KERALA TECHNOLOGICAL UNIVERSITY

CLUSTER ERNAKULAM WEST (06)

DRAFT

SCHEME AND SYLLABI
FOR
M. Tech. DEGREE PROGRAMME

IN

ENERGY MANAGEMENT

(MECHANICAL ENGG STREAM)
(2015 ADMISSION ONWARDS)

COCHIN SHIPYARD LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)
KOCHI - 682 015, INDIA

कोचीन शिपयार्ड लिमिटेड
(भारत सरकार का उद्यम)
कोच्ची - 682 015, भारत

13/07/2015.

Letter of Recommendation

I have examined the M.Tech. Mechanical Engineering (Specialization: Energy Management) syllabus prepared for submission to Kerala Technological University (KTU) and forwarded to me by Principal, Model Engineering College, Cochin. The syllabus, as per my knowledge, conforms to the requirements of industry. I recommend the approval of the syllabus.

एस हरिकृष्णन
S Harikrishnan
उप महा प्रबन्धक
Deputy General Manager
कोचीन शिपयार्ड लिमिटेड
Cochin Shipyard Limited
कोच्ची / Kochi - 682 015

पंजीकृत कार्यालय : प्रशासनिक भवन, पी.ओ. बैग सं 1653, पेरूमानूर पी. ओ., कोच्ची-682 015
Registered Office : Administrative Building, P.O. Bag No. 1653, Perumanoor P.O., Kochi - 682 015
फाक्स/Fax : +91(484) 2370897/2383902. फोन/Phone : +91(484)2361181/2380181/2366340
ग्राम/Grams : SHIPYARD, ERNAKULAM. ई-मेल/E-mail: info@cochinshipyard.com
CIN: U63032KL1972GOI002414

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN ENERGY MAMAGEMENT

SEMESTER-1

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06ME6013	Numerical Methods in Heat Transfer	4-0-0	50	50	3	4
B	06ME6023	Energy Conversion Systems	4-0-0	50	50	3	4
C	06ME6033	Solar Energy Engineering	4-0-0	50	50	3	4
D	06ME6043	Economics of Energy Engineering	3-0-0	50	50	3	3
E	06ME61X3	Elective 1	3-0-0	50	50	3	3
F	06ME6053	Research Methodology	0-2-0	100	0	0	2
G	06ME6063	Seminar	0-0-2	100	0	0	2
H	06ME6073	Computational Laboratory	0-0-2	100	0	0	1

23

Elective 1 (06ME61X3)

06ME6113	Electrical Energy Systems and Management
06ME6123	Process Reliability Engineering
06ME6133	Energy Policies For Sustainable Development

SEMESTER-II

A	06ME6014	Energy Conservation in Thermal and Electrical Systems	4-0-0	50	50	3	4
B	06ME6024	Energy Audit and Management	3-0-0	50	50	3	3
C	06ME6034	Renewable Energy Technology	3-0-0	50	50	3	3
D	06ME61X4	Elective 2	3-0-0	50	50	3	3
E	06ME62X4	Elective 3	3-0-0	50	50	3	3
F	06ME6044	Mini Project	0-0-4	100	0	0	2
G	06ME6054	Solar Energy Engineering Laboratory	0-0-2	100	0	0	1

19

Elective 2 (06ME61X4)

06ME6114	Energy Systems Modelling and Analysis
06ME6124	Management tools in Engineering Design
06ME6134	Vehicle Power Management

Elective3 (06ME62X4)

06ME6214	Heat Transfer in Energy Systems
06ME6224	Emerging Refrigeration Technologies
06ME6234	Thermal Energy Storage Systems

SEMESTER-III

A	06ME71X3	Elective 4	3-0-0	50	50	3	3
B	06ME72X3	Elective 5	3-0-0	50	50	3	3
C	06ME7013	Seminar	0-0-2	100	0	0	2
D	06ME7023	Project (Phase 1)	0-0-12	50	0	0	6

14

Elective 4 (06ME71X3)

06ME7113	Optimum Utilization of Heat and Power
06ME7123	Safety Technology and Management
06ME7133	Energy and Environment

Elective 5(06ME72X3)

06ME7213	Nuclear Energy Engineering
06ME7223	Bio Energy Engineering
06ME7233	Wind Energy Engineering

SEMESTER-IV

A	06ME7014	Project (Phase 2)	0-0-21	70	30	0	12

12

Total: 68

Course No:	**Course Title:**	**Credits:4**-0-0 , 4	**Year:** 2015
06ME6013	Numerical methods of Heat transfer		

Pre-requisites: Knowledge in Heat and Mass Transfer

Course Objectives:

- To provide new approaches to the numerical solutions of heat transfer problems.
- Methods of interest include all well established and efficient numerical techniques like finite volume method, finite elements and boundary elements.

Syllabus:

Methods of prediction of heat transfer - choice of coordinates and physical interpretation –Finite difference methods – classification of second order partial difference equations –finite difference approximation of derivatives through Taylor series –Discretization equations for steady state conduction in one dimension and two dimensions for different boundary conditions-Discretization equations for steady state conduction in one dimension and two dimensions for different boundary conditions - Discretization equation for unsteady one dimensional heat conduction using Explicit, implicit, and Crank Nicolson schemes

Course Outcome:

Students will get knowledge to solve heat transfer problems by using numerical methods.

Course Plan:

COURSE No. 06ME6013 COURSE TITLE : Numerical methods of Heat transfer
(L-T-P : 4-0-0) CREDITS :4

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Methods of prediction of heat transfer – experimental investigation – theoretical calculation – advantages and disadvantages of theoretical calculation – choice of coordinates and physical interpretation– one way and two ways coordinates.	14	25
MODULE : 2 Finite difference methods – classification of second order partial difference equations – elliptic – parabolic – hyperbolic – physical significance – finite difference approximation of derivatives through Taylor series –forward difference -backward difference – central difference formulas	14	25
FIRST INTERNAL TEST		
MODULE : 3 Discretization equations for steady state conduction in one dimension and two dimensions for different boundary conditions - Energy balance method - Solution using Gauss - Seidel iteration method	14	25
SECOND INTERNAL TEST		
MODULE : 4 Discretization equation for unsteady one dimensional heat conduction using Explicit, implicit, and Crank Nicolson schemes - solution.	14	25

References:

1. Patankar S.V., “Numerical heat transfer and fluid flow”, Hemisphere Publishing Corporation, 1980
2. Ozisik N.M. “ Heat Conduction” Wiley-Inter science, 1993.
3. J.P. Holman. “Heat Transfer”, McGraw Hill Higher Education, 2001
4. Michael Schäfer. “Computational Engineering – Introduction to Numerical Methods”, Springer, 2006
5. Anderson D.A., Tannehill I.I. and Pletcher R.H., “Computational Fluid Mechanics and Heat Transfer”, Hemisphere Publishing Corporation, New York, USA, 1984

Course No:	**Course Title:** Energy Conversion Systems	**Credits:** 4-0-0 4	**Year:** 2015
06ME6023			

Pre-requisites: Basic Knowledge in Thermal Engineering

Course Objectives:

- To impart knowledge about various types of power plants.
- To familiarise with the power and efficiency calculations of steam and gas turbine power plants.
- To familiarise with nuclear energy conversion systems.

Syllabus:

Feature of power plants; Different types of boilers; Classification of steam turbines; Steam cycles; Gas turbine power; Nuclear energy conversion systems; Nuclear reactors.

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the working principles of various power plants. They are able to calculate the various parameters of steam and gas turbine power plants. To demonstrate the working and principles of Nuclear power plants.

Course Plan:

COURSE No. 06ME6023 COURSE TITLE : Energy Conversion Systems
(L-T-P : 4-0-0) CREDITS : 4

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Power Plants Features, Components and Layouts - Working of Power Plants - Classification and types of boilers - Fire Tube & Water Tube Boilers, Fluidized Bed Boilers - Positive Circulation Boilers. Thermal Liquid Heaters & Vaporizers	14	25
MODULE : 2 Classification of Steam Turbines – Different steam cycles - Rankine cycle – Superheat – reheat – problems of steam cycles – regeneration - Losses in Steam Turbines	14	25
FIRST INTERNAL TEST		
MODULE : 3 Gas turbine power plants - analysis – Inter-cooling, reheating and regeneration cycles - problems of gas turbine power plants - Combined cycles with heat recovery boiler – Combined cycles with multi-pressure steam - STAG combined cycle power plant - Influence of component efficiencies on cycle performance.	14	25
SECOND INTERNAL TEST		
MODULE : 4 Nuclear energy conversion - Chemical and nuclear equations - Nuclear reactions -Fission and fusion – Energy from fission and fuel burn-up - Radioactivity – Neutron energies - Fission reactor types - Nuclear power plants - Fast breeder reactor and power plants - Production of nuclear fuels.	14	25

References:

1. M. M. El-Wakil: Power Plant Technology, McGraw Hill, 1985
2. A. W. Culp Jr: Principles of Energy Conversion, McGraw Hill, 2001
3. H. A. Sorensen: Energy Conversion Systems, J. Wiley, 1983
4. T. F. Morse: Power Plant Engineering, Affiliated East West Press, 1978
5. M. M. El-Wakil: Nuclear Power Engineering, McGraw Hill, 1962
6. R. H. S. Winterton: Thermal Design of Nuclear Reactors, Pergamon Press, 1981
7. R . L. Murray: Introduction to Nuclear Engineering, Prentice Hall, 1961

Course No:	**Course Title:** Solar Energy Engineering	**Credits:** 4-0-0, 4	**Year:** 2015
06ME6033			

Pre-requisites: Nil

Course Objectives:

- A foundation in the fundamentals of Solar Energy Engineering.
- Solar radiation and energy calculations.
- Design and analysis of solar engineering applications.

Syllabus:

Solar radiation ; Solar time & Solar angles; Solar energy calculations; Instruments to measure solar radiation; Solar collectors ; Solar powered absorption A/C system; Photo-voltaic cell; Heat storage systems.

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of Solar Energy Engineering. Apply the basic equations of Solar Angle calculations and to determine solar irradiance. To demonstrate the working and principle of various solar energy applications.

Course Plan:

COURSE No. 06ME6033 COURSE TITLE : Solar Energy Engineering
(L-T-P : 4-0-0) CREDITS : 4

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Solar radiation – Sun-earth relationships – Solar constant – basic definitions – Beam radiation – diffuse radiation – irradiance – irradiation – emissive power – solar time – calculations -Solar angles – equation of time - sunrise and sunset times and day length- incidence angles – problems – sun path diagrams.	14	25
MODULE : 2 Solar energy calculations – estimation of extraterrestrial radiation – problems - measurement of terrestrial solar radiation - instruments to measure solar radiation- pyranometer – pyrheliometer.	14	25
FIRST INTERNAL TEST		
MODULE : 3 Solar collectors - flat-plate solar collector – design and analysis - brief description of other type of collectors- Solar green house- Focusing solar concentrators.	14	25
SECOND INTERNAL TEST		
MODULE : 4 Solar powered absorption A/C system, water pump, drier, dehumidifier, still, cooker. Photo-voltaic cell – characteristics- cell arrays - Heat storage systems - air system thermal storage - liquid system thermal storage.	14	25

References:

1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, “Principles of Solar Engineering”, 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2000.
2. Edward E. Anderson, “Fundamentals for solar energy conversion”, Addison Wesley Publishing Co., 1983.
3. Zekai Sen, “Solar Energy Fundamentals and Modeling Techniques”, Springer, 2008.
4. G. N. Tiwari and M. K. Ghosal, “Fundamentals of Renewable energy Sources”, Narosa Publishing House, New Delhi, 2007

Course No:	**Course Title:**	**Credits:** 3-0-0, 3	**Year:** 2015
06ME6043	Economics of Energy Engineering		

Pre-requisites: Nil

Course Objectives:

- Studying methods of investment evaluation in energy sector
- To study methods for energy production cost calculation and energy pricing methodology.

Syllabus:

Time value of money; Methods of Investment appraisal; Classification of energy; Analysis of public projects.

Course Outcome:

Understanding of economic and viability to apply economic and financial evaluation of energy projects. Learning the basics of cost calculation for electricity and Study on various forms and classification of energy, Decision making, Energy accounting frame work.

Course Plan:

COURSE No. 06ME6043 COURSE TITLE: Economics of Energy Engineering.
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Time value of money – cash flow diagram – interest formulas – single payment compound amount factor – single payment present worth factor – equal payment series sinking fund factor – equal payment series compound amount factor– equal payment series capital recovery factor – equal payment series present worth factor - problems	11	25
MODULE : 2 Methods of Investment appraisal - payback period - Accounting Rate of Return (ARR) -Net Present Value (NPV) - Internal Rate of Return (IRR) - Profitability Index (PI)	11	25
FIRST INTERNAL TEST		
MODULE : 3 Classification of energy - primary and secondary forms of energy - renewable and non-renewable forms of energy - conventional and non-conventional energies – energy information required in decision making - energy accounting framework- components of the energy account.	10	25
SECOND INTERNAL TEST		
MODULE : 4 Analysis of public projects – Benefit/ Cost analysis – quantification of project costs and benefits – problems - Energy Return on Investment (EROI) - The economic influence of EROEI - Economics of replacement – reasons for replacement of assets – problems	10	25

References:

1. James L. Riggs, David D. Bedworth, Sabah U. Randhawa. Anderson, Engineering Economics", Tata McGraw- Hill, 2011.
2. Subhes C. Bhattacharyya, "Energy Economics - Concepts, Issues, Markets and Governance", Springer, 2011.
3. Abdiel Worthy, "Economics and Energy", The English Press, New Delhi, 2011.
4. Chan S. Park, "Fundamentals of Engineering Economics", Prentice Hall, 2003.

Course No:	**Course Title:** Electrical Energy Systems and Management	**Credits:**3-0-0, 3	**Year:** 2015
06ME6113			

Pre-requisites: Nil

Course Objectives:

- To provide an intensive introduction to the transmission system, power factor correction and distribution losses.
- To introduce fundamentals of operation and control of power system, relaying and
- Protection of transmission lines with emphasis on their technology and applications.
- To elucidate concepts on energy losses in transmission, distribution and energy saving by power factor correction.

Syllabus:

Overall structure of electrical systems - Tariff types, Energy efficiency, Energy accounting and auditing, Energy consumption models, Electric motors , Variable speed drives, Electric loads of air conditioning and refrigeration, Energy conservation.

Course Outcome:

Gaining appropriate knowledge on various parameters of transmission lines and losses.
Gaining
Awareness on power factor correction and energy saving by capacitor and
Becoming aware of the operation and control of power system, power system harmonics and protection of transmission lines.

Course Plan:

COURSE No. 06ME6113 COURSE TITLE : ELECTRICAL ENERGY SYSTEMS AND MANAGEMENT
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Overall structure of electrical systems, Economic operation, Input-output curves. Load sharing - Industrial Distribution, Load profiling, Electricity tariff types and calculation- Reactive Power. Power factor - Capacitor sizing - Capacitor losses.	11	25
MODULE : 2 Energy efficiency, Energy accounting, monitoring and control. Electricity audit instruments – Energy consumption models - Specific Energy Consumption, Transformer loading/efficiency analysis – Feeder loss evaluation - Lighting - Energy efficient light sources , Domestic/commercial /industrial lighting	11	25
FIRST INTERNAL TEST		
MODULE : 3 Types and operating characteristics of electric motors - Energy efficient control and starting - Load matching Selection of motors - Efficiency and load analysis – Energy efficiency - High efficiency motors – Industrial drives - Control schemes - Variable speed drives and Energy conservation schemes - Pumps and fans	10	25
SECOND INTERNAL TEST		
MODULE : 4 Electric loads of air conditioning and refrigeration - Energy conservation – Power consumption in compressors, Energy conservation measures - Electrolytic process - Electric heating	10	25

References:

1. A. P.W. Thumann:“Plant Engineers and Managers Guide to Energy Conservation, 7e, UNR, 1977
2. H. Partab, Art and Science of Utilisation of Electrical Energy, Pritam, 1985
3. S.C. Tripathy, Electric Energy Utilization And Conservation, Tata McGraw Hill, 1991
4. W.C. Turner, Energy Management Handbook, 2e, Fairmont Press, 1993
5. IEEE Bronze Book: IEEE Standard 739-1984 - Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities, IEEE Publications, 1996

Course No:	**Course Title:** Process Reliability Engineering	**Credits:**3-0-0, 3	**Year:** 2015
06ME6123			

Pre-requisites: Nil

Course Objectives:

- Obtain knowledge of the various methods of component and system reliability and risk analysis.
- Be able to evaluate risks as applied to different engineering disciplines and their associated consequences and propose ways to mitigate risk.
- Apply quantitative as well as qualitative methods for risk assessment.
- Obtain the ability to collect, evaluate and use data towards risk control and application of Risk Based Maintenance Management

Syllabus

Definition of reliability and key elements, Hazard models and problems, System reliability, Reliability improvement methods and cost of reliability

Course Outcome

Have knowledge of the techniques of reliability engineering. Be able to carry out a failure mode effect and criticality analysis, Analysis of different failures of a component/equipment

Course Plan

COURSE No. 06ME6123 COURSE TITLE : PROCESS RELIABILITY ENGINEERING
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1Definition of reliability – key elements; failure analysis – failure density – failure rate – probability of failure - bathtub curve - Basic reliability equations – Reliability in terms of – failure rate – failure density - relation between reliability, failure density and hazard rate - Mean time to failure (MTTF) – Integral equation of MTTF in terms of reliability	11	25
MODULE : 2 Hazard Models – Constant Hazard Model – Linearly increasing Hazard Model – Expression for Reliability for these models – Problems. Weibull model	11	25
FIRST INTERNAL TEST		
MODULE : 3 System reliability – components connected in series – components connected in parallel – mixed configuration – reliability block diagrams (RBD) – distinction between physical configuration and logical configuration – problems	10	25
SECOND INTERNAL TEST		
MODULE : 4 Reliability improvement methods – Redundancy – unit redundancies – element redundancies – simplification of design – parts de rating – operating environment; Cost of reliability – factors to be considered for optimizing the reliability cost	10	25

References

1. L.S.Srinath, “Reliability Engineering”, Affiliated East-West Press Ltd., 1985
2. E. Balaguruswamy, “Reliability Engineering”, Tata McGraw Hill Publishing Co., 1984
3. Charles E. Ebling, “Reliability & Maintainability Engg.”, Tata McGraw Hill Publishing Co., 1997
4. Alessandro Birolini “Reliability Engineering Theory and Practice”, Springer, 2007.
5. Lewis, E., “Introduction to Reliability Engineering”, John Wiley & Sons, 1995

Course No:	**Course Title:**	**Credits:**	**Year:**
06ME6133	ENERGY POLICIES FOR SUSTAINABLE DEVELOPMENT	3-0-0, 3	2015

Pre-requisites: Nil

Course Objectives

- To provide an intensive introduction to the basic perspectives, processes and institutions, major developments in the environmental policy of the country, environmental regulations associated with energy policy and recent innovations, and implications of emerging national issues and institutions.
- To develop student's skills in critical thinking and reasoning about policy issues associated with various industrial sectors.

Syllabus:

Energy policies of India, Energy and environment, Environmental laws , Latest development in climate change policies & CDM , Energy conservation schemes , Social cost benefit analysis

Course Outcome:

Gaining appropriate knowledge on various policies and legislations associated with energy administration. Gaining awareness on policies that facilitate development of energy conservation strategies and methods. Becoming aware of the Energy Acts and of the legal energy requirements applicable to the various industrial sectors

Course Plan:

COURSE No. 06ME6133 COURSE TITLE : ENERGY POLICIES FOR SUSTAINABLE DEVELOPMENT
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Energy policies of India - Supply focus approach and its limitations - Energy paradigms – DEFENDUS approach - End use orientation - Energy policies and development - Central and State policies on the consumption and wastage of energy - Critical analysis - Need for renewable energy policies in India	11	25
MODULE : 2 Energy and environment - Green house effect - Global warming - Global scenario - Indian environmental degradation - Environmental laws - Water (prevention & control of pollution) act 1974 - The environmental protection act 1986 - Effluent standards and ambient air quality Standards - Latest development in climate change policies & CDM.	11	25
FIRST INTERNAL TEST		
MODULE : 3 Energy conservation schemes - Statutory requirements of energy audit - Economic aspects of energy audit - Capital investments in energy saving equipment - Tax rebates - Advantages of 100% depreciation – India's plan for a domestic energy cap & trade scheme.	10	25
SECOND INTERNAL TEST		
MODULE : 4 Social cost benefit analysis - Computation of IRR and ERR - Advance models in energy planning – Dynamic programming models in integrated energy planning - Energy planning case studies - Development of energy management systems - Decision support systems for energy planning and energy policy simulation.	10	25

References:

1. J. Goldemberg, T.B. Johansson, A.K.N. Reddy and R.H. Williams: Energy for a Sustainable World, Wiley Eastern, 1990
2. P. Chandra: Financial Management Theory and Practice, Tata McGraw Hill, 1992
3. Annual Energy Planning Reports of CMIE, Govt. of India
4. A.K.N. Reddy and A.S. Bhalla: The Technological Transformation of Rural Inda, UN Publications, 1997
5. A.K.N. Reddy, R.H. Williams and J.B. Johanson: Energy After Rio-Prospects and Challenges, UN Publications, 1997
6. P. Meier and M. Munasinghe: Energy Policy Analysis & Modeling, Cambridge University Press, 1993
7. R.S. Pindyck and D.L. Rubinfeld: Economic Models and Energy Forecasts, 4e, McGraw Hill, 1998

Course No:	**Course Title:** Research Methodology.	**Credits:** 0-2-0, 2	**Year:** 2015
06ME6053			

Pre-requisites: Nil

Course Objectives:
The primary objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis. Some other objectives of the course are:

- To develop understanding of the basic framework of research process.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.
- Appreciate the components of scholarly writing and evaluate its quality.

Syllabus:
Research methodology; Research Process; Application of results , ethics and intellectual property rights; Techniques of developing measurement tools; Processing and analysis of data; Interpretation and report writing-techniques of interpretation; Graphic & diagrammatic representation data; Defining research problem ; Experimental Designs; Sampling fundamentals; Testing of hypotheses.

Course Outcome:
At the end of this course, the students should be able to:

- Understand some basic concepts of research and methodologies.
- To Identify appropriate research topics.
- Select and define appropriate research problem and parameters.
- Prepare a project proposal (to undertake a project) .
- Organize and conduct research (advanced project) in a more appropriate manner.
- Write a research report and thesis.
- Write a research proposal (grants).
- Attain basic knowledge of experimentation methods and statistical analysis

Course Plan

COURSE No. 06ME6053 COURSE TITLE: Research Methodology.
(L-T-P : 0-2-0) CREDITS : 2

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Research methodology: meaning of research, objectives, type of research approaches, research process, and criteria for good research. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process Application of results and ethics - Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability. (Only the basic concepts are expected to cover)	7	25
MODULE : 2 Techniques of developing measurement tools – scaling – important scaling techniques. Methods of data collection–collection of primary data–observation method questionnaires –other methods of data collection. Processing and analysis of data – processing operations – editing – coding – classification – tabulation. Interpretation and report writing-techniques of interpretation – steps in report writing. Graphic & diagrammatic representation data - Purpose of Diagrams& Graphs, Bar diagrams (Simple, Component & Percentage), Pie Charts, Line Square Diagrams, Interpretations & Comparisons, Graphical Representation of Frequency Distribution, Histograms, Frequency Polygon, Frequency Curve. (Only the basic concepts are expected to cover)	7	25
FIRST INTERNAL TEST		
MODULE : 3 Defining research problem – research design, features of good design - different research designs- basic principal of experimental design developing a research plan. Experimental Designs - purpose of designing experiments, methods of increasing accuracy of experiments, replication, control & randomization and their objectives & advantages - basic ideas of completely randomized , randomized block, Factorial and Latin square designs. (Only the basic concepts are expected to cover)	7	25
SECOND INTERNAL TEST		
MODULE : 4 Sampling fundamentals – need for sampling – important sampling distribution: Sampling distribution of mean- sampling distribution of proportion – student's't' distribution – F distribution –Chi-square distribution – concept of standard error - – sample size and its determination. Testing of hypotheses – procedure for testing hypotheses - important parametric tests: Z test, t-test, chi- square test, F test and ANOVA. (Only the basic concepts are expected to cover)	7	25

References:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Deepak Chawla and Neena Sondhi 2011 Research Methodology concepts and cases Vikas Publishing house pvt ltd.
4. R. Paneerselvam , 2014 Research Methodology, PHI Learning Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
7. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.

Course No	Course Name	L-T-P Credits	Year of Introduction
06ME6063	**SEMINAR**	0-0-2, 2	2015

Course Objective:

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the program. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Course No	Course Name	L-T-P Credits	Year of Introduction
06ME6073	COMPUTATIONAL LABORATORY	0-0-2, 1	2015

Course Objective:

To implement the numerical techniques to problems of engineering interest.
To use these tools and packages to solve process simulation problems.

List of experiments

I. Development of algorithms and computer programs using C and C++

II. Programming assignments on the following topics
Roots of algebraic and transcendental equations
Solution of simultaneous algebraic equations
Curve fitting and optimization
Numerical integration of ordinary differential equations: Initial value problems
Numerical Solution of ordinary differential equations: Boundary value problems
Numerical solution of partial differential equations

III. Hands on Training on the following Soft wares.

MATLAB OR OCTAVE
LATEX

Expected Outcome

As an outcome of completing this course, students will:

- Expertise the procedural programming concepts
- Become proficient in the use of a modern computational tool
- Develop problem solving skills
- Develop experience in specifying and designing a solution to an engineering problem using a software tool
- Gain familiarity with basic linear algebra concepts
- Be able to express algebraic equations governing engineering systems in a modern computational environment
- Be able to document solutions to engineering problems

SEMESTER II

Course No:	**Course Title**:	**Credits**:4-0-0, 4	**Year**: 2015
06ME6014	Energy Conservation in Thermal and Electrical Systems		

Pre-requisites: Basics of Thermal Engineering

Course Objectives:

- To understand and appreciate the energy crisis and environmental concerns associated with the energy management, and the importance of energy conservation.
- To know the techniques of energy analysis and the associated energy efficient technologies for the routinely used thermal and electrical energy systems.
- To understand the energy management systems and their essential elements.
- To acquire the knowledge and the basic skills for energy monitoring, energy bench marking, energy action planning and energy auditing.

Syllabus:

Energy conservation schemes, Waste heat management, Thermodynamic availability analysis, Insulation, Available energy Thermodynamics and economics, Process improvements, Potential for waste heat recovery, Potential for energy conservation, Energy Efficient Technologies in Electrical Systems:

Course Outcome:

- Becoming aware of the energy crisis, and of environmental and sustainability concerns associated with the energy management.
- Appreciating the importance of energy conservation and having the knowledge of energy conservation strategies and methods.
- Understanding the Energy Management Systems (EnMS) and their essential elements.
- Becoming aware of the Energy Conservation Act, 2001, and of the legal energy requirements applicable to the routinely used thermal and electrical energy systems.
- Exposure to the most used energy planning and management softwares.

Kerala Technological University

Course Plan

COURSE No. 06ME6014 COURSE TITLE : Energy Conservation in Thermal and Electrical Systems
(L-T-P : 4-0-0) CREDITS : 4

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Energy conservation schemes - Optimizing steam usage - Waste heat management - Insulation - Optimum selection of pipe size – Energy conservation in space conditioning – Energy and cost indices - Energy diagrams - Thermodynamic availability analysis – Thermodynamic efficiencies - Available energy	14	25
MODULE : 2 Thermodynamics and economics - Systematic approach to steam pricing - Pricing other utilities – Investment optimization - Process improvements - Characterizing energy use – Optimum performance of existing facilities - Steam trap principles.	14	25
FIRST INTERNAL TEST		
MODULE : 3 Potential for waste heat recovery - Direct utilization of waste heat boilers – Use of heat pumps – Improving boiler efficiency - Industrial boiler inventory - Potential for energy conservation	14	25
SECOND INTERNAL TEST		
MODULE : 4 Energy Efficient Technologies in Electrical Systems: Maximum Demand Controllers; Automatic Power Factor Controllers; Energy Efficient Motors; Soft Starter; Variable Speed Drives; Energy Efficient Transformers; Energy Efficient Lighting Controls	14	25

References:

1. W.F. Kenney: Energy Conservation in the Process Industries, Academic Press, 1984
2. A.P.E. Thummann: Fundamentals of Energy Engineering, Prentice Hall, 1984
3. M.H. Chiogioji: Industrial Energy Conservation, Marcel Dekker, 1979
4. A.P.E.Thummann, Plant Engineers and Managers Guide to Energy Conservation, van Nostrand, 1977
5. W. R. Murphy and G. McKay: Energy Management, Butterworth-Heinemann, 2001
6. F.B. Dubin: Energy Conservation Standards, McGraw Hill, 1978
7. S.C. Tripathy, Electric Energy Utilization And Conservation, Tata McGraw Hill, 1991

Course No:	Course Title: Energy Audit and Management	Credits:3-0-0, 3	Year: 2015
06ME6024			

Pre-requisites: Basic knowledge in Thermal Engineering

Course Objectives:

(1) To impart knowledge about skills and techniques required to implement energy management in industrial situations.

(2) To impart knowledge about energy audit and how it helps an organization to understand and analyze its energy utilization and identify area where energy can be reused and minimize energy costs.

Syllabus

Definition of energy management, approach to energy conservation in industry, energy auditing, data to be collected in auditing-types of audit. Waste heat recovery, sources of waste heat, high temperature heat recovery, medium temperature heat recovery, waste heat recovery applications. Improving steam system performance-condensate heat recovery-flashing of steam-minimizing boiler blow down-heat recovery from boiler blow down-use of economizers and air pre heaters , Cogeneration-need for cogeneration, cogeneration potential-methods of cogeneration-combined topping cycles, impact of cogeneration .

Course Outcome

By the end of this course student will have:
• An understanding of the energy auditing process
• Gained hands on experience of conducting an audit
• Learnt about a range of reporting methods and formats
• The knowledge to create a prioritised audit report
• The confidence to carry out an audit in your own organisation.

Course Plan

COURSE No. 06ME6024 COURSE TITLE : Energy Audit and Management
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1	11	25
Definition of energy management-approach to energy conservation in industry-energy auditing – data to be collected in auditing-types of audit.		
MODULE : 2	11	25
Waste heat recovery-sources of waste heat-high temperature heat recovery-medium temperature heat recovery-waste heat recovery applications.		
FIRST INTERNAL TEST		
MODULE : 3	11	25
Improving steam system performance-condensate heat recovery-flashing of steam-minimizing boiler blow down-heat recovery from boiler blow down-use of economizers and air pre heaters		
SECOND INTERNAL TEST		
MODULE : 4	11	25
Cogeneration-need for cogeneration- cogeneration potential-methods of cogeneration-combined topping cycles-impact of cogeneration		

References:

1. Albert Thumman, “Fundamentals of energy engineering”, Prentice Hall,May 1984
2. Steve Doty, Wayne C. Turner, “Energy management handbook”, Fairmont Press, 2009
3. W. F. Kenney, “Energy conservation in the process industries”, Academic Press, 1984
4. “Improving steam system performance: a sourcebook for industry”, Industrial Technologies Program, U.S. Dept. of Energy, Energy Efficiency and Renewable Energy, 2004

Course No:	Course Title:	Credits:	Year:
06ME6034	Renewable Energy Technology	3-0-0, 3	2015

Pre-requisites: Nil

Course Objectives:

- To provide an understanding of solar energy systems and wind energy resources, with scientific examinations of the energy field and emphasis on their technology and applications.
- To facilitate development of skills to formulate waste to energy appropriate technologies in industrial applications.

Syllabus:

Thermo chemical Conversion, Energy from Biomass, Economics of thermo chemical conversion, Biochemical Conversion, Aerobic and anaerobic bioconversion processes, Individual and community biogas operated engines and their use, Wind Energy, Geothermal energy conversion, Ocean thermal energy conversion, Wave and tidal energy, Hydrogen and Fuel cell, Utilization of Hydrogen.

Course Outcome:

- Gaining appropriate knowledge on principles of operation, construction and working of solar photo voltaic and solar thermal devices.
- Ability to design solar thermal and wind energy conversion system for appropriate applications.
- Gaining comprehensive knowledge of how performance of solar and wind energy can be evaluated.

Kerala Technological University

Course Plan

COURSE No. 06ME6034 COURSE TITLE : Renewable Energy Technology
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Energy from Biomass: Sources of biomass, Classification and characteristics. Thermo chemical Conversion: Different processes-direct combustion, incineration, pyrolysis, gasification and liquefaction, Economics of thermo chemical conversion.	11	25
MODULE : 2 Biochemical Conversion: Importance of biogas technology, Different Types of biogas Plants, Aerobic and anaerobic bioconversion processes, various substrates used to produce biogas. Individual and community biogas operated engines and their use.	11	25
FIRST INTERNAL TEST		
MODULE : 3 Wind Energy: Conversion technologies, Aerodynamics of wind turbine rotor, Site selection, Wind resource assessment, concept of wind farms, Various aspects of wind turbine design, Hybrid wind energy systems. Geothermal energy conversion, Ocean thermal energy conversion, Wave and tidal energy.	10	25
SECOND INTERNAL TEST		
MODULE : 4 Hydrogen and Fuel cell: Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles, Hydrogen Production, Storage of Hydrogen. Utilization of Hydrogen: Fuel cell – principle of working, construction and applications.	10	25

References:

1. Renewable Sources of Energy and Conversion Systems: N.K.Bansal and M.K.Kleeman.
2. Chakraverthy A, “Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes”, Oxford & IBH publishing Co, 1989.
3. Handbook : Batteries and Fuel cell – linden (Mc.Graw Hill)1984.
4. Venkata Ramana P and Srinivas S.N, “Biomass Energy Systems”, Tata Energy Research Institute, 1996.
5. G.D. Rai: Non-conventional Energy Sources, Khanna Publishers, 2003.
6. S. Rao & B. B. Parulekar, “Energy Technology”, 4th edition, Khanna publishers, 2005.
7. Wind and Solar Power Systems, Mukund. R. Patel, 2nd Edition, Taylor & Francis, 2001
8. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.
9. Hydrogen Technology for Energy – D.A.Maths (Noyes Data Corp.) –1976.

Course No:	Course Title: Energy Systems Modelling and Analysis	Credits:3-0-0, 3	Year: 2015
06ME6114			

Pre-requisites: Basic knowledge in energy modelling and analysis.

Course Objectives:

- To impart knowledge about skills and techniques required to implement energy management in industrial situations.
- To impart knowledge about energy audit and how it helps an organization to understand and analyze its energy utilization and identify area where energy can be reused and minimize energy costs.

Syllabus:

Overview of technologies and conventional methods of energy conversion, Workable and Optimum systems. Mathematical modelling, Exponential forms. .Classes of simulation, flow diagrams, The Lagrange multiplier equations, Pressure temperature relationship at saturated conditions.

Course Outcome:

- Input requirements - sources of energy and economic statistics; assumptions used
- Scenario development – parameters, accuracy and sensitivity; business-as-usual vs. climate-friendly scenarios
- Country-wide energy demand modelling – by sector and fuel
- Power generation modelling - technologies and fuel mix needed to meet future demand
- Transport sector modelling - by mode of transport
- Oil, gas and coal production modelling
- Carbon dioxide (CO_2) emissions modelling

Course Plan:

COURSE No 06ME6114 COURSE TITLE : Energy Systems Modelling and Analysis
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Overview of technologies and conventional methods of energy conversion, Workable and optimum systems, Steps in arriving at a workable system, Creativity in concept selection	11	25
MODULE : 2 Mathematical modelling, Exponential forms- Method of least squares - Counter flow heat exchanger Evaporators and Condensers, Effectiveness, NTU, Pressure drop and pumping power	11	25
FIRST INTERNAL TEST		
MODULE : 3 Classes of simulation, flow diagrams, Sequential and simultaneous calculations, Newton- Raphson method- Optimization procedure, mathematical statement of the problem .The Lagrange multiplier equations, Sensitivity coefficients- Single variable – Exhaustive, Dichotomous and Fibonacci, Multivariable unconstrained - Lattice, Univariable and Steepest ascent	11	25
SECOND INTERNAL TEST		
MODULE : 4 Dynamic Programming-Geometric Programming-Linear Programming-Linear regression analysis, Internal energy and enthalpy, Pressure temperature relationship at saturated conditions	11	25

References:

1. W.F. Stoecker: “Design of Thermal Systems”, 3rd Ed., McGraw Hill,1989.
2. B.K.Hodge: “Analysis and Design of Thermal Systems”, Prentice Hall Inc., 1990.
3. I. J. Nagrath & M .Gopal: “Systems Modelling and Analysis”, Tata McGraw Hill.
4. D.J. Wide: “Globally Optimal Design”, Wiley- Inter science, 1978

Course No:	Course Title:	Credits:3-0-0, 3	Year: 2015
06ME6124	management tools in engineering design		

Pre-requisites: Basic knowledge in engineering design.

Course Objectives:

- To impart knowledge about skills and techniques required in engineering design and project management methods.
- To impart knowledge about quality control charts and cost capacity model analysis.

Syllabus:

Introduction to design, design purposes, design failures, design types. Design Process,
Design review phases .X Quality control charts for design assurance. Product marketing, functions, marketing procedure, mathematical models for marketing, Cost estimation models .

Course Outcome:

This course provides an introduction to performing project management and system engineering activities using system design tool

Course Plan:

COURSE No06ME6124 COURSE TITLE : Management tools in engineering design
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Introduction to design – design purposes – design failures – design types – qualities of a typical design engineer – design related information sources.	11	25
MODULE :2 Design Process – steps involved in design process – design specifications – design reviews – design review phases Project management methods in design – CPM & PERT – probability of accomplishing the design project on stated date .	11	25
FIRST INTERNAL TEST		
MODULE : 3 X Quality control charts for design assurance – variable control charts – chart and R chart – attribute control charts – P chart – C chart	11	25
SECOND INTERNAL TEST		
MODULE : 4 Product marketing -functions – marketing procedure – mathematical models for marketing – buying power index model , multi attribute attitude model Cost estimation models – cost capacity model – corrective maintenance model – software maintenance model – machining mode – cutting tool model – A C motor operating model – lighting model .	11	25

References:

1. B.S. Dhillon, “Engineering Design: A Modern Approach”, Times Mirror Higher Education Group Inc. company, 1996.
2. Dieter G.E., “Engineering Design”, Mc Graw Hill, 1996
3. L.S. Srinath, “PERT And CPM Principles And Applications”, Affiliated East West Press, 2001.
4. Brown, R.J. and Yanuck, R.R, “Life Cycle Costing A Practical guide for Energy Managers”, Fairmont Press, 1980.

Course No:	Course title: Vehicle power management	Credits:3-0-0, 3	Year: 2015
06ME6134			

Pre-requisites: Basic knowledge in vehicle power management.

Course Objectives:

- To impart knowledge about Understand vehicle transmission architectures
- To impart knowledge about concepts for hybrid vehicles
- To know about the challenges and opportunities in hybrid technologies

Syllabus:

Energy Conversion Chain for Vehicle Energy Consumption, Fuel efficiency of automobiles Vehicle Emissions Vehicle Fuel Consumption and emissions, Vehicle Energy Losses Vehicle Performance and Drivability Analysis Power Demand in Drive Cycles, Power Management in Conventional Vehicles

Course Outcome:

- Energy Conversion Chain for Vehicle Energy Consumption,
- Fuel efficiency of automobiles Vehicle Emissions Vehicle
- Fuel Consumption and emissions, Vehicle Energy Losses
- Vehicle Performance and Drivability Analysis Power Demand in Drive Cycles.
- Power Management in Conventional Vehicles

Course Plan:

COURSE No. 06ME6134 COURSE TITLE :Vehicle Power Management
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Energy Conversion Chain for Vehicle Energy Consumption - Fuel efficiency of automobiles – Vehicle Configurations - Configuration of Conventional Vehicles - Configuration of Electric Vehicles - Configuration of Hybrid Electric Vehicles - Parallel Hybrid - Series Hybrid - Series–Parallel Hybrid - Complex Hybrid	11	25
MODULE : 2 Vehicle Fuel Consumption and emissions - Vehicle Energy Losses - Engine Losses – Drivetrain Losses - Standby/Idle – Accessories Aerodynamic Drag- Rolling Resistance – Inertia – Vehicle Emissions - Particulate Matter (PM) - Carbon Monoxide (CO) - Nitrogen Oxides (NOx) – Volatile Organic Compounds (VOC)	11	25
FIRST INTERNAL TEST		
MODULE : 3 Vehicle Performance and Drivability Analysis - Maximum Speed - Gradeability or Uphill Driving – Acceleration – Vehicle Operation Modes - Traction mode - Braking mode - Coasting mode - operation modes for series hybrid electric vehicles	11	25
SECOND INTERNAL TEST		
MODULE : 4 Power Demand in Drive Cycles - Power Management in Conventional Vehicles – Power Management of Hybrid Electric Vehicles - Introduction to Simulation tools – MATLAB/ Simulink – ADVISOR – PSAT	11	25

References:

1. Xi Zhang and Chris Mi. “Vehicle Power Management: Modelling, Control and Optimization”, Springer, 2011.
2. Chau KT. “.Modern electric vehicle technology”, Oxford University Press, 2001.
3. Smith JH An introduction to modern vehicle design. Butterworth-Heinemann, Oxford University Press, 2001
4. Ehsani M, Gao Y, Emadi A. “Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory and design. CRC Press, 2010.

Course No:	**Course Title:** HEAT TRANSFER IN ENERGY SYSTEMS	**Credits:**3-0-0, 3	**Year:** 2015
06ME6214			

Pre-requisites: Nil

Course Objectives:

- To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

Syllabus:

Review of fundamental flow equations, differential formulation of general heat transfer problems, Conductive heat transfer in energy systems, Convective heat transfer in energy systems, Review of thermal radiation

Course Outcome:

- Ability to understand and solve conduction, convection and radiation problems
- Ability to design and analyze heat flow equipments

Course Plan:

COURSE No. 06ME6214 COURSE TITLE : HEAT TRANSFER IN ENERGY SYSTEMS (L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1	11	25
Review of fundamental: integral and differential forms of continuity, momentum and energy equations, Navier-Stokes equations and boundary conditions. Differential formulation of general heat transfer problems. Initial and boundary conditions, different kinds of boundary conditions, homogeneous boundary conditions.		
MODULE : 2	11	25
Conductive heat transfer in energy systems: Practical examples including nuclear reactors, solar thermal collectors, heat exchangers, energy storage systems.		
FIRST INTERNAL TEST		
MODULE : 3	10	25
Convective heat transfer in energy systems - Differential formulation of heat and fluid flow - relevant boundary conditions - Convection models for solar flat plate collectors, solar ponds, boiler tubes etc.		
SECOND INTERNAL TEST		
MODULE : 4	10	25
Review of thermal radiation - Shape factor algebra - Modelling of enclosure – Radiation in non absorbing media - Radiation exchange in absorbing media - Radiation from gases, vapours and flames.		

References:

1. Muralidhar, K. and Biswas, G., Advanced Engineering Fluid Mechanics, Second Edition, Narosa Publishing House, 2005.
2. D. Poulikakos: Conduction Heat Transfer, Prentice Hall, 1994
3. V.S. Arpaci: Conduction Heat Transfer, Addision Wesly, 1996
4. H.S. Carslaw and J.C. Jaeger: Conduction of Heat in Solids, Oxford UniversityPress, 1959.
5. A. Bejan: Convection Heat Transfer, J. Wiley, 2007
6. M.F. Modest: Radiative Heat Transfer, McGraw Hill, 1993

Course No:	**Course Title:**	**Credits:**3-0-0, 3	**Year:** 2015
06ME6224	Emerging Refrigeration Technologies		

Pre-requisites: Nil

Course Objectives:

- The objective is to provide new tools, concepts and solutions for improving refrigeration technologies
- To study the benefits of advanced refrigeration technologies over the traditional ones

Syllabus

Introduction to refrigeration systems and methods of refrigeration, Thermoelectric refrigeration, introduction to Magnetic refrigeration, Principles and application of steam jet refrigeration system

Course Outcome

- Know about air conditioning system operations
- Know about modern and alternative refrigerants
- Know about non conventional refrigeration technologies

Course Plan

COURSE No. 06ME6224 COURSE TITLE : EMERGING REFRIGERATION TECHNOLOGIES
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1	11	25
Introduction to refrigeration systems, methods of refrigeration, units of refrigeration, COP, Review of vapour compression refrigeration system, vapour absorption system, Introduction to non conventional refrigeration technologies- Thermoelectric refrigeration, magnetic refrigeration, pulse tube refrigeration, acoustic refrigeration, steam jet refrigeration, vortex tube refrigeration.		
MODULE : 2	10	25
Thermoelectric refrigeration-principle, thermoelectric properties, Seabeck effect, Peltier effect, System description, performance, analysis, Applications		
FIRST INTERNAL TEST		
MODULE : 3	10	25
Introduction to Magnetic refrigeration, magneto-caloric effect, magnetic materials, magnetic refrigeration near room temperature cooling, advantages over traditional refrigeration system, clean refrigeration in future-pulse tube refrigerator-principle-analysis		
SECOND INTERNAL TEST		
MODULE : 4	11	25
Principles and application of steam jet refrigeration system, Performance, vortex tube refrigeration system, system description, Applications Modern refrigerants - Need for alternative refrigerants – eco friendly refrigerants - properties of mixtures of refrigerants-modifications required for retrofitting, safety precautions and compatibility of refrigerants with the materials.		

References:

1. Arora C.P “Refrigeration and Air conditioning”-Tata Mc Graw Hill, 2004
2. Gosney W. B “Principles of Refrigeration”, Cambridge University Press, 1983
3. Stanley W Angrist “Direct Energy conversions”, Allyn & Bacon, 1982
4. HJ Goldsmid, “Thermoelectric Refrigeration”, Springer, 1st Ed. 1995

Course No:	**Course Title:** Thermal Energy Storage Systems	**Credits:3**-0-0, 3	**Year:** 2015
06ME6234			

Pre-requisites: Nil

Course Objectives:

- Describe what energy storage is
- List examples of different forms of thermal storage
- Describe how thermal storage works in heating and cooling applications
- Describe why thermal storage is needed to make new renewable generation sources

Syllabus:
Thermal Energy Storage methods, TES Heating and Cooling Applications, Sensible TES, Latent TES

Course Outcome:

- Define the advantages and disadvantages of various thermal energy storage systems.
- Detailed knowledge of various thermal heating and cooling applications.
- Gaining familiarity with sensible and latent heat storage methods and its comparison.

Course Plan:

COURSE No. 06ME6234 COURSE TITLE : **Thermal Energy Storage Systems**
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Thermal Energy Storage methods - Basic Principle of TES - TES Processes - Benefits of TES - Criteria for TES Evaluation - Technical Criteria - Environmental Criteria - Economic Criteria - Energy Savings Criteria - Sizing Criteria - Feasibility Criteria - Integration Criteria - Storage Duration Criteria - Barriers to TES Adoption	11	25
MODULE : 2 TES Heating and Cooling Applications - Heating TES - Cooling TES - TES and Gas Cooling - TES Operating Characteristics - Diurnal versus Seasonal TES - Individual versus Aggregate TES Systems	11	25
FIRST INTERNAL TEST		
MODULE : 3 Sensible TES - Thermally Stratified TES Tanks - Types and Features of Various Stratified TES Tanks - Design Considerations for Stratified TES Tanks - Concrete TES – Rock and Water/Rock TES - Design Considerations for TES in Rocks - Water–Rock Beds - Aquifer Thermal Energy Storage (ATES) - Utilization of ATES - Deep Confined Aquifers - ATES Using Heat Pumps - Solar Ponds - Evacuated Solar Collector TES –	10	25
SECOND INTERNAL TEST		
MODULE : 4 Latent TES - Operational Aspects of Latent TES - Phase Change Materials (PCMs) – Paraffins – Zeolites - Requirements of PCMs - Characterization of PCMs - Difficulties with PCMs - Desirable characteristics of PCMs thermodynamic, kinetic, chemical, technical, and economic characteristics - applications of PCMs	10	25

References:

1. Ibrahim Dincer and Marc A. Rosen.” Thermal Energy Storage Systems and Applications”, John Wiley & Sons, Ltd, 2011.
2. Jaluria, Y. “Design and Optimization of the Thermal Systems”, CRC Press, 2008.
3. A. Ter – Gazarian “ Energy Storage for Power Systems”, Peter Peregrinus Ltd., 1994.
4. Ralph Zito. “Energy Storage: A New Approach”, Wiley-Scrivener, 2010.

Course No	Course Name	L-T-P Credits	Year of Introduction
06ME6044	**MINI PROJECT**	0-0-4, 2	2015

Course Objective:

Each student has to conduct an Energy Audit in a well established industry /organization / institution/ any energy consuming sector after getting approval from Faculty in Charge. He /She has to submit an energy audit report and present it in the class. Every student shall participate in the seminar. Grade will be awarded on the basis of the quality of the energy audit, his/her presentation and participation in the seminar.

Course No	Course Name	L-T-P Credits	Year of Introduction
06ME6054	**SOLAR ENERGY ENGINEERING LABORATORY**	0-0-2, 1	2015

Course Objective:

To initiate research projects inside and with outside institutions
To play an important role as an alternative energy engineering applications and Such Solar Energy Initiatives.
To initiate projects on solar energy for senior students in Energy Management Programs.
To study specific aspects of solar energy, and /or other sources.

List of Experiments

Study and experiments on solar energy systems from the following list:

1. Study of radiation measuring instruments pyrheliometer, pyranometer, sunshine recorder, Eppley pyrheliometer
2. Estimation of relationship between basic earth – sun angles
3. Estimation of solar energy availability
4. Determination of local civil time, solar time and time of day
5. Estimation of thermal losses, overall heat loss co-efficient of FPC
6. Estimation of efficiency of solar flat plate collectors.
7. Testing of solar cookers
8. Testing of solar air heaters
9. Testing of solar water heater
10. Testing of solar dryers
11. Testing of solar still
12. Testing of PV cells
13. Estimation of PV characteristics
14. Study on PV sprayer

Expected Outcome

As an outcome of completing this course, students will:
Be able to installation, operation and maintenance of solar energy equipment.
Be able to initiate projects on solar energy for senior students in Energy Management programs.

Course No: 06ME7113	**Course Title:** Optimum Utilization of Heat and Power	**Credits:**3-0-0, 3	**Year:** 2015

Pre-requisites: Knowledge in thermal engineering

Course Objectives:

- Learn about the energy saving opportunities from waste heat and optimum power utilization.

Syllabus

Basic concepts and economics of CHP, pinch technology and its significance, insulations, waste heat recovery, principles of thermodynamics, applications and techno-economics of co generation

Course Outcome

- Understand the energy saving potentials from waste heat.
- Understanding of energy conservation and identification of energy conservation opportunities in various industrial processes.
- Knowledge about co-generation.

Course Plan

COURSE No. 06ME7113 COURSE TITLE :OPTIMUM UTILIZATION OF HEAT AND POWER (L-T-P : 3-0-0) CREDITS : 0		
MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Basic concepts of CHP- The benefits and problems with CHP -Balance of energy demand–Types of prime movers –Economics– CHP in various sectors	11	25
MODULE : 2 Pinch Technology–significance– Selection of pinch temperature difference – Stream splitting– Process retrofit – Installation of heat pumps, heat engines - Grand composite curve.	11	25
FIRST INTERNAL TEST		
MODULE : 3 Insulation – Recuperative heat exchanger – Run –around coil systems – Regenerative heat exchangers – Heat pumps – Heat pipes – Waste Heat Recovery – Cogeneration Technology - Principles of Thermodynamics - Combined Cycles - Topping - Bottoming - Organic Rankine Cycles- Advantages of Cogeneration Technology	10	25
SECOND INTERNAL TEST		
MODULE : 4 Application & techno economics of Cogeneration- Cogeneration - Performance calculations, Part load characteristics- financial considerations - Operating and Investments	10	25

References:

1. Eastop, T.D. & Croft D.R, “Energy efficiency for engineers and Technologists”, 2nd edition, Longman Harlow, 1990.
2. O’Callaghan, Paul W, “Design and Management for energy conservation”, Pergamon,1993.
3. Osborn, peter D, “Handbook of energy data and calculations including directory of products and services”, Butterworths, 1980.
4. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
5. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987

Course No: 06ME7123	**Course Title:** Safety Technology and Management	**Credits:**3-0-0, 3	**Year:** 2015

Pre-requisites: Nil

Course Objectives:

- Anticipate, identify, and evaluate hazardous conditions and practices in the workplace and formulate hazard control designs, methods, procedures, and programs.
- Solve safety-related problems using mathematics, chemistry and life sciences, or management techniques.
- Use the techniques, skills, and modern scientific and technical tools necessary for professional practice.

Syllabus:

Need for safety, Goals of safety engineering, plant safety inspection -Risk assessment SHE Plan-product safety, Aims and objectives of first aid

Course Outcome:

The Safety Technology program prepares its students for technical and management oriented positions in Business, Education, Government agencies and institutions such as Construction, Energy, Chemical, Petroleum etc..

Course Plan:

COURSE No. 06ME7123 COURSE TITLE : SAFETY TECHNOLOGY AND MANAGEMENT (L-T-P : 3-0-0) CREDITS : 3		
MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Need for safety - Goals of safety engineering – basic definitions of accident, injury, unsafe act, unsafe condition, dangerous occurrence, reportable accidents - theories and principles of accident causation -cost of accidents	11	25
MODULE : 2 Indices of safety performance - plant safety inspection - inspection procedures - safety sampling techniques - job safety analysis – potential Risk assessment- SHE Plan-product safety –material safety data sheet-total loss control - fire prevention and catastrophe control – fire extinguishers- protective equipments	11	25
FIRST INTERNAL TEST		
MODULE : 3 Aims and objectives of first aid - first aid principles - role of the first aider – sequence of action on arrival at scene - vital scenes-breathing – pulse - introduction to the body – basic anatomical terms – body cavities – head-cranium – thorax – abdomen and pelvis - management of unconsciousness and shock	10	25
SECOND INTERNAL TEST		
MODULE : 4 safety in engineering industry – . safe work practice of shop equipments and hand tools - safety in welding – safe use of material handling equipments-excavation safety-work permit system lifting procedure-work place environmental standards	10	25

References:

1. Grose,V.L and Englewood Cliffs. “Managing Risk : Systematic Loss Prevention for Executives” , Prentice – Hall, Inc, 1987.
2. Russell Dereamer. “Modern Safety and Health Technology”, John Wiley,1980
3. Schilling. “Occupational Health Practice” R.S.F(ed) Boston : Butterworth, 1981
4. McCormick, E.J. “Human Factors in Engineering and Design”,McGraw Hill, 1982.

Course No: 06ME7133	**Course Title:** Energy And Environment	**Credits:**3-0-0, 3	**Year:** 2015

Pre-requisites: Nil

Course Objectives:

- Understand and analyse the social, economic, industrial aspects pollution and its control methods.

Syllabus:

Air pollutants, meteorology, plume behaviour and types, controlling aerosol emissions.

Course Outcome:

- Understanding pollution.
- Knowledge about ill effects of pollution.
- Knowledge about different pollution control methods.

Course Plan:

COURSE No. 06ME7133 COURSE TITLE : ENERGY AND ENVIRONMENT (L-T-P : 3-0-0) CREDITS : 0		
MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Air pollution – basic definitions – aerosol – dust – droplet – fly ash – fog –fume – mist particle – smoke soot – vapour – gas – smog- ill effects of atmospheric pollution Effects of individual pollutants – particulates - SO2 – lead – asbestos – mercury – organic carcinogens – hydrogen sulphide – carbon monoxide – photochemical pollutants.	11	25
MODULE : 2 Meteorology – temperature variation along the altitude – arriving at the relationship – conditions for pollutant dispersion – adiabatic lapse – super adiabatic lapse – sub adiabatic lapse – isothermal – inversion conditions	11	25
FIRST INTERNAL TEST		
MODULE : 3 Plume behavior - Types of plumes- looping – coning – fanning – lofting - fumigation, trapping - buoyant plume rise – estimation of pollutant concentration of plume given out through the stack at a given location – plume rise for various atmospheric conditions – problems.	10	25
SECOND INTERNAL TEST		
MODULE : 4 Control of Aerosol emission to atmosphere – gravitational settling chamber – design of settling chambers – problems – centrifugal or cyclone separators – filters – wet scrubbers – electrostatic precipitates	10	25

References:

1. C. S. Rao, “Environmental Pollution Control Engineering”, Wiley Eastern, 1992
2. Y. Anjaneyulu, “Air Pollution and Control Technologies”, Allied Publishers, 2002
3. J. Rau and D.C. Wooten “Environmental Impact analysis Handbook”, McGraw Hill, 1980
4. D.H.T. Liu: Environmental Engineers Handbook, Lewis, 1997

Course No:	**Course Title:**	**Credits:** 3-0-0, 3	**Year:** 2015
06ME7213	Nuclear Energy Engineering		

Pre-requisites: Nil

Course Objectives:
The objective of this course is to present an overview of the field of nuclear and radiological engineering and introduce fundamental concepts that are important to nuclear and radiological engineering. These concepts will prepare the students for more advanced study in nuclear and radiological engineering.

Syllabus:
Radioactivity ; Nuclear Processes ; Radiation and Materials ; The Fission Process ; Energy from Nuclear Fuels ; Fusion Reactions ; Neutron Chain Reactions ; Reactor Types

Course Outcome:
Understanding basic principles of Nuclear Engineering and Nuclear physics, Understand the process of nuclear fission and nuclear fusion and knowing more about radiation sources and interactions including those of gamma, beta, alpha, and neutron radiation.

Course Plan:

COURSE No. 06ME7213 COURSE TITLE : Nuclear Energy Engineering
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Radioactivity - Radioactive Decay -The Decay Law - Radioactive Chains - Measurement of Half-Life - Nuclear Processes - Transmutation of Elements - Energy and Momentum Conservation - Reaction Rates - Particle Attenuation - Neutron Cross Sections - Neutron Migration.	11	25
MODULE : 2 Radiation and Materials - Excitation and Ionization by Electrons - Heavy Charged Particle Stopping by Matter - Gamma Ray Interactions with Matter - Photon-Electron Scattering - Photoelectric Effect - Electron-Positron Pair Production - Neutron Reactions	11	25
FIRST INTERNAL TEST		
MODULE : 3 Fission - The Fission Process - The Fission Process - Byproducts of Fission -Energy from Nuclear Fuels – Fusion - Fusion Reactions - Electrostatic and Nuclear Forces - Thermonuclear Reactions in a Plasma	10	25
SECOND INTERNAL TEST		
MODULE : 4 Neutron Chain Reactions - Criticality and Multiplication - Multiplication Factors - Neutron Flux and Reactor Power - Reactor Types - Reactor Operation - The Natural Reactor.	10	25

References:

1. Raymond L. Murray, Nuclear Energy - An Introduction to the Concepts, Systems and Applications of Nuclear Processes, 5th Edition, Butterworth Heinemann.
2. W. B. Mann, R. L. Ayres, and S. B. Garfinkel, Radioactivity and Its Measurement, 2nd
3. edition, Pergamon Press, Oxford, 1980.
4. Robert A. Gross, Fusion Energy, John Wiley & Sons, New York, 1985.
5. Ronald Allen Knief, Nuclear Engineering: Theory and Technology of Commercial Nuclear
6. Power, Taylor & Francis, Bristol, PA, 1992.
7. J. Kenneth Shultis, Richard E. Faw, and Kenneth Shultis, Radiation Shielding, Prentice-Hall,1996.

Course No:	**Course Title:**	**Credits:** 3-0-0, 3	**Year:** 2015
06ME7223	Bio Energy Engineering		

Pre-requisites: Nil

Course Objectives:
The objective of this course is to Know how to develop a successful bio energy project, Feed stock for biogas . To be familiarize with the Thermal chemical conversions of various biomass techniques.

Syllabus:
Sources and Classification of Biomass; Feedstock for Biogas ; Thermo chemical conservation techniques ; Combustion of various Biomasses.

Course Outcome:
To understand and apply energy balances, and thermodynamics in biomass conversion, To understand unit processes/operations involved in bio energy production.

Course Plan

COURSE No. 06ME7223 COURSE TITLE : Bio Energy Engineering (L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Sources and Classification. Chemical composition, properties of biomass. Energy plantations .Size reduction, Briquetting, Drying, Storage and handling of biomass.	11	25
MODULE : 2 Feedstock for biogas, Microbial and biochemical aspects- operating parameters for biogas production. Kinetics and mechanism- High rate digesters for industrial waste water treatment	11	25
FIRST INTERNAL TEST		
MODULE : 3 Thermo chemical conversion of lignocelluloses biomass. Incineration, Processing for liquid fuel production. Pyrolysis -Effect of particle size, temperature, and products obtained. Thermo chemical Principles: Effect of pressure, temperature , steam and oxygen. Fixed and fluidized bed Gasifiers- Partial gasification of biomass by CFB.	10	25
SECOND INTERNAL TEST		
MODULE : 4 Combustion of woody biomass-Design of equipment. Cogeneration using bagasse- Case studies: Combustion of rice husk.	10	25

References:

1. Chakraverthy A, “Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes”, Oxford & IBH publishing Co, 1989.
2. D. Yogi Goswami, Frank Kreith, Jan. F .Kreider, “Principles of Solar Engineering”, 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003[chapter 10]
3. Mital K.M, “Biogas Systems: Principles and Applications”, New Age International publishers (P) Ltd., 1996.
4. Nijaguna, B.T.,Biogas Technology, New Age International publishers (P) Ltd.,2002
5. VenkataRamana P and Srinivas S.N, “Biomass Energy Systems”, Tata Energy Research Institute, 1996.
6. Rezaiyan. J and N. P. Cheremisinoff, “Gasification Technologies, A Primer for Engineers and Scientists”, Taylor & Francis, 2005
7. Khandelwal. K. C.and Mahdi S. S, “Bio-Gas Technology”, Tata McGraw-Hill Pub. Co.Ltd, 1986.

Course No:	**Course Title:**	**Credits:** 3-0-0, 3	**Year:** 2015
06ME7233	Wind Energy Engineering		

Pre-requisites: Nil

Course Objectives:
The course is designed to address all aspects of wind power harnessing starting from wind resources assessment to project implementation and operations & maintenance in a focussed manner.

Syllabus:
Measurement and Instruments in wind energy; Energy in wind; HAWT and VAWT principles; Wind energy conversion systems

Course Outcome
At the end of this course, participants will have strong understanding on fundamentals of wind energy technology along with applications, standards, wind resource availability and leverage on the research that continues to shape this rapidly evolving discipline

Course Plan:

COURSE No. 06ME7233 COURSE TITLE : Wind Energy Engineering
(L-T-P : 3-0-0) CREDITS : 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 Measurement and instrumentation – Beau fort number -Gust parameters – wind type – power law index -Betz constant -Terrain value.	11	25
MODULE : 2 Energy in wind– study of wind applicable Indian standards – Steel Tables, Structural Engineering.	11	25
FIRST INTERNAL TEST		
MODULE : 3 Variables in wind energy conversion systems – wind power density – power in a wind stream – wind turbine efficiency –Forces on the blades of a propeller –Solidity and selection curves.	10	25
SECOND INTERNAL TEST		
MODULE : 4 HAWT,VAWT–tower design-power duration curves-wind rose diagrams-study of characteristics- actuator theory- controls and instrumentations. Grid-combination of diesel generator, Battery storage – wind turbine circuits- Wind farms - fatigue stress.	10	25

References:

1. S.Rao & B.B.Parulekar, “Energy Technology”, 4th edition, Khanna publishers, 2005.
2. Wind energy Handbook, Edited by T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, John Wiley & Sons, 2001
3. Wind and Solar Power Systems, Mukund. R. Patel, 2nd Edition, Taylor & Francis, 2001
4. L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
5. D.A.Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.

Course No	Course Name	L-T-P Credits	Year of Introduction
06ME7023	**PROJECT – (PHASE - I)**	0-0-12, 6	2015

Course Objective:

Normally students are expected to do the project within the college. However they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization. (However, this is only possible in the fourth semester and during the entire third semester students should be present at the college).Progress of the project work is to be evaluated at the end of the third semester. For this a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor. If the project is done outside the college, the external supervisor associated with the Student will also be a member of the committee.

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Course No	Course Name	L-T-P Credits	Year of Introduction
06ME7014	**PROJECT – (PHASE - II)**	0-0-21, 12	2015

Course Objective:

Final evaluation of the project will be taken up only on completion of the project in the fourth semester. This shall be done by a committee constituted for the purpose by the principal of the college. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and the external supervisor, if any, of the student and an external expert either from an academic/R&D organization or from Industry as members. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project.

While students are expected to do their projects in their colleges, provision is available for them to do it outside the college either in an industry or in an institute of repute. This is only possible in the fourth semester and the topic of investigation should be in line with the project part planned in the 3rd semester. Student should apply for this through the project supervisor indicating the reason for this well in advance, preferably at the beginning of the 3rd semester. The application for this shall include the following:-

Topic of the Project:
Project work plan in the 3rd Semester:
Reason for doing the project outside:
Institution/Organization where the project is to be done:

External Supervisor –
Name:
Designation:
Qualifications:
Experience:
Letter of consent of the External Supervisor as well as from the organization

This application is to be vetted by a departmental committee constituted for the same by the Principal and based on the recommendation of the committee the student is permitted to do the project outside the college. The same committee should ensure the progress of the work periodically and keep a record of this.

Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations the grade is finalized in the fourth semester.