energy Potential, Nuclear Energy

Unit-V: (07 Contact Periods)

Wind Energy: Fundamental of Wind Energy, Indian Wind Energy Potential, Types of wind turbine, Characteristics of the wind, Wind speed monitoring instruments and applications, Offshore Wind energy systems concepts and design.

SUGGESTED BOOKS

1. Twidell & A. W. Wier, Renewable energy resources, English Language book, Society I E & F N Spon (1986).
2. N. K. Bansal, M. Kleeman& M. Mielee, Renewable Conversion Technology, Tata McGraw Hill, New Delhi.
3. T. John and W. Tony, Renewable Energy Resources, Taylor & Francis.

EML 6012			**Fuel Technology**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	5	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand and learn the working of basic instruments required for measuring of various physical quantities.
2. Identify, trace and solve various combustion related problems and evaluate theoretically the performance of various components involved in power plants.
3. Look up for better designing of various combustion equipments to reduce pollution.
4. Helps to adopt various inter-conversion procedures to convert different types of existing fuels for better efficiency.

COURSE CONTENT

Unit-I: (7Contact Periods)

Principles of combustion, different types of Solid, Liquid and Gaseous fuels, processing, applications

Unit-II: (7Contact Periods)

Coal as source of energy and chemicals, Coal preparation, Carbonization, Gasification and Liquefaction of coal and lignite

Unit-III: (7Contact Periods)

Petroleum and its derived products, Inter conversion of fuels, Natural gases and derivatives, Sources and Potential.

Unit-IV: (7 Contact Periods)

Combustion equipment for solid, Liquid and gaseous fuels

Unit-V: (8 Contact Periods)

Nuclear fuel, extraction, fabrication and technology Different types of Reactors, chain reactions, Applications

SUGGESTED BOOKS

1. Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch & Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
3. F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/ Academic Press, 2013.
4. C Subhash, Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications

EML 6013			**Energy Economics and Planning**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understanding of economic and ability to apply economic and financial evaluation of energy projects.
2. Learn different economic models and statistical approaches can be deliberated.
3. familiar with tools of Decision making and uncertainty in the technology implementation
4. To provide relevant inputs on energy economy-environment interaction related policy studies.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

System economics, Reference energy systems, Econometrics, Statistical approach

Unit-II: (8 Contact Periods)

Langrangian multiplier, Input–output economics, Macroeconomic growth models

Unit-III: (7 Contact Periods)

Dynamic models of the economy and simple theory of business fluctuations,Multiple linear andnon linear regression analysis, structure ,

Unit-IV: (7 Contact Periods)

Environmental repercussions and economic, Social costs , Decision and uncertainty.

Unit-V: (7 Contact Periods)

Economics in Renewable Energy Systems.

SUGGESTED BOOKS

1. B.V. Desai, Energy Policy, Wiley Eastern.
2. A. S. Pabla, Electrical Power Systems Planning, McMillan Publishers, India, 1998.
3. C. Wayne, Turner, Energy Management /Handbook, Lilburn, The Fairmont Press, 2001
   Engineering Mechanics – R K Bansal and Sanjay Bansal, Laxmi Publication, Delhi.

EML 6015			**Thermal Science and Engineering**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students will be able to;

1. Learn application of basic concepts of heat and mass transfer. However, mathematical hands on practice will be carried out to assess the various heat transfer methods.
2. Acquire knowledge about the use of the various mathematical tools and thermodynamic graphs will also be addressed and discussed
3. Understand requirement of steam as a working substance for power generation or for process and space heating etc.
4. Understand the Classification of Boilers, mounting and accessories, Boiler performances equivalent evaporation and boiler efficiency

COURSE CONTENTS

Unit-I: (7 Contact Periods)

First and second law of thermodynamics, Thermal fluid systems, Standard cycles, Mixtures of gases, Heat transfer, Fluid mechanics, Practical examples, Use of steam tables. Theory of heat conduction.

Unit-II: (8 Contact Periods)

Mathematical and numerical analysis of two dimensional heat conduction with and without internal heat generation

Unit-III: (7 Contact Periods)

Mathematical and numerical analysis of transient and periodic state heat conduction.
Theory of convective heat transfer, Boundary layer theory,

Unit-IV: (7 Contact Periods)

Heat transfer in duct flow, laminar and turbulent, Heat exchangers, Radiation heat transfer, between black and grey bodies

Unit-V: (7 Contact Periods)

Laws of radiation heat transfer, Numerical solution of radiation network analysis.

SUGGESTED BOOKS

1. Thermal engineering by Sarkar, Tata McGraw Hill
2. Thermodynamics: An Engineering Approach by Yunus A Cengel; Michael A Boles, McGraw Hill
3. Heat and Mass Transfer: Fundamentals and Applications by Yunus A Cengel; Afshin J. Ghajar, McGraw Hill
4. Fundamentals of Thermal - Fluid Sciences by Yunus A. Cengel, McGraw Hill

EML 6026				**Research Methodologies**				Pre Requisites		
								Co-requisites		
L	T	P	C	Minor Duration	Major Duration	Assignment/Quiz	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	1	0	4	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students will be able to;

1. Introduce the basic concept of research, sampling methods.
2. Enable the students to understand the measures of Central tendency and dispersion, Probability Distributions
3. Understand the different methods of Testing of Hypothesis, Correlation, regression and Analysis of Variance.
4. Understand the different methods of Correlation, regression and Analysis of Variance.

COURSE CONTENTS

Unit-I **(16 Contact periods)**

Meaning and Objectives of Research, Criteria of good research, Significance of research, Types of research, Research methods: Historical method, case study method, survey method, and experimental method. Research process, Identification and formulation of a research problem, Relevance of literature review. Hypothesis: types and characteristics. Research Design: need, features and characteristics of a good research design. Different research designs: descriptive, exploratory and experimental. Design of Sample surveys: concept of census and sample survey, Sampling and non-sampling errors, Probabilistic and non-probabilistic sampling designs and their types.

Unit-II **(16 Contact periods)**

Measurement and Scaling Techniques: Scales of measurement for qualitative and quantitative data, Scaling techniques: comparative and no-comparative, Multi-dimensional scaling. Collection of data: Method of collection of primary and secondary data, Questionnaire design. Data preparation process: editing, coding, classification, tabulation and graphical representation. Descriptive Statistics: Measures of central tendency, Measures of dispersion, and Measures of relationship. Association of Attributes. Concept of probability distribution, Normal, Binomial and Poisson distributions.

Unit-III **(16 Contact periods)**

Elementary knowledge of matrices, vectors and differential calculus. Inferential Statistics: Point and Interval estimation, determination of sample size. Sampling distribution. Type-I and Type-II errors. Hypothesis testing procedure, t-test, z-test, chi square test, F-test, ANOVA. Regression Analysis: Simple linear regression, multiple linear regression, Logistic regression. Problem of multicollinearity. Factor Analysis: Centroid and Principal Components Method.

Writing Scientific Report, Writing a research project proposal, Academic ethics and Plagiarism, Intellectual Property Rights and Patent Law.

SUGGESTED BOOKS

1. S.C. Gupta , V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2005.
2. S.P.Gupta, Statistical Methods, Sultan Chand and Sons, 2012.
3. C.R. Kothari, Research Methodology, New Age International Publishers, 2004.
4. Deepak Chawla, NeenaSondhi, Research Methodology, Vikas Publishing House 2016.
5. P. Sivaramakrishna Das, C. Vijayakumari, Engineering Mathematics, Pearson 2017.

EMP 6011			**Energy Laboratory-I**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
0	0	6	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Evaluate the building blocks components of renewable energy and
2. Acquire skills of utilization of renewable energy sources.
3. Analyze the design and development of solar thermal systems including solar cooker, solar dryer, solar heater and solar photovoltaic.
4. Evaluate the potential of renewable energy sources such as solar, wind, small hydro power, bio-energy. Analyze the techno-economical feasibilities and technical viabilities of renewable energy sources

COURSE CONTENTS

Unit-I: (7Contact Periods)

Solar Radiation Data Monitoring and Analysis:
Sunshine hour duration, Direct Solar Radiation, Global Solar Radiation, Diffuse Solar Radiation, Net radiation [W/m2], Outgoing radiation [W/m2], Infra red radiation, Diffuse radiation from global and direct radiation at a given zenith angle

Unit-II: (7Contact Periods)

Solar Radiation Data Monitoring and Analysis:
Sunshine hour duration, Direct Solar Radiation, Global Solar Radiation, Diffuse Solar Radiation, Net radiation [W/m2], Outgoing radiation [W/m2], Infra red radiation, Diffuse radiation from global and direct radiation at a given zenith angle.

Unit-III: (7Contact Periods)

Solar Photovoltaic:
Current-voltage characteristics of Solar Cell, Efficiency Variation of solar cell, Performance variation of solar photo cell at different light intensities,; Determination of power produced by a solar photo voltaic system, Performance Evaluation of a Solar Photo voltaic lighting system and its components: inverter, charge controller and battery, Performance evaluation of a solar photovoltaic water pump.

Unit-IV: (7Contact Periods)

Fuel Properties and analysis:
Proximate and ultimate analysis, Calorific value of solid fuels, Density, Viscosity, Flash-point, Fire-point Pour-point, Distillation of liquid fuels, Fuel properties determination: Cloud and pour (melt) point, Viscosity, Calorific value, Sulfur percentage, Flash point, relative density of fuel, Iodine value of bio-fuel, Ash percentage of fuel.

Unit-V: (8 Contact Periods)

Solar thermal measurements and analysis:
Experimental study of thermal performance of Solar water heater, Evacuated tube solar collector, Solar still, Thermal performance of solar drying system, Thermal testing of a box type Solar Cooker, Concentrator type and community solar cookers, Designing and testing of Innovative solar thermal systems. Introduction to Engineering Equation Solver software.

EML 6025			**Basic of Electrical & Mechanical Engineering**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
1	0	0	1	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand fundamentals of electrical and Mechanical Engineering
2. Evaluate the basic principles of electrical and mechanical engineering
3. Analyze and revive the previous knowledge.

Unit-I: (2 Contact Periods)

Elementary Concepts

Concept of Potential difference. Current and resistance. Ohm's law, effect of temperature on resistance, insulation resistance. D. C. Circuits - Kirchhoff's law, ideal and practical voltage and current sources.

Unit-II: (3 Contact Periods)

A.C. Fundamentals

Sinusoidal voltage and currents, their mathematical and graphical representation, concept of cycle period, frequency, instantaneous, peak, average, r.m.s. values, peak factor and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Concept of active, reactive, apparent, resonance in series and parallel RLC circuit. Q- Factor

Unit-III (3 Contact Periods)

Basic concept of thermodynamics-Introduction, States, Work, Heat, Temperature, Zeroth, 1st, 2nd and 3rd law of thermodynamics, Concept of internal energy, enthalpy and entropy.

Formation of steam at constant pressure, Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation

Unit-IV: (2 Contact Periods)

Stress and strain, elastic constants, Poisson ratio; shear force and bending moment, bending and shear stresses; torsion of circular shafts; testing of materials with universal testing machine; testing of hardness and impact strength.

SUGGESTED BOOKS

1. V. N. Mittal and Arvind Mittal;, " Basic Electrical Engineering" McGraw Hill
2. Vincent DelToro, "Electrical engineering Fundamentals", PHI second edition 2011
3. D.P. Kothari and Nagrath "Theory and Problems in electrical Engineering", PHI edition 2011
4. Elements of Mechanical Engineering – R.K.Rajput Lakmi Pub., Delhi
5. Elements of Mechanical Engineering – D.S.Kumar, S.K. Kataria and Sons
6. Engineering Thermodynamics- P.K.Nag TMH, New Delhi

EML 6016			**Energy Auditing**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	1	0	4	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand and learn the basic knowledge of Energy Auditing, Energy Standards And Different Govt. Schemes for Energy Saving
2. Learn different techniques for Energy Auditing according to requirements i.e. Residential, Commercial, Industrials
3. Learn the working of different Instruments/Devices used for Energy Auditing
4. Learn about Planning of Energy Audit according to time

COURSE CONTENTS

Unit-I: (10 Contact Periods)

Global energy auditing scenario and overview, Need for energy auditing, Difference between energy auditing and energy management.

Unit-II: (10 Contact Periods)

Basic concepts in energy auditing, Energy auditing methodology, Measurement techniques, Mass and energy balances

Unit-III: (10 Contact Periods)

Energy auditing in buildings (HVAC and lighting systems), Energy auditing in power plant, Evaluation of energy conservation opportunities.

Unit-IV: (9 Contact Periods)

Environmental concepts and concerns, Elements measurements, Impact assessment, Guidelines and legislations.

Unit-V: (9 Contact Periods)

Energy monitoring, Presentation of report, Case studies and Laboratory work.

SUGGESTED BOOKS

1. L.C.Witte, P.S.Schmidt, D.R.Brown , Industrial Energy Management and Utilisation, Hemisphere Publ, Washington,1988.
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
3. I.G.C.Dryden, Butterworths, The Efficient Use of Energy, London, 1982
4. W.C.Turner, Wiley, Energy Management Handbook, New York, 1982

EML 6024			**Solar Energy Utilization and System Design**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	1	0	4	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand and learn the basic knowledge of tracking the Sun for Solar Energy Utilization
2. Learn different techniques for Solar Energy Conversion into useful Energy i.e. Electrical Energy Thermal Energy etc.
3. Learn the working of different Instruments/Devices used for Convert/Measuring Solar Energy
4. Learn about Basic Designing concept of different Solar Thermal Devices i.e. Different Thermal Collectors, Their Orientations etc.

COURSE CONTENTS

Unit-I: (10 Contact Periods)

Solar Radiation

Irradiation and Peak Sun Hours, Solar Radiation Data, Sun path Diagram , Defining the Position of the Sun, Sun Tracking, Solar Altitude, Geometric Effects, Tilting Solar Modules.

Unit-II: (10 Contact Periods)

PV / Solar Cell and Solar Lighting

Introduction, Characteristics of a Solar Cell, Power Characteristics of a Solar Cell, Fill factor and Equivalent Solar cell Circuit, STC and NOCT, Factors Which Affect the Performance of Solar Cells, Types of Solar Cells, Different PV Technology, solar lanterns, home lighting systems, solar lanterns, solar PV pumps.

Unit-III: (10 Contact Periods)

Solar thermal Applications

Solar collectors & its types-Flat plate, Concentrating solar collectors, Evacuated Tube Collector, advanced collectors and solar concentrators, Collector Efficiency, solar water heating System, solar cooking, solar drying, , solar thermal power generation.

Unit-IV: (09 Contact Periods)

Solar Building Applications

Solar heating, cooling & its types, Active and Passive heating and cooling of buildings

Unit-V: (09 Contact Periods)

Solar Storage & Industrial Applications

Solar Energy Storage, Industrial process heat systems, Low Temperature application

SUGGESTED BOOKS

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
4. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York, 1986

EML 6023			**Disaster Management**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
2	0	0	2	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in Syllabus.

COURSE CONTENTS

Unit-I: (4 Contact Periods)

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude

Unit-II: (5 Contact Periods)

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit-III: (5 Contact Periods)

Disaster Prone Areas in India Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases and Epidemics.

Unit-IV: (5 Contact Periods)

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness

Unit-V: (5 Contact Periods)

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-operation in Risk Assessment and Warning and People's Participation in Risk Assessment.

Different Strategies for Survival, Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation.Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

SUGGESTED BOOKS

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi. 3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.

PCN 7067			**Discourse on Human Virtues**				Pre Requisites		
							Co-requisites		
L	T	P	Minor Duration	Major Duration	Assignment/Quiz	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Understand the relevance of human values and peaceful co-existence
2. Widen their perspectives in moral decision making
3. Develop right understanding with respect to the basic aspirations of human life
4. Gain holistic understanding of the interrelatedness of individual, family, society and nature
5. Enhance clarity, assurance & purposefulness of life

COURSE CONTENTS

Unit I **(14 Contact Hours)**

1. What is Value Education?
2. Knowledge and Skill
3. Value and Virtue
4. Moral Agency and the Notion of Dharma
5. Freedom of Will and Determinism

Unit II **(13 Contact Hours)**

6. Understanding Human Existence: Human Being and Human Person
7. The Basic Human Aspirations: Continuous Happiness and Prosperity
8. Understanding harmony at the level of Individual, Family and Society

Unit III **(13 Contact Hours)**

9. Understanding harmony at the level of Nature
10. Cardinal Human Virtues such as Compassion, Wisdom, Justice, Tolerance, Non-violence, Service to Humanity with the help of suitable illustrations

SUGGESTED BOOKS

1. Gurucharan Das, *The Difficulty of Being Good*. New Delhi: Penguin Books, 1990 (Chapter 3)
2. Herry G. Frankfurt (1971). Freedom of the Will and the Concept of a Person. *The Journal of Philosophy*, 68 (1): 5 – 20.
3. R.R. Gaur et al, *A Foundation Course in Human Values and Professional Ethics*. New Delhi: Excel Books, 2006.
4. Excerpts from relevant books supplied by the instructor as and when required.

EMP 6012			**Energy Laboratory-II**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
0	0	6	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Evaluate the building blocks components of Electrical energy and Acquire skills of utilization of renewable as well as Electrical energy efficiently
2. Analyze the design with the help of different Simulations Software for solar thermal systems including solar collectors and solar photovoltaic
3. Interpret probability which is capable of estimating various energy management options to minimize the losses to promote the efficiency of the systems
4. Do Mathematical hand on practice will be carried out to assess the various sources of heat loss which can further be checked

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Bio-mass energy:

Biomass properties, Enzyme Production, Cellulose Hydrolysis, Glucose Fermentation, Pentose Fermentation, Ethanol Recovery, Lignin Utilization, Cellulose hydrolysis, Bio-diesel Production.

Unit-II: (7 Contact Periods)

Energy performance of buildings: solar passive buildings:

Testing & performance evaluation of Solar air heating systems: Solar Trombe wall, Thermosyphon heating panels, Attached green houses; Lighting measurements & analysis, Measurement and analysis of heat gain and air-conditioning load in a building, day lighting in a building: sky luminance, daylight from illumination from window and skylight.

Unit-III: (7 Contact Periods)

Energy audit:

Thermal energy audit: Measurement of variables such as, temperature, pressure, air flow, etc of selected energy equipments and analysis; Electric energy audit: Measurement of basic parameters in electric power systems i.e. current, voltage, resistance, power factor, power and energy.

Unit-IV: (7 Contact Periods)

Wind energy measurements:

Wind speed, Wind direction, Data measurement and analysis, Performance evaluation of Wind energy system, Wind potential assessment

Bio- energy systems

Unit-V: (8 Contact Periods)

Experimental study on thermal performance and efficiency of Biomass Energy systems: Gasifier, sampling and analysis of air and flue gas from biomass energy systems: Gasifier, combustor and cook stoves, Biogas production by anaerobic digestion and analysis, Bio-gas Plant comparison, Experimental study of cow dung, Vegetable waste, Municipal waste for biogas production

Energy Simulation through E-Quest, Trnsys and PVsyst

LNL 6414			**Communication skills and Project Presentation**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
1	0	0	1	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES
After successful completion of this course, students shall be able to;
1. Acquire skills of Job Application
2. Improve their communication and presentation skills
3. Build interview, group discussion and team skills

COURSE CONTENTS
Unit-I:

(2 Contact Periods)

What is communication, components of communication, concepts and problems of communication, basic technical communication skills.
Unit-II:

(2 Contact Periods)

E-mail and formal letter writing, applications, cover letters and CVs, notes making, Notice, Minutes and Agenda, Claims, adjustments and enquiries.
Unit-III:

(3 Contact Periods)

Oral Presentation Skills
Unit-IV:

(3 Contact Periods)

Professional speaking: Group Discussion, the interview process, characteristics of job interview, pre-interview job preparation techniques, answering strategies, body language
Unit-V:

(2 Contact Periods)

Nature and significance of report writing, structure of technical report and writing strategies, project presentation and techniques of individual contributions

SUGGESTED BOOKS

1. Raman, Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice*. Oxford University Press, 2015.
2. Choudhury, Soumitra, and Anjana Neira Dev. *Business English.* Pearson Publication, 2008.

Mukerjee, Hory S. *Business Communication*. New Delhi: Oxford University Press, 2013

EME 6011			**Materials for Solar Photovoltaic**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand and learn the basic knowledge of Different materials used in different PV Technologies manufacturing
2. Learn different Properties of Different types of materials used in Solar PV Panels/Modules
3. Learn the working of different types of Solar PV Technologies
4. Learn about Basic Designing/Manufacturing concept of different types of Solar PV Technologies.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Different types of materials-their availability, advantages, disadvantages and applications; Introduction to basic physics of semiconductor devices.

Unit-II: (7 Contact Periods)

Spectral response of solar cells-dark conductivity, I-V characterization, high efficiency solar cells-PERL Si solar cell-LGBC solar ccell, III-V, II-VI high efficiency solar cells.

Unit-III: (7 Contact Periods)

Thin film technology, GaAs solar cells, Multi junction solar cells, nano-micro and polycrystalline Si for solar cells, mono micro silicon composite structure, silicon and non-silicon thin film deposition techniques.

Unit-IV: (7 Contact Periods)

Advanced solar cell concepts and technologies- amorphous silicon thin film technologies, multi junction solar cells- CDTE, CIGS, quantum dots, peroskvite

Unit-V: (8 Contact Periods)

Conjugate polymers-organic/plastic/flexible solar cells, polymer composite for solar cells-devices fabrication and characterization

SUGGESTED BOOKS

1. Solar cells: Operating principles, technology and system applications, by Martin A. Green, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Seminconductors for solar cells, H. J. Moller, Artech House Inc, MA, USA, 1993.
3. Solid State electronic devices, Ben G. Streetman, , Prentice-Hall of India Pvt. Ltd., New delhi 1995.
4. Carbon nanotubes and related structures: New material for twenty-first century, P. J. F. Harris, Cambridge University Press, 1999.
5. Thin-film crystalline silicon solar cells: Physics and technology, R. Brendel, Wiley-VCH, Weinheim, 2003.
6. Clean electricity from photovoltaics, M. D. Archer, R. Hill, Imperial college press, 2001.

EME 6012			**Environmental Impact of Renewable Energy Sources**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Acquire scientific and engineering knowledge on the renewable energy aspects and associated current environment issues.
2. Evaluate the broad spectrum of environmental impact of renewable energy technologies.
3. Design and optimize carbon neutral renewable systems

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Environmental impacts of fossil fuel based power generation, Renewable electricity and key elements.

Unit-II: (8 Contact Periods)

Environmental Concerns (Biotic/Abiotic): Hydropower and its constraints, Wind energy: technology and economics, Resources, systems and regional strategies.

Unit-III: (7 Contact Periods)

Environmental Concerns (Biotic/Abiotic): Solar thermal power, Photovoltaic technology, Biomass power.

Unit-IV: (7 Contact Periods)

Environmental Concerns (Biotic/Abiotic): Tidal power, OTEC, Global climate change, CO_2 reduction potential of renewable energy

Unit-V: (7 Contact Periods)

Socio-economic considerations of different renewable energy systems, standalone systems and grid integration

SUGGESTED BOOKS

1. Energies: V Smil, MIT Press, Cambridge, 1999..
2. Global Warming: J Houghton, Cambridge University Press, New York, 1997
3. Various reports published by IPCC: http://www.ipcc.ch/, 1990 onwards
4. IPCC Special Report on Carbon Dioxide Capture and Storage: B Metz et al (Eds), Cambridge University Press, NY, 2005.

EME 7016			**Pollution Control in Power Plants and Automobiles**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Learn about various types of pollution and strategies to control pollution.
2. Design the new combustion equipments subsequently reducing the pollution level.
3. Learn how to dispose of and recycle the various waste products from the power plants.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Pollution in power plants, particulate gaseous pollutants, thermal pollution, solid waste pollution strategies to control pollution from coal based thermal plants.

Unit-II: (7 Contact Periods)

Pollution control methods (1) pre combustion controls (2) combustion controls low NOx burners, fluidized bed boilers (3) post combustion controls, particulate controls, cyclone, wet scrubbers, ESP and fabric filters, gaseous pollutants control flue gas desulphurization FGD systems.

Unit-III: (8 Contact Periods)

VSR reduction application of electron beam and non-thermal plasmas for Sox and NOx treatments, Cooling towers for thermal pollution

Unit-IV: (7 Contact Periods)

Solid waste treatment plants, fly ash disposal and utilization, efficiency improvements.

Unit-V: (7 Contact Periods)

PFBC, FGCC, combined cycle systems. Different strategies to promote pollution control in automobiles

SUGGESTED BOOKS

1. Environmental Pollution Control Engineering- CS Rao
2. Environmental Noise Pollution – PE Cunniff
3. Handbook of Noise Measurement – APG Peterson & EE Gross PH
4. Air Pollution Control Equipment – H. Brauer and Y. B. G. Verma

EME 7026			**Energy Scenario and Energy Policy**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand utilization of energy usage and finding alternate energy resources and policy implications
2. Know about various Energy Policies of States, Nationals as well as international level
3. Analyze various Energy Policies according to requirement of different Customers i.e. Residential, Commercials and Industrials

COURSE CONTENTS

Unit-I: (9 Contact Periods)

Global Energy Scenario: Role of energy in economic development and social transformation, Energy and GDP - GNP and its dynamics, Energy sources and overall Energy demand and availability, Energy consumption in various sectors and its changing pattern, Depletion of energy sources and impact exponential rise in energy consumption on economies of countries

Unit-II: (7 Contact Periods)

Energy Policies: International Energy Polices of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries, International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal..

Unit-III: (8 Contact Periods)

Indian Energy Scenario: Energy resources and Sector wise energy Consumption pattern Impact of energy on economy and development, National and State Level Energy polices and Issues, Status of Nuclear and Renewable Energy and Power Sector reforms.

Unit-IV: (6 Contact Periods)

Energy Policy: Global Energy Issues, Energy Security, Energy Vision Energy Pricing and Impact of Global Variations Energy Productivity (National and Sector wise productivity).

Unit-V: (6 Contact Periods)

Energy Conservation: Act-2001 and its features, Electricity Act-2003 and its features - Energy Crisis, Future energy options - Need for use of new and renewable energy sources - Energy for Sustainable development.

SUGGESTED BOOKS

1. Global Warming: J Houghton, Cambridge University Press, New York, 1997
2. Various reports published by IPCC: http://www.ipcc.ch/, 1990 onwards
3. IPCC Special Report on Carbon Dioxide Capture and Storage: B Metz et al (Eds), Cambridge University Press, NY, 2005.
4. CDM Country Guide for INDIA: Institute for Global Environmental Strategies (Ed), Ministry of the Environment, Japan, 2005.

EME 6013			**SOLAR ENERGY FOR INDUSTRIAL PROCESS HEAT**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. This course enables the students to develop special skills particularly on the utilization of solar energy for Industrial heat.
2. Learn the different schemes to use solar energy according to Industrial requirement.
3. Learn the detail concept of solar heat absorbing collector/devices
4. Learn the solar geometry concept for tracking the Sun rays/Insolation.

COURSE CONTENTS

Unit-I: (08 Contact Periods)

Industrial process heat – temperature requirements, consumption pattern.

Unit-II: (09 Contact Periods)

Applications of solar flat plate water heater & air heater for industrial process heat, designing thermal storage, transport of energy, Concentrating Solar collector systems, Basic concepts & parameters.

Unit-III: (10 Contact Periods)

Solar – Earth geometry, Insolation, Optics – ray tracing, Concentrating collector designs, Tracking systems, Absorbers for Concentrators; Parabolic trough concentrators, Concentrators with point focus, Heliostats.

Unit-IV: (09 Contact Periods)

Comparison of various designs, industrial applications of concentrating collectors, Exercises in Industrial Applications

SUGGESTED BOOKS

1. A. Rabl, Active Solar Collectors and Their Applications, Oxford University Press, New York, 1985
2. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
3. W. T. Welford, R. Winston, The Optics of Non-imaging Concentrators – Light & Solar Energy, Academic Press, New York, 1978.

EME 6014			**SOLAR THERMAL POWER GENERATION**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	5	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. This course enables the students to understand the concept of Thermal Energy for power generation.
2. Learn the different schemes to use solar energy according to temperature requirement for Thermal Power Plant.
3. Learn the detail concept of solar heat absorbing collector/devices for heat generation in Thermal Power Plant
4. Learn the solar geometry concept for tracking the Sun rays/insolation.

COURSE CONTENT

Unit-I: (9 Contact Periods)

Relevance of solar thermal power generation; Design and performance characteristics of different solar concentrator types suitable for thermal power generation

Unit-II: (9 Contact Periods)

Tracking of solar concentrators; performance characterization of solar concentrators, Storage option for solar thermal power plants

Unit-III: (9 Contact Periods)

Modes of power generation in solar thermal power plants; Sizing solar thermal power plants

Unit-IV: (9 Contact Periods)

Operation and maintenance issues; Emerging trends in solar thermal power generation; Economics of solar thermal power generation

SUGGESTED BOOKS

1. K. Lovegrove and W. Stein, Concentrating Solar Power Technology: Principles Development and Applications, Woodhead Publishing Ltd., 2012.
2. J.A. Duffie and WA Beckman, Solar Engineering of Thermal Processes, John Wiley and Sons, 2006.
3. S.A. Kalogridis, Solar Energy Engineering, Academic Press, 2009.
4. J.F. Kreider, Medium and High-Temperature Solar Processes, Academic Press, 1979.
5. S. S.Mathur and T.C.Kandpal, Solar Concentrators in "Reviews of Renewable Energy Resources" Volume 2 (edited by M.S. Sodha, S.S. Mathur and M.A.S Malik) Wiley Eastern Limited, New Delhi,1984.
6. W.Vogel and H.Kolb, Large Scale Solar Thermal Power, Wiley-VCH Verlag GmbH&Co. KGaA Weinheim, 2010. In addition, use would be made of the latest

EME 6015			**Generation, Transmission, Distribution and Utilization of Power**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Know the power system components and the different possibilities of electrical energy generation and its control.
2. Calculate the operating conditions of electrical systems.
3. Analyze the performance of transmission lines.
4. Understand the concept of modern distribution system.
5. Study the various methods for the control of HVDC systems.

COURSE CONTENTS

Unit-I: (06 Contact Periods)

Generation: Power system, Asynchronous generator and synchronous generator, Synchronous generator operation, Power angle characteristics and the infinite bus concept, Excitations systems, Prime-mover governing systems, Automatic generation control.

Unit-II: (07 Contact Periods)

Economics of generation: Definition, Load duration curve, Number and size of generators units, Cost of electrical energy; **Auxiliaries:** Power system stabilizer, Artificial intelligent controls, Power quality.

Unit-III: (09 Contact Periods)

AC Transmission: Overhead lines and cables, Power transmission system analysis in steady state (line parameters), Transmission line equations, Regulation and transmission line losses, Reactive power compensation, Ferranti effect, Phenomenon of corona, Skin effect, Corona power loss, Flexible AC transmission.

Unit-IV: (08 Contact Periods)

Distribution: Different type of distribution systems, conductor size, Kelvin's law, Performance calculations and analysis, Quality and Reliability of power supply, Substation, Site & feeder selection considerations in substation, Distribution automation, Futuristic power generation, Transmission and Distribution (T & D) losses, Fault in distribution systems.

Unit-V: (06 Contact Periods)

HVDC transmission: EHV and HVDC, HVDC converters, advantages and economic considerations, Converter control characteristics, Analysis of HVDC link performance, FACTS.

SUGGESTED BOOKS

1. C. L. Wadhwa, 'Generation Distribution and Utilization of Electrical Energy', New Age International Publishers.
2. S. Sivanagaraju & S. Satyanarayana, "Electric Power Transmission and Distribution", Pearson Education.
3. T.A. Short, "Electric Power Distribution Handbook", CRC Press.
4. S.N. Singh, "Electric Power Generation, Transmission &Distribution", PHI Learning
5. V. K. Mehtha and Rohit Mehtha, "Principles of Power System", S Chand & Co.

EME 6016			**Solar Photovoltaic Power Plants: Planning and Design**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Draft installation planning and strategies of SPV systems.
2. Evaluate Life cycle costing and financial assessment to look for better options
3. Analyze Data monitoring, collection and analysis will be carried out
4. Design solar power plant for specific locations

COURSE CONTENTS

Unit-I: (9 Contact Periods)

Solar PV Systems

Fundamentals of solar cell, semiconductors as basis for solar cells materials and properties, P-N junction, sources of losses and prevention, estimating power and energy demand, site selection, land requirements, choice of modules, economic comparison, Overview of different types of solar cells/panels. Photovoltaic industries in India and world.

Unit-II: (9 Contact Periods)

Solar PV Power Plants

Fundamentals of energy-handling electric circuits, power electronic circuits such as inverters, inverter types and characteristics, power conditioning system: working algorithms, performance analysis; interconnection of electric power apparatus and operation of power systems Array design, Design of stand alone, Supporting structures, mounting and installation, junction boxes, battery storage, power condition unit, selection of cables and balance of systems, commissioning of solar PV plant..

Unit-III: (9 Contact Periods)

Off-Grid and On-Grid PV Applications

Introduction, commonly used off-grid PV products, grid-connected rooftop solar power plant, solar net-metering. Hybrid and grid interactive plants.

Unit-IV: (09 Contact Periods)

PV System Design Considerations

Introduction, design and structure concept, preparing DPR including financial evaluation and LCOE calculations financial analysis, life cycle costing, sizing of PV system, cost of PV system. Environmental Analysis and social costs, worksheet, customer care

Unit-V: (09 Contact Periods)

Solar PV Software's designing

Planning with software, maintenance and schedule, SCADA system, sensor, data logger, monitoring, data management, analysis and performance, PV SYST

SUGGESTED BOOKS

1. SuneelDeambi : Photovoltaic System Design: Procedures, Tools and Applications, CRC Press 2016.
2. A. Freundlich, P. Verlinden, WvanSark: Photovoltaic Solar Energy: From Fundamentals to Applications, John Wiley & Sons Ltd. 2017.
3. Md. Rabiul Islam, FazRahman, Wei Xu: Advances in Solar Photovoltaic Power Plants, Springer-Verlag Berlin Heidelberg, 2016
4. Chetan Singh Solanki : Solar photovoltaic: Fundamentals Technology and Applications, Second Edition, PHI, 2012

EME 6020			**Biomass & Bio-Energy Systems**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the biomass energy conversion resources and technologies.
2. Design and optimization for different biomass based power generation systems and its Applications.
3. Evaluate the cost-benefits of different bio-energy conversion systems and technologies.
4. Access Technical and feasibility study for thermo-chemical and biochemical energy conversion systems. .

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Biomass generation and its availability, Types of biomass, Conversion process of biomass for energy generation, Waste biomass for energy.

Unit-II: (6 Contact Periods)

Bio Energy Status and Resources, World Bio Energy Potential, Bio Energy Potential in India, Current Technology Status and Policy prospects.

Unit-III: (8 Contact Periods)

Direct Combustion, Pyrolysis and Liquefaction, Principles of Gasification, Design of Biomass Gasifier (Updraft Gasifier, Down draft gasifier, cross draft gasification), Biomass Fuel Analysis for Gasifier, Gasifier Fabrication materials, Analysis of production gas from gasification process, Gas Cleaning and Conditioning, Scrubbers, Safety and Environmental Considerations, Gasification of plastic-rich waste, applications for cooking, electricity generation, Gasifier Engines, Biomass Cook stove and Energy Efficient Cooking..

Unit-IV: (7 Contact Periods)

Technology of Bio-gas production, Biogas Plants, types of Digester and design, Biogas plant for cold climates, Biogas plants based on different substrates, Biogas storage, Applications of Biogas

Unit-V: (8 Contact Periods)

Introduction of third generation Bio-fuels, Application of Bio-fuels, Alcohol production from biomass, Transesterification process for biofuel production, Biohydrogen: production process and applications

SUGGESTED BOOKS

1. K .M. Mital, *Biogas Systems: Principles and Applicationsby*, New Age Publishers.
2. A Chakraverthy, *Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes* by Oxford & IBH publishing Co, 1989.
3. R. S. Khoiyangbam, Navindu Gupta and Sushil Kumar, *Biogas Technology: Towards Sustainable Development*, The Energy and Resources Institute.
4. B. T. Nijaguna, *Biogas Technology*, New Age International Publishers.
5. Georg M. Guebitz, *Biogas Science and Technology*, Springer.

EME 6021			**Industrial Energy Systems**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	1	0	4	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand and learn the working of basic instruments required for managing/auditing of various industrial equipments.
2. Interpret probability which is capable of estimating various energy management options to minimize the losses to promote the efficiency of the systems.
3. Do mathematical hand on practice will be carried out to assess the various sources of heat loss which can further be checked.
4. Evaluate the cost-benefits of various energy efficient technologies

COURSE CONTENTS

Unit-I: (7Contact Periods)

Energy analysis and mass balance, Economic analysis.

Unit-II: (7 Contact Periods)

Instrumentation and control, combustion analysis

Unit-III: (7 Contact Periods)

Industrial insulation, Heat exchangers, Energy efficiency in buildings

Unit-IV: (8 Contact Periods)

Condensating steam, Cogeneration, Compressors

Unit-V: (7 Contact Periods)

Power factor, Transmission and distribution, Principles of management.

SUGGESTED BOOKS

1. L.C.Witte, P.S.Schmidt, D.R.Brown , Industrial Energy Management and Utilisation, Hemisphere Publ, Washington,1988.
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
3. I.G.C.Dryden, Butterworths, The Efficient Use of Energy, London, 1982
4. W.C.Turner, Wiley, Energy Management Handbook, New York, 1982

EME 7012			**Wind Energy Systems**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Learn about different components of the wind energy system.
2. Design the different components for Wind energy systems.
3. Evaluate significantly about the existing potential in the country.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Historical developments of Wind Energy, energy and power in wind, wind energy dynamics, power extracted, axial thrust on turbines, torque, maximum power and Betz coefficient, wind turbine operational characteristic, site selection. Wind energy conversion system, basic integration issues related to wind power, status of Wind power in India.

Unit-II: (7 Contact Periods)

HAWT and VAWT constructions, basic rotor differences, relative merits and operational difficulties, lift and drag turbines, upwind and down wind machines. Wind turbine design considerations; Analysis of wind turbine characteristics; Introduction to reliability engineering, failure analysis of WECS.

Unit-III: (7 Contact Periods)

Basic components, fixed and variable speeds systems, type of generators used-D.C., induction and synchronous machines; grid, standalone, and hybrid schemes,

Unit-IV: (7 Contact Periods)

Power electronics based controllers used with WECS, power quality, impact of constant and variable speed wind turbines on transient stability of power system, wind system economic components, economic analysis methods, cost of on-shore and off-shore wind turbines.

Unit-V: (8 Contact Periods)

Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy. Utilization of Wind Energy Preparing DPR including financial evaluation and LCOE calculations

SUGGESTED BOOKS

1. V. Yaramasu and B.Wu, Model Predictive Control of Wind Energy Conversion Systems,Wiley- IEEE Press, 2016.
2. E. W. Golding, The Generation of Electricity by Wind farms, E & F. N. Spon Ltd, London, (U.K). 1976.
3. C. G. Justus, Winds and Systems Performance, Franklin Institute Press, Philadelphia (USA) 1978.
4. L. Gary, Johnson, Wind Energy System, Prentice Hall Inc. Englewood Cliffs. N. J. (USA) 1985.
5. L. L. Freris, Wind Energy Conversion System, Prentice Hall, (U.K.) 1990.
6. Thomas Ackermann, Wind Power in Power System, John Wiley & Sons Ltd., 2005.

EME 7013			**Small Hydro Systems**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Learn about different components of the small hydro systems.
2. Design the different components for small hydro systems.
3. Evaluate significantly small hydro potential in the country.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Introduction: Overview of micro, mini and small hydro systems.

Unit-II: (7 Contact Periods)

Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines.

Unit-III: (7 Contact Periods)

Investment issues, site selection and civil works; load management and tariff collection.

Unit-IV: (7 Contact Periods)

Distribution and marketing issues: case studies; economics of wind energy

Unit-V: (8 Contact Periods)

Utilization of Wind Energy, Potential of small hydro power in North East India, Preparing DPR including financial evaluation and LCOE calculations

SUGGESTED BOOKS

1. D. Reimert, Protective Relaying for Power Generation Systems, Taylor and Francis.
2. D. M. Clemen , Hydro Plant Electrical Systems, HCI Publication.
3. A. Harvey, A. Brown, and P. Hettiarachi, Micro Hydro Design Manual, Intermediate Technology.
4. J. J. Fritz. Small and Mini Hydro Power Systems: Resource Assessment and Project Feasibility, McGraw Hills.
5. Gulliver, J. S. and Arndt, E.A., Handbook of Hydro Electric Engineering, McGraw Hills.
6. M. L. Kausal, and G. Chauhan , Planning and Design of Small Hydroelectric Projects, (Publication No. 305), Central Board of Irrigation and Power

EME 7014			**Solar Passive Architecture**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the typical mechanism of heat transfer in a building envelope.
2. Demonstrate the opportunities to understand passive heating and cooling mechanisms in the buildings
3. Design passive system for buildings

COURSE CONTENTS

Unit-I: (9 Contact Periods)

Thermal analysis and design for human comfort

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 effects energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air conditioning systems.

Unit-II: (7 Contact Periods)

Passive cooling and heating concepts

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..

Unit-III: (7 Contact Periods)

Heat transmission in buildings

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. Design of day lighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

Unit-IV: (06 Contact Periods)

Bioclimatic classification

Bioclimatic classification of India; Passive concepts appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes.

Unit-V: (07 Contact Periods)

Energy efficient landscape design

Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design; Sitting and orientation

SUGGESTED BOOKS

1. David A. Bainbridge and Ken Haggard. 2011. Passive Solar Architecture. Chelsea Green
2. Allard, F. and M. Santamouris. 1998. Natural Ventilation in Buildings.
3. Argue, R. 1981. Super-insulated Retrofit Book.
4. Bainbridge, D. A., Corbett, J. and J. Hofacre. 1979. Village Homes' Solar House Designs.
5. Boubekri, M. 2008. Daylighting, Architecture and Health.
6. Elizabeth, L. and C. Adams. 2000. Alternative Construction: Contemporary Natural Building Methods. John Wiley

EME 7022			**Instrumentation and Control in Energy Systems**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the importance of instrumentation and control systems
2. Learn about various instruments and controls
3. Analyze the problems of incorrect measurements
4. Develop control systems and maintenance of the existing control systems.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Overview of Instruments and Measurement Systems Principles of measurements and Measurement errors, Classification of instruments, static and dynamic characteristics, Input Output configurations of measurement system..

Unit-II: (7 Contact Periods)

Types, characteristics and applications of Mechanical transducers, Types, characteristics and applications of electrical transducers, Principles of Modern sensors and typical applications.
instruments for measuring temperature, pressure, velocity and flow, heat flux, liquid level and concentration in energy systems, characterization of combustors, flue gas analyzer, exhaust gas analyzer.

Unit-III: (7 Contact Periods)

Solar energy measurement requirements and instruments, meteorological data measurements, energy auditing instruments, energy audit kit, humidity measurements, Introduction to Control Systems: Overview of control systems, types and components,
Feedback and non-feedback systems and their applications

Unit-IV: (7 Contact Periods)

Transfer function, block diagram, Representation and reduction techniques, Signal conditioning: Operational amplifier types and characteristics, Application circuits- inverter, adder, subs tractor, multiplier and divider, Analog /digital/analog conversion techniques.

Unit-IV: (8 Contact Periods)

Microcontrollers and compilers: Overview of microprocessor and microcontroller,
Microcontroller Types and architecture, Use of compilers for data acquisition, processing and display, typical microcontroller Applications for monitoring and control of electrical and non–electrical parameters/processes.

SUGGESTED BOOKS

1. Morris A. S. (1998); Principles of Measurements and Instrumentation, Prentice Hall of India
2. Sawhney A. K. (2011); A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai
3. Bentley J. P. (2005); PrinciplesofMeasurement Systems, Fourth Edition, Pearson Prentice Hall
4. Jain R. P. (1998); Modern Digital Electronics, McGraw Hill

EME 7024			**Fuel Cell and Hydrogen Energy**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Analyze the electrochemical energy production and their thermodynamic procedures.
2. Evaluate the performance of fuel cells under different operating conditions.
3. Select and apply appropriate fuel cell technology for a given application & adaptation of hydrogen storage materials.
4. Design tools to minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology

COURSE CONTENTS

Unit-I: (9 Contact Periods)

Hydrogen energy: Its merit as fuel; Production: fossil fuels, electrolysis, thermal decomposition, photochemical, photo catalytic, hybrid systems.

Unit-II: (9 Contact Periods)

Storage: metal hydrides, metallic alloy hydrides, carbon nano tubes, sea as source of deuterium.

Unit-III: (9 Contact Periods)

Fuel cell: classification, principle of working, basic thermodynamics.

Unit-IV: (9 Contact Periods)

Operating Principles: Electrochemical principles, electrolytes, fuel types, fuel-cell electrodes and carbon nano tubes;Transportation of hydrogen energy, Application of hydrogen energy and fuel cell in of power generation.

SUGGESTED BOOKS

1. Fuel Cell System, edited by Leo J.M.J. Blomen and michael N. Mugerwa, New York, Plenum Press, 1993.
2. Fuel Cell Handbook, by A. J. Appleby and F. R. Foulkers, Van Nostrand, 1989.

EME 7025			**Solar Refrigeration and Air-Conditioning**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Identify the potential scopes of the renewable energy based cooling systems.
2. Understand modeling methods to assess the performance of the systems.
3. Learn about different cooling systems
4. Evaluate each cooling system for economic viability

COURSE CONTENTS

Unit-I: (9 Contact Periods)

Introduction

Basics of refrigeration and air conditioning, comfort zones, potential and scope of solar cooling and heating, fundamentals of conventional vapor compression system and vapour absorption system. Solar cooling technology: solar electrical cooling, solar thermal cooling:- open cycles (liquid and solid desiccant system), closed cycle (absorption cycle, adsorption cycle, solar radiation cooling), thermo mechanical systems, steam ejector cycle, solar combined power/cooling.

Unit-II: (9 Contact Periods)

Desiccant Air Conditioning

Desiccant materials, classification of desiccant material, fundamentals of desiccant material: adsorption process, regeneration process, adsorption rate, regeneration rate, factor affecting adsorption and regeneration of desiccant material, heating/humidification, cooling/dehumidification, and desiccant dehumidifiers: desiccant bed, desiccant wheel, desiccant coated heat exchanger, solar powered desiccant air conditioning system.

Unit-III: (7 Contact Periods)

Adsorption Refrigeration System

Introduction, principle of adsorption, thermodynamics of adsorption cycles: - basic adsorption cycle, heat recovery adsorption refrigeration cycle, mass recovery adsorption refrigeration cycle, thermal wave cycle, convective thermal wave cycle, intermittent adsorption systems: silica-gel/water and silica-gel methanol systems, zeolite–water systems, activated carbon–methanol systems, activated carbon–ammonia systems.

Unit-IV: (06 Contact Periods)

Absorption Refrigeration System

Absorption cycle of operation, maximum, COP, properties of solution, aqua-ammonia solution, simple absorption system, h-x diagram, ammonia enrichment process and water -lithium bromide refrigeration system, single-effect solar absorption cycle, half-effect solar absorption cooling system, double-effect solar-assisted absorption cooling systems, diffusion absorption solar cooling system, hybrid solar absorption cooling systems

Unit-V: (05 Contact Periods)

Solar Air-conditioning and Economics

Refrigerant storage for solar absorption cooling systems. Solar thermoelectric refrigeration and air conditioning. Economics of solar cooling

SUGGESTED BOOKS

1. Arora C. P Refrigeration and Air conditioning-Tata McGraw Hill, 2004
2. Stanley W Angrist Direct Energy conversions, Allyn& Bacon, 1982

EME 7011			**Energy Efficiency in Buildings**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. understand Qualitative and Quantitative approach to improve efficiency of the buildings.
2. understand the use of various building related softwares for bettering indoor environment.
3. Apply various concepts of Heat transfer in estimating the building cooling load.
4. Evaluate and analysis case studies

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Introduction

Climate and shelter – Historic buildings – Modern architecture – Examples from different Climate zones – Thermal comfort – Solar geometry and shading – Heating and cooling loads Energy estimates and site planning – Integrative Modeling methods and building simulation.

Unit-II: (6 Contact Periods)

Energy conscious building

Principles of Energy conscious building design – Energy conservation in buildings – Day Lighting – Water heating and photovoltaic systems – Advances in thermal insulation – Heat Gain/loss through building components – Solar architecture..

Unit-III: (9 Contact Periods)

Building Heating & Cooling

Passive solar heating – Direct gain – Thermal storage wall – Sunspace – Convective air loop Passive cooling – Ventilation – Radiation – Evaporation and Dehumidification – Mass effect Design guidelines..

Unit-IV: (09 Contact Periods)

Energy Conservative Buildings

Energy conservation in building – Air conditioning – HVAC equipments – Computer packages for thermal design of buildings and performance prediction – Monitoring and instrumentation of passive buildings – Control systems for energy efficient buildings – Illustrative passive buildings-Integration of emerging technologies – Intelligent building design principles

Unit-V: (5 Contact Periods)

Software and case studies

Building Software and Efficient building case studies

SUGGESTED BOOKS

1. Energy Conservation in Buildings by N K Bansal
2. J.K. Nayak and J.A. PrajapatiHadbook on Energy Consious Buildings, Solar Energy Control MNES, 2006.
3. Energy Conservation Building Codes 2006; Bereau of Energy Efficiency.
4. R.W. Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. McFarland and W.O. Wray, Passive Solar Design Hanbook, Vol.3, Report of U.S. Department of Energy (DOE/CS-0127/3), 1982.
5. 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.

EME 7015			**Decentralized Generation Systems**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. interpret the regulatory requirements applicable for handling and management of different generation systems.
2. understand the input of the hybrid generation systems incorporating the renewable energy utilization.
3. Evaluate Cost benefit analysis of various power cycles

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Introduction

Need and advantage of decentralized energy systems, Decentralized generation technologies; Costs and choice of technology, Demand and benefits forecasting and program development, Principles of cost-benefit calculations, Economic and financial analysis of stand-alone electrification projects.

Unit-II: (7 Contact Periods)

Decentralized Generation

Decentralized versus central station generation, Traditional power systems, Load curves and load curve analysis, Demand scheduling, optimal design of hybrid energy systems, Energy economics and cost optimization of integrating energy system: Sample problems & Case study.

Unit-III: (7 Contact Periods)

Different distributed generators

Basic gas turbine generator concepts; Utility system turbine generators; Mini and micro gas turbine generators; Solar thermal power generation, utility scale photovoltaic (USPV)Generation; Wind-powered generation;

Unit-IV: (7 Contact Periods)

Biomass based generation; DG Evaluation: Cost from past, present, and future, basic DG cost analysis, cost Evaluation and schedule of demand.Policies and Schemes-Scope and challenges in implementing off grid solutions; Policy and regulatory framework for decentralized electricity in India: Gokak Committee

Unit-IV: (8 Contact Periods)

Integrated Energy Policy, Power for All,Electricity Act, RGGVY, Village Energy Security Programme (VESP), Status of grid connected and off grid distributed generation (national and International) Grid interconnection options-The power grid; DG-Grid interconnection issues; Case Study

SUGGESTED BOOKS

1. Bollen M. H. and Hassan F. (2011); Integration of Distributed Generation in the Power System, Wiley-IEEE Press
2. Zerriffi H. (2011); Rural Electrification: Strategies for Distributed Generation , Springer Jenkins N. Strbac G. and Ekanayake J. (2009);
3. Distributed Generation, The Institution of Engineering and Technology Keyhani A. (2011); Design of Smart Power Grid Renewable Energy Systems, Wiley–IEEE Press Tester J. W. (et al.) (2012);
4. Sustainable Energy: Choosing among Options, Second Edition, the MIT Press

EME 7023			**Energy Storage**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Evaluate the different types of the energy storage systems.
2. Analyze different PCM's based energy storage systems including latent heat storage systems and sensible heat storage systems.
3. Analyze the importance of chemical energy storage and hydrogen energy storage.
4. Acquire knowledge for compressed air energy storage, electrical and magnetic energy storage systems.

COURSE CONTENTS

Unit-I: (4 Contact Periods)

Introduction

Need for energy storage; Different modes of energy storage; Utilization of energy storage devices, specific areas of applications of energy storage system.

Unit-II: (8 Contact Periods)

Electrical Energy Storage (EES) Technologies and Considerations: Flywheel Energy Storage System (FESS) and Applications; Electrochemical Energy Storage Systems (EESSs): Battery Energy Storage Systems (BESSs) and Applications, Electrical and magnetic energy storage; Capacitor Energy Storage Systems

Unit-III: (8 Contact Periods)

Pumped Hydro Energy Storage Systems (PHESSs); KE and Compressed Air Energy Storage Systems (CAESSs); Thermo-chemical energy storage, Fuel cell (FC) as energy storage systems and Applications (PEMF, SOFC, Microbial Fuel Cell, etc), Hydrogen storage methods and types (Metal hydrides, metallic alloy hydrides).

Unit-IV: (08 Contact Periods)

Thermal energy storage - Necessity, latent heat storage system, Phase Change Materials (PCMs) and classifications, properties of the PCM's for different temperature range, selection criteria of PCMs for heating and cooling in buildings, PCM's use in Solar dryer, water heating system, LHTES systems in refrigeration and air-conditioning applications; Short term heat storage system, Heat storage in SHS systems; SHS mediums, Rock-bed storage systems; Energy analysis of the latent heat storage based different systems

Unit-V: (08 Contact Periods)

Case studies and application of the thermal energy storage for space heating and cooling, green house heating, Solar power plant applications; Drying and heating for process industries, Food preservation; Waste heat recovery; Comparison of different energy storage technologies and future prospects.

SUGGESTED BOOKS

1. Ataer, O. Ercan. Energy Storage Systems-Volume I (2009): 97, Encyclopedia of Life Support Systems.
2. Kalaiselvam, S., and R. Parameshwaran. Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications. Elsevier.
3. Fleischer, Amy S. Thermal Energy Storage Using Phase Change Material, Springer.

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EME 7027			**Smart Grid Technologies**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

COURSE CONTENTS

Unit-I: (5 Contact Periods)

Introduction

Early smart grid initiatives, overview of the technologies required for the smart grid, information security for the smart grid.

Unit-II: (7 Contact Periods)

Smart Grid

Introduction to grid connectivity of RE systems, smart grid and emerging technologies, operating principles and models of smart gird components, key technologies for generation, networks, loads and their control capabilities; decision-making tools.

Unit-III: (6 Contact Periods)

Smart Metering

Introduction, evolution of electricity metering, key components of smart metering, overview of the hardware used for smart meters, smart metering protocols.

Unit-IV: (9 Contact Periods)

Distribution Management Systems

Structure and main components of a distribution management system, SCADA, distribution system modeling, new trends for smart grids, topology analysis, power flow analysis

Unit-V: (9 Contact Periods)

WAMPAC System

System design of WAMPAC systems, Wide Area Monitoring and State Estimation, Real-time Diagnostics and Situational Awareness, Smart Grid Planning Issue, Diagnostics, Self-Healing and Reliability of Smart Grids, Demand Response Management through Smart Grid Technology, System Identification Technologies with PMUs.

SUGGESTED BOOKS

1. Nick Jenkins, JanakaEkanayake, [et al.] *Smart Grid Technology And Applications*, Wiley India Ltd.
2. Ali Keyhani, Muhammad Marwali, *Smart Power Grids 2011*, Springer-Verlag Berlin Heidelberg 2012.

Ali Keyhani, *Design of Smart Power Grid Renewable Energy Systems*, Wiley-IEEE Press 2016

EME 7021			**Demand Side Management & Integration of Energy**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Learn special skills particularly on the load management and control strategies.
2. Learn the different schemes to find/calculate demand/load of particular sector.
3. Learn the working of different Instruments/Devices used to measure/calculate Demand/load of particular sector
4. Decide the true energy pricing for each particular site specifically

COURSE CONTENTS

Unit-I: (6 Contact Periods)

Introduction and Concept of DSM-The concepts and methods of DSM -Load control, Energy efficiency, Load management; DSM planning, design, marketing; Impact assessment. Customer load control- Direct, Distributed, and Local control, Interruptible load; Configuration of control system for load control; Assessment of Impact on load shape.

Unit-II: (6 Contact Periods)

Strategic Conservation and Load Management Technologies-Strategic conservation via improving building envelope, Air-conditioning, Lighting; Electric motor, and other industrial processes and equipment; Load shifting and load leveling through Thermal Energy Storage.

Unit-III: (5 Contact Periods)

Programs & Incentives for Customers, Customer Incentives, Program Marketing Design and Penetration-Type of incentives and programs, Program design; Use of Analytic Hierarchical Process for assessment of Customer Acceptance and Program penetration.

Unit-IV: (10 Contact Periods)

Assessment of Impact on System Load Shape

Energy Audit and assessment of customers' load shape for different customer groups; Impact of DSM programs on load shapes in customer groups, Categorized in economic sub sectors, and by geographical location, Cost/Benefit Analysis and Feasibility of DSM Program

DSM program costing and Load Shape Impact on system; DSM program cost/benefit and Feasibility; Environmental benefits

Unit-V: (09 Contact Periods)

Integrated Electric Utility Service under Deregulated Situation

Institutional, Legal, and Political environments and the stages of development of Electric Utility Service; The mechanism of competition and development of the financial environment for economic utilization of resources for electric service

SUGGESTED BOOKS

1. Demand Side Management, Jyothi Prakash, TMH Publishers.
2. Energy management hand book by W.C.Turner, John Wiley and sons
3. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, WileyEastern, 2005.

EME 7017			**Cogeneration & Energy Efficiency**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. To impart to students knowledge of practical cogeneration possibilities through case studies related to different types of process industries (sugar/textile/paper etc.) and other industries (steel, cement etc.).
2. Understand use of cogeneration technologies in the localities such as hotel industries, hospitals etc.
3. Build a model cogeneration system and evaluation its performance characteristics under various experimental conditions

COURSE CONTENTS

Unit-I: (9 Contact Periods)

Introduction

The concept of cogeneration, main design parameters for cogeneration, cogeneration Alternatives, bottoming and topping cycles, Cogeneration potentials.

Unit-II: (9 Contact Periods)

Steam turbine plants, Gas turbine plant, Diesel and gas engine plants, Thermodynamic evaluation, combined cycle applications, Sterling engine.

Unit-III: (9 Contact Periods)

Industrial Cogeneration

Industry / utility cogeneration, Tri generation, Techno economic and Environ-mental aspects.

Unit-IV: (09 Contact Periods)

Economic & Environmental Aspects

Environmental evaluation, cost allocation methods, Sizing & operating cogeneration systems,Case Studies Cogeneration in sugar, textile, paper and steel industry

SUGGESTED BOOKS

1. Energy Cogeneration Hand Book for Central Plant Design by George Polimeros.
2. Power Plant Technology by M.M.EI- Wakil

EME 7031			**Waste to Energy**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Assess the biomass energy conversion resources and technologies.
2. Design and optimize and biomass power.
3. Evaluate the cost-benefits of various biomass power technologies.
4. Identify suitable bio-energy production technologies for various geographicallocations.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste, MSW, Conversion devices, Incinerators, gasifiers, digestors.

Unit-II: (6 Contact Periods)

Biogas: Properties of biogas (Calorific value and composition), Biogas plant technology and status, Biomass energy programme in India..

Unit-III: (7 Contact Periods)

Bio energy system - Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, Direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, Alcohol production from biomass - Bio diesel production, Urban waste to energy conversion.

Unit-IV: (08 Contact Periods)

Biomass Pyrolysis: Pyrolysis, Types, slow fast, Manufacture of charcoal, Methods, Yields and application, Manufacture of pyrolytic oils and gases, yields and applications. Biomass Gasification: Gasifiers, Fixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers

Unit-V: (08 Contact Periods)

Design, construction and operation, Gasifier burner arrangement for thermal heating, Gasifier engine arrangement and electrical power, Equilibrium and kinetic consideration in gasifier operation. Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation

SUGGESTED BOOKS

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987

EME 7032			**IC Engines and Alternative Fuels**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand concepts of internal combustion engines.
2. Design the new combustion equipment subsequently reducing the pollution level.
3. Adopt options to reuse the large heat content form components for better efficiency.

COURSE CONTENTS

Unit-I: (7 Contact Periods)

Thermo-chemistry of Fuel, Air mixtures, properties, Ideal Models of Engine cycles, Engine Types, Design and operating Parameters, Real Engine cycles difference and responsible factors, Normal and Abnormal Combustion in S.I and C.I Engines.

Unit-II: (8 Contact Periods)

Factors affecting knock, Combustion in CI engines, Different stages of combustion, knocking in diesel engines, importance of ignition delay, Heat release rate in C.I engines, Factors affecting combustion and knock , Fuel spray in diesel engines and air movement.

Unit-III: (7 Contact Periods)

Combustion Chambers in S.I & C.I Engines: Design Principles of chambers, Comparison of DI & IDI Engines, Pollutant Formation and Control: Nitrogen Oxides, Carbon monoxide, Unburnt Hydrocarbon and particulate emission, Measurement, Exhaust Gas Treatment, Exhaust Gas Recirculation (EGR), Catalytic converter- 2 way type & 3 way type

Unit-IV: (7 Contact Periods)

Selective Catalytic Reduction (SCR), NOx traps, Modern Trends in IC Engines, Lean Burning and Adiabatic concepts, Rotary Engines, Modification in IC Engines to suite Bio-Fuels - Fuel supply systems for SI and CI engines to use gaseous fuels like LPG, CNG, and Hydrogen

Unit-V: (7 Contact Periods)

Common Rail Direct Injection (CRDI), Homogenous Charge Compression Ignition (HCCI) & Gasoline Direct Injection (GDI).

SUGGESTED BOOKS

1. A course in internal combustion engines by Mathur and Sharma,
2. A textbook of Internal combustion engines by R. K. Rajput, Lakshmi Publication
3. Internal combustion engines by V. Ganesan, Tat McGraw Hill

EME 7033			**INTEGRATED ENERGY SYSTEMS**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. This course explains the concept of different Energy integrated systems and their requirements.
2. Learn the different schemes to fulfill the requirement of Energy demand by Renewable Sources of Energy.
3. Learn the detail concept of small scale power generation systems from Solar, Wind and other Renewable sources.
4. Learn the basic concept of waste heat utilization and optimize Energy systems.

COURSE CONTENT

Unit-I: (8 Contact Periods)

Pattern of fuel consumption: agricultural, domestic, industrial and community needs

Unit-II: (11 Contact Periods)

Projection of energy demands, Substitution of conventional sources by alternative sources and more efficient modern technologies, Potential, availability as well as capacity of solar, wind, biogas, natural gas, forest produce, tidal, geothermal, mini-hydro and other modern applications, Hybrid and integrated

Unit-III: (9 Contact Periods)

Energy systems, Total energy concept and waste heat utilization, Energy modeling to optimize different systems

Unit-IV: (8 Contact Periods)

Small scales renewable power generation systems

SUGGESTED BOOKS

1. L Barrtom, Renewable Energy Sources for fuels and Electricity, Island Press 1993.
2. T Ohta, Energy Technology, Pergamon Press 1994.
3. J Twidell and T Weir, Renewable Energy Resources, E&FN Spon., 1986.
4. R Hunter and G Elliot, Wind-Diesel Systems, Cambridge University Press, 1994.

EME 7034			**RURAL ELECTRIFICATION & ITS MANAGEMENT**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. This course enables the students to understand the concept of Energy requirement for rural areas/Villages.
2. Learn the different schemes to electrify the rural /remote areas.
3. Learn the detail concept of Transmission and Distribution of Electricity.
4. Learn the Transmission and Distribution Installation systems.

COURSE CONTENT

Unit-I: (8 Contact Periods)

Introduction to Energy World: Sources of Energy, exploitation of different sources and use of energy, Convenience of use of electricity, Electricity from the power plant to the end users, consumers from city to remotest corner of villages.

Unit-II: (7 Contact Periods)

General Aspects of Energy Management: Energy Scenario, Energy Management and Audit, Energy Action Planning, Electricity Regulations.

Unit-III: (10 Contact Periods)

Materials for transmission lines: Line support, different types of poles and towers, insulators, conductors, brackets, cross arms, earthing arrangement, stays and struts, bracings, different types of insulators for HT and LT lines, post insulator, disc insulator, different types of conductors, other line equipment's, (clamp, strain clamp, parallel groove clamp), bolted clip, sleeve, aluminium tape and binding wire, line vibration, insulator hardware.

Unit-IV: (11 Contact Periods)

Tools and equipment: Screw Driver, pliers, cutting pliers, hammer, hand drill, hack, saw, tenon saw, knife, chisel, files, wrench and spanner, pipe wrench, standard wire gauge, bench vice, micrometer, plumb bob, punching machine, chain pulley block, max puller, draw vice, hand glove, safety row, earthing rod with chain, energy meter, ammeter, voltmeter, clip-on ammeter. Erection of overhead lines: Selection of route and line survey, compliance of Indian electricity act and rules, sketch marking of pole locations, pole erection, stay erection, erection of cross arms and insulators, stringing of the conductor, line joints, sag, and its measurement, safety during stringing, fixing of line guards.

SUGGESTED BOOKS

1. Zerriffi Hisham, Rural Electrification, Springer

EME 7035			**Renewable Energy Technologies and Grid Integration**				Pre Requisites			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE CONTENT

Unit I:

Introduction to renewable energy sources, Solar Energy, Sun structure and characteristics, solar constant, Solar Irradiation, Parameters affecting solar energy, Measurement of Solar Irradiance, Solar Energy Generation Technologies, Solar PV System, Principle of working of solar cells, Types of Solar PV Panels, Materials and process requirements for module assembly, Solar Inverters, MPPT working of Solar Inverters, Solar Thermal System, Concentrating Solar Plants, Solar Space Heating / Cooling Systems, Solar Water Heating Systems, Solar Parks, Applications of Solar Energy. New research areas in Solar Energy.

Unit II:

Wind Energy, Characteristics of Wind, Wind Energy Conversion Systems, Parts of Wind Turbines, Principles of working of Wind Turbines, Types of Wind Turbines, Betz Law, Power Output from Wind Turbines, Factors affecting wind Power Generation, Power Curve, Various Wind Power Generators, Offshore Wind Energy, Important Parameters for Site selection and Wind Farm design, Micro / Small Wind Turbines, New Research Areas in Wind Energy.

Unit III:

Hydro Energy, Principle of working, Classification of Hydro Power Plants, Pumped Storage Hydro Power Plants, Components of Hydro Power Plants, Types of Turbines and their working principles, Governor Operation, Magneto-hydro-dynamic (MHD) system

Biomass and Bioenergy: Biomass Characterisation, Energy Conversion Techniques, Thermal Conversion, Thermochemical Conversion, Biochemical Conversion, Chemical Conversion, Biogas Production, Aerobic and anaerobic processes, different designs of biogas plants, New research areas- Algae biomass, Seaweed etc.

Unit IV:

Tidal energy, Understanding Tides, Types of Tidal Generation, Wave Energy, Wave Formation, Wave Energy Conversion Systems, Ocean thermal energy conversion (OTEC), Geothermal Energy, Types of geothermal resources, Geothermal Power Plants, Hybrid Energy Generation Systems, Characteristics of Renewable Energy, Forecasting of Solar and Wind Energy

Unit V:

Grid Integration of Renewables, Challenges in Grid Integration, Balancing Mechanisms, Ancillary Services, Energy Storage, Different types of energy storage systems, Applications of Energy Storage Systems for Balancing Renewables

Books:

1. Non-Conventional Energy Sources by G D Rai
2. Solar Energy by G N Tiwari
3. Renewable Energy G N Tiwari
4. Solar Energy by S P Sukhatme
5. Renewable Energy Technology by I.S. Jha, Subir Sen, M.K. Tiwari and D.P.Kothari

EME 7036			**Heating, Ventilating and Air-Conditioning**				Pre Requisites:			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE Objective:

To introduce students with basics of heating, ventilation, air-conditioning.
To introduce students with concept of thermal comfort
To introduce students with design calculations, equipment, instrumentation and control strategies.

COURSE CONTENT

Unit:-I

Introduction, Applications, Concept of Psychometry.
Psychrometry of air-conditioning processes, enthalpy potential, air-conditioning calculations.

Unit:-II

HVACR Technologies- Vapour Compression System (VCS), Vapour Absorption System (VAS), Evaporative cooling, Desiccant cooling, adsorption cycles, aircraft cycles.
Thermal comfort – Factors influencing comfort, mechanism of heat transfer from human body, comfort chart.

Unit: - III

Outside design conditions – climatic data
Cooling and heating load calculations – Solar heat grain through glass. Heat and water vapour flow through structures, Sol-air temperature, Internal and system heat gains, Infiltration, ventilation.

Unit:-IV

Room air distribution principles: Inlets and outlets selection, Factors affecting grille performance, various types of grilles, Noise considerations. Design of air duct systems, duct sizing.
Indoor air quality – Air Cleaning: Air cleaner performance & classification, Filter location, odour control.
Ventilation – need, principles, Tunnel ventilation.

Unit:-V

Various types of air-conditioning systems. All air systems, Air water systems, Thermal storage, passive cooling concepts – earth tunnels, water walls etc.

Cooling, dehumidification and humidification equipment, Heat and Mass transfer during direct contact of air and water. Design of cooling tower, Spray washers, Cooling and dehumidifying coils.

Temperature, pressure and humidity controllers, various types of systems controls, building management systems, control strategies.

Suggested Reading:

- Prof. N.K. Bansal, Prof. J.M. Mathur, Pracitcal Handbook on Energy Conservation in Buildings, Nabhi publication
- ASHRAE Handbook of HVAC Applications
- ASHRAE Handbook of Systems and equipment
- ASHRAE Handbook of Fundamentals
- Arora, C.P., Refrigeration and Air-conditioning, Tata MrGraw Hill
- Stoecker, W.F. and Jones, Refrigeration and Air-conditioning, Tata McGraw Hill

EME 7028			**Electric Vehicle**				**Pre Requisites**			
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

Course Objectives

The objective of this course is to provide an understanding on different types of electric vehicles including batteries used in such vehicles. The course will impart knowledge on the current technologies for the design of electric vehicle, business model, policy and its impact.

Course Outcomes

CO1: To acquire the knowledge of electric vehicles, charging infrastructure and storage systems.
CO2: Interpret architecture design, components assembly, motor drives & drive control and regenerative system of an EV.
CO3: To implement design of electric vehicles, business model, policy, and its impact.

Course contents

Unit I: Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains.

Unit II: Architecture of Hybrid Electric: Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor Sizing the drive system: Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G(Vehicle-to-Grid), G2V(Grid-to-Vehicle), V2B(Vehicle-to-Building), V2H(Vehicle-to-Home),Vehicle dynamics.

Unit III: Energy Storage Requirements: -Introduction to Battery management system, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.
Fundamental of Rechargeable batteries: Electrochemistry, Lithium batteries, Nickel-metal hydride battery, Lead-acid battery, High temperature batteries, Flow batteries for load levelling and large scale grid application, Battery applications for stationary and secondary use, Battery testing procedures.

Unit IV: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges, Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective.

Unit V: EVs in infrastructure system, integration of EVs in smart grid, Understanding charging economics, Charging Levels and Standards, social dimensions of EVs. Simulations and case studies in above mentioned areas.

Suggested texts and reference materials

1. Emadi, A. (Ed.). (2014). Advanced electric drive vehicles. CRC Press.
2. Larminie, J., & Lowry, J. (2012). Electric vehicle technology explained. John Wiley & Sons.
3. Dincer, I., Hamut, H. S., & Javani, N. (2016). Thermal management of electric vehicle battery systems. John Wiley & Sons.
4. Williamson, S. S. (2013). Energy management strategies for electric and plug-in hybrid electric vehicles. New York, NY: Springer.
5. Pistoia, G., & Liaw, B. (Eds.). (2018). Behaviour of Lithium-Ion Batteries in Electric vehicles: Battery Health, Performance, Safety, and Cost. Springer.