

**ENERGY RESEARCH CENTRE,  
PANJABUNIVERSITY,  
CHANDIGARH**

**Program: M.Tech ( ENERGY ENGINEERING  
&MANAGEMENT )**

**SESSION 2019 – 2020**

**SCHEME OF TEACHING & EXAMINATION**  
**and**  
**DETAILED SYLLABUS**

**ENERGY RESEARCH CENTRE, PANJABUNIVERSITY, CHANDIGARH****Program: M.Tech (ENERGY ENGINEERING & MANAGEMENT)****SESSION 2019 - 2020****SCHEME OF TEACHING AND EXAMINATION**

<b>Paper</b>	<b>Subject</b>	<b>Teaching Hrs. per Week</b>				<b>Major Exam. Marks (End Term)</b>	<b>Sessional Marks</b>	<b>Total Marks</b>
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>			
<b>FIRST SEMESTER</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>			
ENM 1.1	Introduction to Energy Systems	3	0	0	3	40	35	75
ENM 1.2	Transfer Processes*/Process Modeling & Simulation of Energy System	3	1	2	5	50 (Th 50)	75 (Th 50 Pr 25)	125
ENM 1.3	Design Methodology for Energy Systems	3	1	2	5	50 (Th 50)	75 (Th 50 Pr 25)	125
ENM 1.4	Energy Technology	3	1	2	5	50 (Th 50)	75 (Th 50 Pr 25)	125
ENM 1.5	Alternate Energy Technology	3	1	2	5	50 (Th 50)	75 (Th 50 Pr 25)	125
ENM 1.6	Seminar	0	0	2	1		“S” or “X”	
<b>Total</b>		<b>15</b>	<b>4</b>	<b>10</b>	<b>24</b>	<b>240</b>	<b>335</b>	<b>575</b>

\*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 (2019-2020)**

Paper Code	Subject	Teaching Hrs. per Week				Major Exam. Marks (End Term)	Sessional Marks	Total Marks
		L	T	P	C			
<b>SECOND SEMESTER</b>								
ENM 2.1	Energy Technology & Policy Planning	3	1	0	4	50	50	100
ENM 2.2	Energy & Environment	3	1	0	4	50	50	100
ENM 2.3	Selected Topics	3	0	0	3	40	35	75
ENM 2.4	Elective I	3	0	0	3	40	35	75
ENM 2.5	Elective II	3	0	0	3	40	35	75
ENM 2.6	Seminar	0	0	2	1		“S” or “X”	
<b>Total</b>		<b>15</b>	<b>2</b>	<b>2</b>	<b>18</b>	<b>220</b>	<b>205</b>	<b>425</b>

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

1. Bio-Mass Thermal Systems
2. Bio-Methanation
3. Bio-Reactors
4. Biomass Combustion Technology

**SCHEME OF TEACHING AND EXAMINATION (2019-2020)**

Paper Code	Subject	Teaching Hrs. per Week				Major Exam. Marks	Sessional Marks	Total Marks
		L	T	P	C	(End Term)		
<b>THIRD SEMESTER</b>		L	T	P	C			
ENM 3.1	Open Elective*	3	1	0	4	50	50	100
ENM 3.2	Energy & Environmental Economics	3	1	0	4	50	50	100
ENM 3.3	Preliminary Thesis <sup>#</sup>	0	0	20	10	“S” or “X”		
<b>Total</b>		<b>6</b>	<b>2</b>	<b>20</b>	<b>18</b>	<b>100</b>	<b>100</b>	<b>200</b>

<sup>#</sup>: 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 (2019-2020)**

Paper Code	Subject	Teaching Hrs. per Week			Major Exam. Marks	Sessional Marks	Total Marks
		L	P	C	(End Term)		
<b>FOURTH SEMESTER</b>							
ENM 4.1	Thesis*	-	30	15		"S" or "X"	
<b>Total</b>		<b>-</b>	<b>30</b>	<b>15</b>	<b>-</b>	<b>-</b>	<b>-</b>

\*Thesis in Continuation

**NOTE:**

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

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



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**SESSION 2019 – 2020**

**DETAILED SYLLABUS**

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

**SESSION 2019-2020**

**DETAILED SYLLABUS**

Marks: Major Examination: 50

L : T : P : C

Sessionals : 50

3 : 0 : 0 : 3

**Name of the Course : ENM 1.1**

**Introduction to Energy Systems**

Contents :

Historical and contemporary Energy scenario, Historical lives of fossil fuels. Conventional energy systems. Alternate energy technologies, Energy and Environment. Stoichiometry of energy systems. Thermodynamics and energy; Measurement and control of temperature. Energy flow in the economy : Alternate fuels.

Books :

Solar Energy , G.N. Tewari, Narosa Publishing House, 2002

Solar Engineering of Thermal Processes”, JA Duffie and W.A. Backman, , John Wiley, 1981

Solar Energy : Fundamentals and Applications, H.P. Garg : Tata McGraw Hill Publishing Company Ltd.  
1997

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

“Energy and the Environment.” J/M/ Fowler. McGraw Hill, 1975

Marks: Major Examination Theory: 50

L : T : P : C

Practical: 25

3 : 1 : 2 : 5

Sessionals

Theory : 50

Practical: 25

**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

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

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

“Solar Thermal Engineering Systems”, G.N. Tiwari and SangeetaSuneja, Narosa Publishing House, 1997

“Solar Energy Fundamentals and Applications”, H.P. Garg, Tata McGraw Hill Publishing Co. 1997

Solar Engineering of Thermal Processes, J.A. Duffie and W.A. Backman, Jolm Wiley, 1981

Marks: Major Examination Theory: 50

L : T : P : C

Practical: 25

3 : 1 : 2 : 5

Sessionals

Theory : 50

Practical: 25

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

Energy System. Overview of various technologies and conventional methods of energy conversion, thermodynamics, power cycles, introduction to steam power generation. Models and Modelling “General concepts in modeling, classification of models, digital computers in modeling and analysis. Introduction of Numerical Methods – Finding roots, interpolation techniques, numerical integration, solving sets of simultaneous equations, ordinary differential equations, finite difference methods applied to fluid flow and heat transfer problems.

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 :

“Handbook of Applied Thermal Design”, Eric. C. Guyer, Editor, Taylor & Francis 1999

“Systems Modelling and Analysis”, I J Nagrath and M/ Gopal, Tata McGraw Hill 1982

Engineering Modelling and Computation”, Walter J. Gajda, Jr and William E. Biles, Houghton Mifflin Co. Boston, 1978

Numerical Methods for Scientists and Engineer”, R. Hamming, McGraw Hill, 1973

“Computer Applications of Numerical Models”, S.S. Kus, Addison-Wesley, 1972

“Numerical Methods for Engineers”, Santosh K/ Gupta, New Age International, 1999

Marks: Major Examination Theory: 50

L : T : P : C

Practical: 25

3 : 1 : 2 : 5

Sessionals

Theory : 50

Practical: 25

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

Basic Principles of heat transfer, Solar Radiations, Design and performance of flat plate collectors Solar concentrators design and characteristics, Testing of collectors. Design of Solar stills, Solardrier, Solar Cooling and Cooking System, Conversion to mechanical energy, Sterling engine. Water pumping, Passive Solar Architecture, Green Houses Solar Thermal Energy Storage, Solar Photovoltaics.

Books :

“Solar Energy”, G.N. Tewari, Narosa Publishing House, 2002

“Solar Energy”, H.P. Garg & J. Prakash, “Tata McGraw Hill Company Ltd., New Delhi, 2000

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

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

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

“Solar Thermal Engineering systems”, G.N. Tiwari and SangeetaSuneja, Narosa Publishing House, 1997

“Solar Energy Fundamentals and applications, H.P. Garg, Tata McGraw Hills Publishing Co. 1997

“Solar energy and Energy Conservation”, Rajkamal, K.P. Maheshwari& R.C. Sawhney Willey Eastern Ltd., 1992

“Analysis and Design of Energy Systems”, B.K. Hodge, Prentice Hall, 1990.

“Solar Engineering of Thermal Processes”, J/A. Duffi and W.A. Backman, John Wiely, 1981

Marks: Major Examination Theory: 50

L : T : P : C

Practical: 25

3 : 1 : 2 : 5

Sessionals

Theory : 50

Practical: 25

**Name of the Course ENM 1.4            Energy Technology**

Contents

Fuels and combustion, Classification of fuels, Boilers, Design of furnaces, properties and testing of fuels, Solids, liquid and gaseous fuel burners, Refractories, classification, properties and applications, insulated pipe work systems, Building heat balance. Heat recovery. Heat Pumps and refrigeration, Pulverized fuel burners gasification. Alternative fuels, Different Hydroelectric Power Plants, Fluidized bed combustion systems.

Books :

“Power Plants Engineering”, S.C. Arora and S. Do Kundwar, Dhanpat Rai & Co. 2001

“Handbook of Applied Thermal Design”, Eric, C. Guyer, Taylor & Francis, 1999

“Energy Management and Operation Cost in Building”, J. Mass Keith, E & FN Spoon, 1977.

“Solid Liquid Gaseous Fuels”, Brame and King, McGraw Hill 1962

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

Marks: Major Examination Theory: 50

L : T : P : C

Practical: 25

3 : 1 : 2 : 5

Sessionals

Theory : 50

Practical: 25

**Name of the Course – ENM 1.5**

**Alternate Energy Technology**

Contents

Solar Energy Fundamentals, Solar Radiation Characteristics and Measurements. Low temperature energy collection, high temperature energy collection, solar thermal power generation systems, domestic industrial and agricultural applications of solar energy, wind resource assessment, aerodynamic analysis and design of wind mills, interphasing of wind machines, geothermal energy and ocean thermal, thermal energy. Energy storage, Solar refrigeration and Air-conditioning, Energy Storage.

Books :

Solar Energy, G.N. Tewari, Narosa Publishing House, 2002

Solar energy, H.P. Garg & J. Prakash, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2000

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

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

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

Marks: Major Examination Theory: 50

L : T : P : C

3 : 1 : 0 : 4

Sessionals

Theory : 50

**Name of the Course ENM 2.1**

**Energy Technology and Policy Planning**

Contents

Energy Crisis and India, Demand and supply of energy, Energy and economy, Social benefit cost analysis of energy systems, Essential elements of energy policy and planning, Environment and Energy, Sustained reduction in energy use, Energy Databases, Energy modeling, Energy management information systems. Supply and demand side management of energy systems. Power Plant system analysis Power distribution systems.

Books :

Solar energy : Fundamentals and Applications, H.P. Garg, Tata McGraw Hill Publishing Company Ltd., 1997

Industrial Energy Conservation, D.A. Reay, Pergamon Press, 1994

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

Thermal Energy Recovery, T.L. Boyen, Wiley, 1980

Solar Engineering of Thermal Processes, JA Duffie and W.A. Backman, John Wiley, 1981.



Marks: Major Examination Theory: 50

L : T : P : C

3 : 1 : 0 : 4

Sessionals

Theory : 50

**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 in petroleum industry. Environmental aspects of alternate energy systems.

Books :

“Pollution Control in Process Industries”, S.P. Mahajan, Tata McGraw Hill, 2000

“Energy Management, Paul O Collaghan”, McGraw Hill Book Company, 1993

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

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

“Air Pollution Control Engineering”, N.D. Nevers, McGraw Hill, 1995

“Thermal Environmental Engineering, J.L. Trelker, Prentice Hall, 1970

Marks: Major Examination Theory: 50

L : T : P : C

3 : 0 : 0 : 3

Sessionals

Theory : 50

**Name of the Course ENM 2.3**

**Selected Topics**

Contents

Advanced Energy Conversion Technologies, Chemical Conversion Systems, Two Stage Bio conversion Systems. Alternate fuels, Advanced storage systems, Advanced combustion systems. Ocean Thermal power Generation Systems, Rural Energetics, space energy conversion systems, energy management, economics of energy systems

Books :

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

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

Energy Management, W.R. Murphy, G. McKay, Butter Worth & Co., 2001

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

Handbook : Batteries and Fuel Cells, Inden, McGraw Hill, 1984.

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

UNFCCC Protocol

CDM & Sustainable Development

**Name of Course : Elective I and Elective II (ENM 2.4 and ENM 2.5)**

Marks: Major Examination Theory: 50

L : T : P : C

3 : 0 : 0 : 3

Sessionals

Theory : 50

## **GROUP - ENERGY MANAGEMENT**

### **1 Industrial Energy Management Systems**

#### Contents

Energy Conservation prospects in India, Energy Management and Conservation, Energy indices, Flow chart for the construction of energy audits. Energy throughputs – Energy flow chart – energy audit, energy saving options. Energy and environmental analysis of products. Rules for the efficient conservation of energy materials, Laws of energy and material flows, Effect of Energy conservation on the energy characteristics, Demand and supply side management in power systems, Energy cascading, use of computational acids in energy audit. Conservation in Energy Production Industry.

#### Books :

Energy Management, W.R. Murphy, G. McKay, Butter Worth & Co., 2001

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

Economics of solar energy and conservation system, vol. I & III, F. Kreith and R.E. Westt (eds).

CRC Press, 1980

Thermal Energy Recovery, T.L. Boyen, Wiley, 1980

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

Strategies for Energy Conservation in India, Ed. Pradeep Chaturvedi, Shalini Joshi, Concept Publishing Company 1997.

## 2 Economics of Energy Systems

### Contents

Solar Economics, Life Cycle Costing Principle of Discounted Cash Flow Analysis, Solar System Life Cycle Costs, Cost Benefit analysis and Optimization. Costing Techniques, Economics Operation of Steam Plants. Incremental Production Cost and Incremental Transmission Losses. Economic Scheduling of Generation Simulation of Management systems, Net Work Analysis, Benefits of Combined Operation of Hydro and Thermal Plants. Cost of Hydroelectric Power Pumps Storage Schemes, Economic of Electric Power Supply and Utilization, Economic of Alternate Energy Systems.

### Books :

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

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

Economics of Solar Energy and Conservation Systems. Vol. III, Frank Kreith and Ronald West, CRC Press, 1980

Energy Management, W.R. Murphy, G. McKay, Butter Worth 2001

Utilization of Electric Power, N.V. Surya Narayana, Willey Eastern Ltd., 1994

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

### **3 Financial Management**

#### Contents

Scope and objectives 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

Fundamentals of financial Management, R.K.S. Rao, Maxwell Macmillan, 1989

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

Financial Management, A.K. Vashist, N.K. Sahni, Kalyani Publishers, 1997

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

Financial Management, V. Sharma, Anmol Publishers, 1991

### **4 Project Management**

#### Contents

Concept of project management, project management systems, Responsibilities and qualities of a project manager. Project management team composition, functions and responsibilities coordination procedure. Principles of Project identification. Importance of capital investment decision. Phases of capital expenditure management. Appraisal criteria and selection of investment. Technical, economic, commercial and financial feasibility analysis, preparation of techno-economic feasibility report. Network analysis, PERT/CPM, Preconstruction Planning, Project scheduling, control and monitoring.

#### 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 :

Solar Energy, G.N. Twari, Narosa Publishing House, 2002

Solar Energy, H.P. Garg & J. Prakash, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2000

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

Solar Thermal Engineering System, G.N. Tiwari and Saneja, NarosePublishig House, 1997

Solar Energy Thermal Process, J.A. Duffie and W.A. Backman, Johan Wiley, 1981

Principles of Solar Engineering, K.Kreith and J.F. Kreider, McGraw Hill, 1978

### **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 chargeable batteries,

Photo-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

Physics of Semiconductor Devices, S.M. Sze, Wiley Estern, Ltd., 1983

Essentials of Solar Cells, R.K. Kotnala and N.P. Singh, Allied Publishers, 1986

Elementary SolidState Physics Principles and Applications, M.A. Omar, Addison Wesley 1975

Energy Technology Hand Book Considine, McGraw Hill, 1977

Hand book : Batteries and Fuel Cells, Inden, McGraw Hill, 1984

### **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. Occurence 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 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

Wind Power, D.K. Simson, McGraw Hill, 1977

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

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



Wave Energy, Duckers L.J. World Renewable energy Congress 11, Ed. Sayigh, A.M. Reading, September, 1992

Wave Energy a design challenge, Ronald Shaw, Ellishorwood, Pub. 1982

Wind Engineering, Vol. 1-3, PremKrishana (ed.) Wiley Eastern, 1994

Geophysical aspects of the energy problem, A Rapola, G.V. Keller, D.J. Moore, Elsevier Scientific Publishing Company, 1980.

#### **4 Hydroelectric Power Generation**

##### **Contents**

Hydraulics, Hydraulic turbines and general arrangement of plant. Types of hydroelectric plants. Dams, The water ways, canals and pen stock, power house. Transmission lines, cost and value of water power. Social and Environment impact of hydroelectric power stations.

##### **Books:**

Hydroelectric Engineering practice, J.Guthrie and Brown(ed). CBS Publishers,1984

Utilization of Electric Power, n.V. Surya Narayana, Willey Eastern Limited, 1994.

#### **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 electric lighting). Passive and active methods of heating and cooling loads. Computer packages for carrying out thermal design of buildings and predicting performance.

##### **Books:**

Solar Passive Building, Science and Design. M S Sodha, N. K. Bansal, P K Bansal, A

Kumar and M AS Malik, Pergamon Press,1996.

Passive Solar Heating R W Jones, J D Balcomb. C E kosiewiez, Abn Arber Science, 1983.

Passive solar design Handbook, Vol 3. G S Lazarus, R D McGVFarland and W. O. Wray, Report of US Department of Energy(DDE/CS-0127/3),1982

Thermal Environmental Engineering. E L Trelkeld, Prentice Hall, 1970.

## **6 Alternative Fuels and Advanced Energy Systems**

### **Contents:**

Global Energy Overview, Coal liquification, Syngas, Integrated Gasification Combined Cycle Technology, Coal Slurry Fuels, Energy from Solid waste, Alcohol from biogas, MHD Power, Thermo Electric Power, Chemical Energy Sources, Hydrogen Energy, Thermionic Generation, thermo nuclear fusion solar ponds, advanced storage systems.

### **Books:**

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

Solar pond, K.S.Rao, VVN Kishore, Daksha Vaja, GEDA,1990

Alternative Fuels, Sunggyu Lee, Taylor and Francis, 1996.

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

## **GROUP - BIOMASS ENERGY SYSTEM**

### **1 Biomass Thermal Systems**

#### **Contents**

Biomass as energy source, Photosynthesis, Photobiology, Wood and biomass composition, properties and combustion. Characteristics Biomass and food stock for synthetic fuel production, Thermal and chemical conversion. Briquetting of biomass, Principles of gasification, types of gasifiers, design of gasification system, Flash pyrolysis. Biomass based rural energy systems, environmental impact of biomass combustion system.

**Books:**

Energy from biomass, W, palz, J.Coombs and D O Hall, Elsevier Applied Science,1985

Improved solid biomass Burning cookstoves: A development manual, S.K.Sharma, F.A.O.Field document No.44. 1993.

Advances in Biomass Burning gasification technology, K.K.Singh, A.N. Mathur, N.S.Rathod, Himansu Publications, 1991.

Biomass gasification Principles and Technology Energy Technology Review, 67, T.B.read; Noyes Data Corporation USA,1978.

Biomass as fuel, P. White, L.G.claskett, Academic, 1980.

**Biomethanation****Contents:**

Sources of Biomass materials, Macro scopic and Microscopic components of Biomass materials. Physical and Chemical Characteristics of biomass materials, Biomass characterization, Microbial Biomass conversion Principles, Acrobic 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:**

Bio-Energy, A.N. Mathur, Himansu Publication,1991.

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

## **Bio Reactors**

### **Contents**

Principles of Bioconversion, Types of bio reactor, Batch reactors, plug flow reactors, Stirred Tank and film reactors, Reaction kinetics, Bio Reactor Design, Analysis of Materials, Bio-methanol, Treatment of Municipal Refuse, Sewage, Industrial waste, Agricultural Wastages, Animal & Human Waste, landfill systems, properties and uses of biogas, health & environmental Considerations. Photosynthesis, Source & classification of Biomass.

### **Books:**

Energy Resources, Demand and Conservation. Kashkarichaman, Tata Mcgraw Hill, 1987

Micro Processes, HJ, Roger porter, National Academy of Sciences, 1979.

## **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, Thermo pyrolysis and Gasification of biomass Advanced Biomass combustion system.

**Books:**

Energy from biomass, W.Palz, J. Coombs and D.O.Hall, Essevier Applied Science,1985

Improved solid biomass Burning cookstoves: A development manual, S.K. Sharma, .A.O. Field document No.44.

Advances in biomass gasification technology,K.K.Singh, A.N. Mathur, N. S. Rathod, Himansu Publications, 1991.

**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 and Renewable Energy. VenkataRamana P, TERI,1997

S K Sharma Improved solid biomass Burning cookstoves, A development manual F A O Fold document No 44, 1993

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

Energy for Rural Development, NationalAcademy Press, 1981

Rural Technologies, Amulya k. Reddy, Indian Academy of Sciences,1980.

## 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

1. Englezos, P., Kalogerakis, N., “Applied Parameter Estimation for Chemical Engineer”, Marcel Dekker (2001)
2. MATLAB Manual

