ENERGY RESEARCH CENTRE,
PANJAB UNIVERSITY,
CHANDIGARH

Program: M.Tech (ENERGY ENGINEERING & MANAGEMENT)

SESSION 2016 – 2017
SCHEME OF TEACHING & EXAMINATION

and

DETAILED SYLLABUS

### SCHEME OF TEACHING AND EXAMINATION

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hrs. per Week</th>
<th>Major Exam. Marks (End Term)</th>
<th>Sessional Marks</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
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<tr>
<td><strong>FIRST SEMESTER</strong></td>
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<tr>
<td>ENM 1.1</td>
<td>Introduction to Energy Systems</td>
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<td>ENM 1.2</td>
<td>Transfer Processes*/Process Modeling &amp; Simulation of Energy System</td>
<td>3</td>
<td>1</td>
<td>2</td>
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<td>ENM 1.3</td>
<td>Design Methodology for Energy Systems</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>5</td>
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<tr>
<td>ENM 1.4</td>
<td>Energy Technology</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>5</td>
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<tr>
<td>ENM 1.5</td>
<td>Alternate Energy Technology</td>
<td>3</td>
<td>1</td>
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<td>5</td>
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<tr>
<td>ENM 1.6</td>
<td>Seminar</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
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</tbody>
</table>

*Transfer processes will be offered to the candidates with Non-Engineering background.

L: Lecture hours/Week
P: Practical Hours/Week
C: Number of Credits

**Note:** Sessional marks include: Evaluation towards two minor tests (60% of the marks), Assignments (20% of the marks), Class surprise tests, presentations etc. (20% of the marks).
### SCHEME OF TEACHING AND EXAMINATION (2016-2017)

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<tr>
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<td>(End Term)</td>
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<td><strong>SECOND SEMESTER</strong></td>
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<td>ENM 2.1</td>
<td>Energy Technology &amp; Policy Planning</td>
<td>3 1 0 4</td>
<td>50</td>
<td>50</td>
<td>100</td>
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<tr>
<td>ENM 2.2</td>
<td>Energy &amp; Environment</td>
<td>3 1 0 4</td>
<td>50</td>
<td>50</td>
<td>100</td>
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<tr>
<td>ENM 2.3</td>
<td>Selected Topics</td>
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<td>50</td>
<td>50</td>
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<tr>
<td>ENM 2.4</td>
<td>Elective I</td>
<td>3 0 0 3</td>
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<td>Elective II</td>
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<td>Seminar</td>
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<td>15 2 2 18</td>
<td>250</td>
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The Candidate is required to select the two electives from the following groups in consultation with the Director, Energy Research Centre

**Group : Energy Management**

1. Industrial Energy Management Systems
2. Economics of Energy Systems
3. Financial Management
4. Project Management

**Group : Energy System**

1. Solar Thermal Applications
2. Photovoltaic Systems
3. Wind, Geothermal and Ocean Energy Systems
4. Hydro-Electric Power
5. Passive Solar Buildings
6. Alternate Fuels and Advanced Energy Systems

Group: **Bio-Mass Energy System**

2. Bio-Methanation
3. Bio-Reactors
4. Biomass Combustion Technology
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<td>Open Elective*</td>
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<td>50</td>
<td>100</td>
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<td>ENM 3.2</td>
<td>Energy &amp; Environmental Economics</td>
<td>3  1  0  4</td>
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<td>50</td>
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<td>Preliminary Thesis#</td>
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<td>“S” or “X”</td>
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<td></td>
<td>6  2  20  18</td>
<td>100</td>
<td>100</td>
<td>200</td>
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</table>

#: Preliminary thesis will be evaluated on the basis of seminar presentations and discussions and the candidate shall be awarded ‘S’ grade i.e. satisfactory for continuation or else ‘X’ grade i.e. unsatisfactory.

* List of Open Elective (ENM 3.1)

1. Research Methodology
2. Optimization Techniques
3. Safety & Hazards
4. Analytical Techniques
5. Composite Materials
6. Environmental Engineering
SCHEME OF TEACHING AND EXAMINATION (2016-2017)

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<td>L P C</td>
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<tr>
<td>FOURTH SEMESTER</td>
<td>ENM 4.1 Thesis*</td>
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<td>“S” or “X”</td>
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<td>Total</td>
<td></td>
<td>- 30 15</td>
<td>-</td>
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</table>

*Thesis in Continuation

NOTE:

The student is required to make seminar presentation(s) of the results achieved before the submission of the thesis.

1. The Post Graduate Student Research Committee (PGRC) of the Institute will evaluate the Thesis. The constitution of the committee is as under:
   a. Director, ERC
   b. Senior professor related to the area of research
   c. Supervisor(s)
   d. External examiner

2. The PGRC will evaluate the final thesis based on an open house presentation by the student, which will be attended by the faculty members, PG students and other research scholars of the institute.

3. No marks are assigned to Preliminary Thesis and Thesis evaluation work. On successful completion and presentation of Research Seminars, the candidate will be awarded ‘S’ grade i.e. satisfactory or else ‘X’ grade i.e. unsatisfactory.

4. Requirement for the award of M.Tech (Energy Engineering & Management) degree is 75 credits with minimum CGPA of 6.0 and successful completion of thesis work.
ENERGY RESEARCH CENTRE,
PANJAB UNIVERSITY,
CHANDIGARH

Program: M.Tech (ENERGY ENGINEERING & MANAGEMENT)

SESSION 2016 – 2017

DETAILED SYLLABUS

SYLLABI FOR M.TECH. (ENERGY ENGINEERING & MANAGEMENT)

SESSION 2016-17

DETAILED SYLLABUS

Marks:  Major Examination: 50

Sessionals : 50

L : T : P : C

3 : 0 : 0 : 3

Name of the Course : ENM 1.1   Introduction to Energy Systems

Contents :


Books :


“Energy Systems and Development” Jyuoti, K./ Parikh, Oxford University Press, 1982


Name of the Course : ENM 1.2 Transfer Processes

Contents

Fundamentals of heat transfer, conduction, convection (free and forced) and radiation, Boiling and condensation heat transfer, theory of diffusion, Psychrometry, drying transportation and metering of fluids, simultaneous heat and mass transfer in energy systems.

Books


“Non Conventional Energy Sources”, G.D. Rai, Khanna Publisher, 1997


Name of the Course : ENM 1.2  Process Modeling & Simulation of Energy Systems


Models and Optimization, Optima of functions of single as well as unconstrained optima, linear programming, nonlinear programming and its application to thermal systems, dynamic programming applied to energy systems.

Selected Application Problems – Computer modeling and analysis of energy systems, dynamic programming applications in energy systems, Numerical analysis in thermal design.

Texts/References :


Name of the Course : ENM 1.3       Design Methodology for Energy Systems


Books :


“Principles of Solar Engineering”, D. Yoi Goswami, Frank Kreith, Jan F. Kreider, Taylor and Francis, 2000

“Energy Technology”, S. Rao, Dr. B.B. Parulekar, Khanna Publisher, 2000


Name of the Course ENM 1.4 Energy Technology

Contents


Books :


Fuels and Combustion, S.P. Sharma and Chander Mohan, Tata McGraw Hill

Marks: Major Examination Theory: 50
       Practical: 25

Sessionals
       Theory: 50
       Practical: 25

Name of the Course – ENM 1.5 Alternate Energy Technology

Contents


Books:

Energy Technology, S. Rao, Dr. B.B. Parulekar, Khanna Publisher, 2000.
Non Conventional Energy Sources, G.D. Rai, Khanna Publisher, 1997
Name of the Course ENM 2.1 Energy Technology and Policy Planning

Contents


Books:


Economics of solar energy and conservation system vol. I & II, F. Kreith and R.E. West (eds) CRC Press 1980


Name of the Course: ENM 2.1     Energy and Environment

Content

Energy & Environmental Conservation, Energy & Environmental Analysis of Products.

The Cost of environmental Control, Evaluation of Environmental goods & cost, Emissions from power stations and their effect on environment, Ash collection, Strategies for reduction in emissions from industrial units,. Gas cleaning, dispersion of pollutants in atmosphere and design of stack, Industrial waste water treatment measurements and control, Environmental pollution control strategies inn petroleum industry. Environmental aspects of alternate energy systems.

Books:


“Environmental Impact of Coal Mining”, Paul O Collaghan, Pergamen Press 1987

“Environmental Pollution Control Engineering”, C.S.Rao, Wiley Eastern Ltd. 1991


Name of the Course ENM 2.3            Selected Topics

Contents


Books :

Non Conventional Energy Sources, G.D. Rai, Khanna Publisher, 1997
Economic Operation of Power systems, Leon K. Kirchmayer, Wiley Eastern, 1993
Photo electrochemical solar cells, M/ Sharon and K.S.V. Santhanam (ed.) Elsevier, 1988

Marks: Major Examination Theory: 50
        L : T : P : C
        3 : 1 : 0 : 4

Sessionals Theory : 50

Name of Course : ENM 3.2 Energy & Environmental Economics

Contents

Energy & Environmental Auditing

RET Model for Economics of Renewable Energy System

Energy Conservation Act. 2002

The Electricity Bill – 2003

UNFCC Protocol

CDM & Sustainable Development
GROUP - ENERGY MANAGEMENT

1 Industrial Energy Management Systems

Contents


Books:


Industrial Energy Conservation, D.A. Reay, Pergamon Press; 1987


Efficient Electricity Use, B. Smith Graig Editor, Pergamon Press, 1976

2 Economics of Energy Systems

Contents


Books :

Economic Operation of Power systems, Leon K. Kirchmayer, Wiley Eastern, 1993


Hydroelectric Engineering Practice, J. Guthrie Editor, Brown Vol. 3 CBS Publishers & Distributors, 1984

3 Financial Management

Contents

Scope an objective of financial management. Techniques of Financial analysis, time series techniques, combining financial statement and non-financial statement information, working capital concept, need and influencing factors, operating cycle of short term finance, financing of long term requirements,
underwriting and shortage agreement, provisions of the ……………of private enterprises, budgeting techniques, cost of capital and its measurements, dividend policy and retention of profits.

Books


Fundamental of financial Management, P. Chandra, TMH, 1993


4 Project Management

Contents


Books :

Project Management, D. Lock/Gower Pub. 1993

Project Management,, S. Choudhary, TMH, 1990

Project Management, H. Kerzner, CBS, 1987
GROUP - ENERGY SYSTEM

1 Solar Thermal Applications

Contents

Analysis and design of flat Plate collectors and focusing collectors Solar systems modeling. Application to water heating, power generation, Air heating, Air Conditioning, House heating and cooling, Drying, Green Houses and cooking.

Books:


Principles of Solar Engineering, D. Yogi Goswami, Frank Kreith, Jan F. Kreider, Taylor and Francis, 2000

Energy Technology, S. Rao, Dr. B.B. Parubkar, Khanna Publisher, 2000

Non conventional Energy Sources, G.D. Rai, Khanna Publisher, 1997


2 Photovoltaic and Photo Chemical Systems

Content

The Sun, structure, fusion reaction in sun’s core; solar radiation and its intensity at AM0, AM1 and AM2

Physics of Semiconductor Properties of semiconductor which are relevant to p.n. junction band diagram, Fermi energy Surface states, types of defects Photovoltaic solar cell p.n. junction. Metal-Schottky junction, Electrolyte-semiconductor junction, types of solar cells, and their applications, Experimental techniques to determine the characteristics of solar cells. Photovoltaic hybrid systems. Photovoltaic thermal systems, storage battery, solar array and their characteristics evaluation, solar chargable batteries,
Pho-Chemical Cells, Fuel cells with special reference to hydrogen, oxygen and carbon dioxide/air systems.

Books:

Photo electrochemical solar cells, M. Sharon and K.S.V. Santhanam (ed.) Elsevier, 1988


Energy Technology Hand Book Considine, McGraw Hill, 1977


3 Wind, Geo thermal and Ocean Energy Systems

Contents

Nature and availability of wind energy. Wind turbines, classification, construction and control
Performance evaluation methods, Power efficiency, storage, reliability and cost, load matching.
Occurance and Resources of geothermal Energy.. Technologies for harnessing Geothermal Energy,
applications of geothermal energy. Prime Movers for Geothermal Energy, operational Environmental
problems, Tides and waves as energy supplement low healthy to \( \text{t} \)and there mechanism. Hydrological
investigations. Turbines governing and local power supplies. Fundamental Ocean thermal Power
Generation Systems, characteristics of Tidal power conversion/wave energy/wind energy

Books

Alternative Fuels, Sunggyu Lee, Taylor and Francie, 1996


Energy Technology, S. Rao, Dr. B.B. Parubkar, Khanna Publisher, 2000

Energy Sources, G.D. Rai, Khanna Publisher, 1997
4 Hydroelectric Power Generation

Contents.


Books:


5 Passive Solar Buildings

Contents

Climates and buildings. Thermal properties and energy contents of building materials, psychrometry. Comfort conditions, Airconditioning systems. Energy conservation techniques Lighting(Daylighting and

**Books:**


6 Alternative Fuels and Advanced Energy Systems

**Contents:**


**Books:**

Advanced Energy Systems, Nikolai V. Khartchenko, Taylor and Francis, 1998


GROUP - BIOMASS ENERGY SYSTEM

1 Biomass Thermal Systems

Contents


Books:


Biomethanation

Contents:

Sources of Biomass materials, Macroscopic and Microscopic components of Biomass materials. Physical and Chemical Characteristics of biomass materials, Biomass characterization, Microbial Biomass conversion Principles, Aerobic and Anaerobic microbial processes. Two stage biomethanation, Design of
bioreactors, Patenting of Biological systems, design of biogas plants, conversion of biomass to alcohol and other products. Biomass as a Energy Source, Energy Plantations.

Books:

Microbial Processes, J.Roger porter, National Academy of Sciences, 1979

Bio Reactors

Contents


Books:


Biomass Combustion Technologies

Wood and Biomass Composition, properties and combustion characteristics. Improved cookstove Technologies Environmental and health implications. Improved cookstoves and combine technology. Biomass based energy systems for rural industries, Therme pyrolysis and Gasification of biomass Advanced Biomass combustion system.

Books:


Rural Energy Technologies

Rural Energy Planning, rural energy supply and demand, Rural energy programs. Historical review of cookstove development, Principles of improved cookstove design and development. Wood and biomass Composition properties and combustion characteristics, Improved Cookstoves and combined Technology, Rural Industrial combustion systems, application of solar energy for rural applications, Biogas technology.
Books:


Rural Technologies, KPA Menon, Pradeep Chaturvedi and anuj sinha, Indian Association for the Advancement of Science, 1989.


OPEN ELECTIVES (ENM 3.1)

Marks: Major Examination Theory: 50

L : T : P : C
3 : 1 : 0 : 4

Sessionals Theory : 50

Research Methodology

Contents

Applied Computations: Formulation of the parameter estimation problem; Computation of parameters in linear models, use Microsoft Excel, Gauss – Newton method for algebraic models. Use of MATLAB

Design of experiments, Preliminary Experimental design, Sequential Experimental design.

Books


2. MATLAB Manual