DEVI AHILYA VISHWAVIDYALAYA, INDORE

School of Energy and Environmental Studies

1.1.2
Minutes of the Meetings and Changes in Syllabus

Minutes of Board of Studies (BOS) Meeting

School of Energy & Environmental Studies, DAVV Indore, BOS meeting for Pre Ph.D. course work was held in the office at 3.0 pm on 10th October 2012.

The following Member were present

Prof. S.P. Singh, Head, SEES, D.A.V.V., Indore : Chairman
Prof. R.N. Singh, SEES, D.A.V.V, Indore : Member
Dr. Rubina Chaudhary, Reader, SEES, D.A.V.V, Indore : Member

The following agenda was taken into consideration by the board member.

Agenda 1: Discussion on Pre- Ph.D. (Energy and Environment) course.

Decision: It was anonymously decided that as per the UGC guide line (UGC Regulation 2009, dated 1-06-2009) for Pre-Ph.D. course followed by University letter 29-08-2012. School of Energy and Environmental Studies followed and started the pre-Ph.D. course work with effect of January 2013. Following courses with a total credit of 15 (including Comprehensive Viva-Voce - 4 credits) were offered for Pre Ph.D Course work.

Course Code	Course Title	Credits
Ph.D-701	Research Methodology	5
Ph.D-702	Computer Applications	3
Ph. D -703	Research Paper	3
	Comprehensive Viva-Voce	4
Total		**15**

(Chairman)

Dr. S. P. Singh
Head
School of Energy & Environmental Studies
Devi Ahilya University Campus,
Khandwa Road, INDORE-452 001 (INDIA)

(Member) 10-10-12

(Member)
10.10.2012

Minutes of Board of Studies (BOS) Meeting

School of Energy & Environmental Studies, DAVV Indore, BOS meeting for Pre Ph.D. course work was held in the office at 3.0 pm on 27th November 2017.

The following Member were present

Prof. R.N. Singh, SEES, D.A.V.V, Indore : Chairman
Prof. S.P. Singh, Head, SEES, D.A.V.V., Indore : Member
Dr. Rubina Chaudhary, Reader, SEES, D.A.V.V, Indore : Member

The following agenda was taken into consideration by the board member.

Agenda 1: Discussion on Pre- Ph.D. (Energy and Environment) course as per the revised ordinance of UGC

Decision: As Approved by the Coordination Committee in its meeting held on 25/10/2017 and Adopted by Devi Ahilya Vishwavidyalaya in its EC meeting held on 04/12/2017, ORDINANCE NO. 11 DOCTOR OF PHILOSOPHY Revised in light of the University Grants Commission (Minimum Standards and Procedure for Awards of M.Phil./Ph.D. Degrees Regulations, 2016 published in the Gazette of India on July 05, 2016) Pre Ph. D course work was revised. Following courses with total credits of 16 (including Comprehensive Viva-Voce-3 credit) were offered for Pre Ph.D. Course work with effect of 2017.

Course Code	Course Title	Credits
Ph.D-701	Research Methodology	4
Ph.D-702	Review of Published Research	3
Ph. D -703	Computer Applications	3
Ph. D -704	Advancement in Energy & Environment Systems & Technologies	3
	Comprehensive Viva-Voce	3
Total		**16**

27-11-17
(Chairman)

(Member)

(Member)
27.11.2017

Dr. S. P. Singh
Head
School of Energy & Environmental Studies
Devi Ahilya University Campus,
Khandwa Road, INDORE-452 001 (INDIA)

Reviewed the Course work of Pre Ph.D. (Energy and Environment) as per UGC Guideline

Revision in the syllabus of Pre Ph.D. (Energy and Environment) Course work was done in the different year in view of the UGC norms. All the modifications is summarized in the below table.

SN.	**2013-14 syllabus (Base year)** **Total credits: 15**	**2014-15 syllabus** **Total credits: 15**	**Percentage Changed on Cr. basis**
1		No Change	
2	**2014-15 syllabus** **Total credits: 15**	**2017-18 syllabus** **Total credits: 16**	
		Major changes have been taken in the syllabus. One new course (Advancement in Energy & Environment Systems & Technologies) was introduced in the Pre Ph.D. (Energy and Environment) Course work.	20%

(Chairman) **(Member)** **(Member)**

Dr. S. P. Singh
Head
School of Energy & Environmental Studies
Devi Ahilya University Campus,
Khandwa Road, INDORE-452 001 (INDIA)

PhD in Energy; Energy & Environment (Regular)

Year 2016

Pre PhD Syllabus

School of Energy & Environmental Studies
Devi Ahilya Vishwavidyalaya,
Takshashila Campus, Khandwa Road,
Indore-452 017(M.P)

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SCHOOL OF ENERGY AND ENVIRONMENTAL STUDIES
DAVV INDORE

PhD in Energy; Energy & Environment (Regular)

Course Code	Course Title	Credits
Ph.D-701	Research Methodology	4
Ph.D-702	Review of Published Research	3
Ph. D -703	Computer Applications	3
Ph. D -704	Advancement in Energy & Environment Systems & Technologies	3
	Comprehensive Viva-Voce	3
	Total	**16**

Ph D 701: Research Methodology

4 Credits (64 Hrs)

UNIT I

Foundation of Research : Motivation and objectives – Research methods V*s* Methodology. Types of research – Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.

UNIT II

Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

UNIT III

Theory of Sampling - Population and sample Preliminary Ideas of Random, Stratifies, Systematic and Multistage including allocation of resources- Parameter and statistics – Sampling distribution and standard Error.

UNIT IV

Theory of Testing Hypothesis: Meaning, Basic concepts, Null hypothesis – Alternate Hypothesis – Two types of errors levels of significance of a test – power of a Test. Limitations of Tests of hypothesis. Student T test, F test, Z test, ANOVA Table, Chi Square test est.

UNIT VI

Correlation and Regression – Persons Coefficient for Raw and frequency. Data - Spearman's Rank Correlation Coefficient – Regression lines and their use – curve fitting – principle of Least squares-fitting of straight line – length – weight Relationship and Bertrand Growth equation – operational Research and its application, Measurement in Research.

UNIT VII

Modeling Ecosystems- Population Dynamics, Models for single and interlinking, populations, stable points, Limit cycles, chaos, competition, prey predation.

UNIT VIII

Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling. Energy and Environmental System modeling

Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, formats of publications in Research journals.

Recommended Books:

1. Environmental systems- Benett R.J.
2. Studies in Environmental Mathematics- Sinha D.K. Mishra A.
3. Mathematical Modeling- Kapur S.N.
4. Research methodology Methods & Techniques - C R Kothari

Ph.D-702: Review of Published Research

Credits 3 (48 Hours)

Students suppose to prepare a Review Paper. Title of the review paper may be mutually decided by student and concern Supervisor. At the end of the Semester Review Paper needs to be presented in front of DRC.

Ph D – 703: Computer Applications: Energy Software

Credits 3 (48 Hours)

UNIT I: ENERGY MANAGEMENT INFORMATION SYSTEM (EMIS)

Introduction, Components, Design and Development issues, Concept of Energy Data, Energy Reporting, role of metering and measurement.

UNIT –II: USE AND APPLICATION OF OFFICE AUTOMATION TOOLS

MS office (MS Word, MS Excel, MS Power Point, MS Access), simulation of statistical models.

UNIT – III: TRNSYS & MATLAB

Introduction, use and application of various energy systems, designing and simulation Programs such as: PREBID, BIDWIN, PRESIM, TRNSHELL & TRNSED, Introduction, use and application of MATLAB.

UNIT – IV : DESIGN BUILDER & ENERGY PLUS

Introduction, DesignBuilder Interface**,** Create Building Geometry, Drawing Option ,Modal Options, Introduction to Modal Datas, Data Management, Exerciser on Geometry and Modal Data., Heating & Cooling Design Calculation, Simulation using Hourly Weather data, timing-schedules, profiles, Holidays. Glazing & Solar Shading, Delighting, Natural ventilation, Simple HVAC, Design Builder Compact HVAC.

UNIT – V : RET Screen & ECOTECT

Introduction and Modal Flow Chart, Energy Modal, Cost analysis, GHG Emission Reduction Analysis, Sensitivity and Risk Analysis.

Recommended Books

1. Turba, Information Technology, Wiley & Sons
2. Dennis P Curtin, Information Technology, TMH
3. Whitten, System Analysis & Design, TMH
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural
5. Resources Canada
6. Manuals of TRNSYS
7. Manuals of Design Builder
8. Computer and common sense- Roger Hunt and John Shelly.
9. Using MS –office 2000-Woody Leonhard.
10. The computer guide to MS –office-Ron Monsfield.
11. The complete ref, office 2000- Stephen L Nelson.
12. Learn DOS in a Day- Stulz

Ph D – 704: Advancement in Energy & Environment Systems & Technologies

Credits 3 (48 Hours)

UNIT I: Design of the Renewable energy conversion systems

Solar energy system, Bio-energy system, Introduction to wind energy system and its design aspect, Sterling engine, Green IC engine, Low wind machine, ETP plant

UNIT II: Process

Solar Energy: Solar cooker, solar concentrator, solar water heater, solar distillation

Biomass: Biomass to bio-methanation, Biomass to gasification, Biomass to Pyrolisation, Biomass to bio-diesel, Biomass to bio-alcohol, stabilization

Algae to alcohol, Algae to biodiesel, Algae to alcohol, Algae to bio hydrogen, Algae to biogas.

UNIT III: Mathematical Modeling

Thermal comfort conditions, Green building, components of buildings Cooling system, heating system, ventilation system, energy efficiency in building, Techno economic model

UNIT IV: System and Technology Development and Testing

Solar water heating, solar cooking system, Solar Distillation. Biomass gasifier, bio-gas plant, biodiesel Plant, Bio-alcohol Plant (thermal mode), ETP Plant

Reference Books:

1. Arceivala S.J., and Asolekar S.R "Wastewater Treatment for Pollution Control and reuse "McGraw Hill , third Edition, New Delhi, 2007.
2. Kaup and Goss (1984) “Small Scale Gas Producer Engine System” Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. Klaus von Mitzlaff, “Engines for biogas- theory, modification & economic operation” Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
4. K M Mital, Biogas System - Principles & Applications Published by new Age international (p) Ltd, New Delhi
5. Manual on “Sewerage and Sewage Treatment” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
6. Metcalf & Eddy, INC, Waste water Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
7. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980
8. Reed, T. B. and Das, A. (1988) “Hand book of biomass down draft gasifier engine systems”. Published by Solar Energy Research Institute, U.S. Dept. of Energy

Reviewed the curriculum of M Tech (Energy management) as per ordinance (31) by the Departmental Committee

Revision in the syllabus was done in the different year in view of the UGC norms, student feedback and Intentional/ National scenario. The content of the courses were separated or merged in the different courses as per the requirement. All the modifications of last five year is summarized in the below table.

SN.	**2013-14 syllabus (Base year) Total credits: 113**	**2014-15 syllabus Total credits: 120**	**Percentage Changed on Cr. basis**
1		• One new Course Computer Application: Energy & Environment Software of 4 credits was introduced • Sustainable development topic was added in Environmental Auditing and Environmental Impact Assessment.	6.19%
2	**2014-15 syllabus Total credits: 120**	**2015-16 syllabus Total credits: 84**	
		• Major changes has been taken in the syllabus • 36 credit (30%) has been reduced to meet the requirement of CBCS • Water and Waste Water: Pollution and Control Technologies & Air and Noise Pollution: Effects and Control Technologies have been merged and content is reduced to make it of 3cr. • Energy Auditing Techniques paper content has been merged in Energy Conservation (Electrical Systems) and content is reduced to make it of 3 credits. • Electrical Power Generation, Transmission and Distribution paper content has been merged in Instrumentation, Measurements and Controls and content is reduced to make it of 3 credits. Name was changed as Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution • Bio and Fossil Fuels Technology paper content has been merged in Solid Waste Management and content is reduced to make it of 3 credits. Name was changed as Bio & Solid Waste Management	30%
3	**2015-16 syllabus Total credits: 84**	**2016-17 syllabus Total credits: 84**	
		No change in the syllabus	0 %
4	**2016-17 syllabus Total credits: 84**	**2017-18 syllabus Total credits: 88**	
	Water and Waste Water: Pollution & Control Technologies & Air and Noise	This paper was changed into two papers of 6 credit (3 credit each) named as • Water and Waste Water: Pollution and Control Technologies • Air and Noise Pollution: Effects and Control Technologies	4.76%

P.T.O

	Pollution: Effects and Control Technologies were 3 credits.		
5	**2017-18 syllabus Total credits: 88**	**2018-19 syllabus Total credits: 96**	
	Total cr. of theory core courses was of 30 credits.	Total credit of theory core courses increased from 30 to 40cr.	9.09%

Reviewed the curriculum of M Phil (Energy and Environment) as per ordinance by the Departmental Committee

Changes in the courses of M Phil were done as per the decision of UGC/ Coordination committee of MP. All the modifications of last two year is summarized in the below table.

SN.	**2013-14 syllabus (Base year) Total credits: 60**	**2014-15 syllabus Total credits: 90**	**Percentage Changed on Cr. basis**
1	The duration of the course was one year	• The duration of the course was one and half years • All the papers and their credit were remain same except major project was 46 credits instead of 24 credits.	50%

R. Chaudhary

Dr. S. P. Singh
Head
School of Energy & Environmental Studies
Devi Ahilya University Campus,
Khandwa Road, INDORE-452 001 (INDIA)

Minutes of Board of Studies (BOS) Meeting

School of Energy & Environmental Studies, DAVV Indore, BOS meeting was held in the office at 3.0 pm on 30th April 2014.

The following Member were present

Prof. S.P. Singh, Head, SEES, D.A.V.V., Indore	: Chairman
Prof. R.N. Singh, SEES, D.A.V.V, Indore	: Member
Dr. Rubina Chaudhary, Reader, SEES, D.A.V.V, Indore	: Member

The following agenda was taken into consideration by the board member.

Agenda 1: Discussion on Modification of syllabus of M Tech (Energy Management) program.

Decision: It was anonymously decided that Revision in the syllabus was required. It was done in the view of the UGC norms, student feedback and Intentional/ National scenario. As per the 2013-14 syllabus was taken as a base for the revision of 2014-15 syllabus. In M Tech (Energy Management) syllabus:

- Computer Application: Energy & Environment Software of 4 credits course was introduced
- Sustainable development topic was merged with Environmental Auditing and Environmental Impact Assessment course.

Agenda 2: Discussion on course duration of M. Phil (Energy and Environment) program

Decision: As per the decision of UGC/ Coordination committee of MP the duration of the M. Phil (Energy and Environment) program was extend from one year to one and half years. All the papers and their credits were remaining same except major project was continued to 3rd semester (46 credits instead of 24 credits). Total credit of the program was made 90 credits.

(Chairman) **(Member)** 30-1-14 **(Member)** 30.4.2014.

Minutes of Departmental Committee Meeting

School of Energy & Environmental Studies, DAVV Indore, Departmental Committee meeting was held in the office of Head, SEES, DAVV, Indore at 4 pm on 6th July 2015.
The following Members were present

Dr. S P Singh - Chairman
Dr. R N Singh – Member
Dr. Rubina Chaudhary – Member
Ms. Monika Dubey, Student Representative

The following agenda was taken into consideration and approved by the Committee member.

Agenda 1: Implementation of Choice based Credit system and Credit based Semester System

Decision: In the reference of UGC DO No.F.1-1/2015 (CM), dated 8th January 2015; No.F.1-1/2014 (Secy), dated 20th January 2015 and MHRD Convened meeting off State education Ministers/Principal Secretaries, 6th January 2015, and Recommendation of DAVV working group formed by Honorable Vice- Chancellor, following decision was taken in Departmental Committee for the recommendation of BOS of School of Energy & Environmental Studies.

1. Department should have choice based credit system (CBCS) in every semester, in which there are 68 actual credits and 16 virtual credits in the complete span of the course of two years. From these 27 credits should accrue from core subjects, 09 credits from elective subjects/ inter disciplinary subjects, 12 credits from laboratory and 20 credits from project/ field based work/ Seminar.
2. Virtual Credits are 16 which the student has to earn through Comprehensive Viva Voce held after every Semester. Hence 04 virtual credits are given to each Comprehensive Viva Voce. From these 84 credits the credits for each subhead is given below. Detail syllabus for core and elective subjects are attached as Annexure 1.
3. It view of the modified University exam ordinance 31, whole syllabus is restructures and modified.

S. No	Type of Subject/ Activity	Code	Number of Subjects	Credit/ Subject	Total Credits
1	Core	EN-701 to EN-711	9	9 x 3=27	27
2	Elective	EN-712 to EN-714	3	3x 3	09
3	Laboratory	EN-801 to EN-804	4	4 x 3	12
4	Field Visit (Lab)	EN-805	1	3 x 1	03
5	Seminar	EN-806	1	1 x 1	01
7	Minor Project	EN-807	1	4 x 1	04
8	Major Project	EN-808	1	12 x 1	12
9	Comprehensive viva-vice	-	04	4 x 4	16
				Grand Total	**84**

24-8-15

The M Tech/M Phil Courses will be governed by the approved University Exam ordinance 31.
The meeting ended with thanks of chairman.

(Dr. S P Singh)
Chairman D C

Dr. R N Singh
Member

Dr. Rubina Chaudhary
Member 6/8/2015

Ms. Monika Dubey
Student
Representative

Minutes of Board of Studies (BOS) Meeting

School of Energy & Environmental Studies, DAVV Indore, BOS meeting was held in the office at 3.0 pm on 20th April 2017.

The following Member were present

Prof. R.N. Singh, SEES, D.A.V.V, Indore : Chairman
Prof. S.P. Singh, Head, SEES, D.A.V.V., Indore : Member
Dr. Rubina Chaudhary, Professor, SEES, D.A.V.V, Indore : Member

The following agenda was taken into consideration by the board member.

Agenda 1: Discussion on Modification of syllabus of M Tech (Energy Management) program.

Decision: It was anonymously decided that Revision in the syllabus was required. It was done in the view of the, Student and Industrial feedback. For the better understanding & clarity of subject, in 2016-17 M Tech (Energy Management) syllabus, Water and Waste Water: Pollution & Control Technologies & Air and Noise Pollution Effects and Control Technologies, course was changed into two courses of 6 credit (3 credit each). Named of the courses

- Water and Waste Water: Pollution and Control Technologies
- Air and Noise Pollution: Effects and Control Technologies

20-4-17
(Chairman)

(Member)

(Member)
20.4.2017

Board of Studies Meeting was held on Friday, 5th May 2018 at 3.00 PM at RNT Marg, D.A.V.V, Indore

The Following Members were present:

Prof.R.N. Singh, SEES, D.A.V.V, Indore	: Chairman
Prof. S.P.Singh, Head, SEES,D.A.V.V., Indore	: Member
Dr.S.C.Sharma ,Director, Acropolis,Indore	: Expert member
Dr Rubina Chaudhury, Reader, SEES, D.A.V.V, Indore	: Member

The Item wise minutes of the meeting are as under

Chairman welcomed all BOS members and present agenda items for discussion.

Agenda item no.1:

- Modification in **the Syllabus of M.Tech**(Energy and Environment Management) and M.Tech.(Energy Management) as per the revised ordinance 14 for the session 2018-2019 onwards.

Agenda item no.2:-

- **Revision in the syllabus of MBA (Energy Management)Distance learning Programme as per the UGC letter**

Agenda item no.3:-

- **M.Tech (Energy Management) for working Executive will be started in the session 2018 onwards.**

Decision:

M.Tech (energy and Environment management) and M.Tech EnergyManagement) The modification was made in the credits system, previously 88 credits are evaluated instead of 96 credits including 16 virtual credits (copy of syllabus is attached) for the reference.

MBA (Energy Management) the total credits was 124 instead of 133 , field visit and comprehensive viva voce examination was not required as per the UGC.The major project duration is 18 credits instead of 20 credits.The examination and assignment is followed as per the revised ordinance 31.

MTech (Energy Management) for working executive is started in the coming session . syllabus and number of seats will be decided in the due time.All the requirement is followed by ordinance 14.

The meeting ended with vote of Thanks to Chairman. (Copy of modified syllabus is attached)

(Chairman) 5-5-18 (Member) 5-5-18 (Member) 05/5/18 (Member)

(Member)

5-5-18

(Dr. S.C. SHARMA)

M. TECH. ENERGY MANAGEMENT (REGULAR)

YEAR 2013-2015

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,

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SCHOOL OF ENERGY AND ENVIRONMENTAL STUDIES
DAVV INDORE

M.TECH. (ENERGY MANAGEMENT) 2013-2015
TWO YEARS COURSE STRUCTURE

COURSE	COURSE TITLE	Credits	Hours	Semester
	Core Theory Course			
EN-701	Solar Energy: Fundamentals, Devices and Systems	3	48	I
EN-702	New and Renewable Energy Sources and Technologies	3	48	I
EN-703	Heat Transfer And Process Integration	3	48	II
EN-704	Engineering Thermodynamics : Quality & Quantity Aspects	1½	24	II
EN-705	Water and Waste Water: Pollution and Control Technologies	3	48	I
EN-706	Air and Noise Pollution: Effects and Control Technologies	3	48	I
EN-707	Energy Conservation (Thermal Systems)	3	48	II
EN-708	Energy Conservation (Electrical Systems)	3	48	II
EN-709	Energy Auditing Techniques	1½	24	I
EN-710	Environmental Auditing and Environmental Impact Assessment	3	48	II
EN-711	Energy Modeling and Project Management	3	48	II
	Other Theory Courses			
EN-712	Efficient Lighting: Sources, Systems and Design Aspects	3	48	II
EN-713	Green Building Technologies	3	48	II
EN-714	Electrical Power Generation, Transmission and Distribution	3	48	I
EN-715	Global and Indian Energy Scenario	1½	24	I
EN-716	Instrumentation and Measurements and controls	3	48	I
EN-717	Computer Applications: Energy Software	3	24	II
EN-718	Bio and Fossil Fuels Technology	3	48	II
EN-719	Energy Conservation Opportunities in Process of Designated Industries (Self Study)	3	48	III
EN-720	Solid Waste Management	3	48	III
EN-721	Sustainable Development	3	48	III
	TOTAL CREDITS (THEORY)	57		
EN-801	Energy Conservation Laboratory	3	48	III
EN-802	Heat Transfer Laboratory	3	48	II
EN-803	Biomass/Biogas laboratory	3	48	II
EN-804	Solar Thermal and Photo - Voltaic Laboratory	3	48	II
	TOTAL CREDITS (LABORATORY)	12		
EN-805	Field Visits	6	-	II
EN-806	Seminar	3	-	I
EN-807	Digital Video Review	3	-	II
EN-808	Mini Project	12	-	III
EN-809	Major Project	26	-	IV
	TOTAL CREDITS (OTHERS)	50	-	
	GRAND TOTAL	120.5		

EN 701: Solar Energy: Fundamentals, Devices and systems

Credits: 3 (48Hours)

UNIT I

Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II.

Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III.

Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow and Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.

Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**

Solar Power Generator

i. Solar Thermal Power Generation	: Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	: Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	: Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	: Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 3 (48 hours)

UNIT - I

Wind Energy:

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, wind Farms, wind mills & their applications, Cost economics, case studies. 12

UNIT - II

Small Scale Hydroelectric (Mini And Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems. Hydrolic Ram and its Applications 06

UNIT - III

Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues. (06)

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies. (06)

UNIT - IV

Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems) and Application areas, Hydrogen energy production, storage & application. (06)

UNIT - V

Direct Energy Conversion

MHD Generators Basic, Principle of MHD, Open Cycle and Closed Cycle MHD Technologies, Applications Advantages & Disadvantages. (04)

Fuel Cells

Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration (04)

UNIT – VI

Hydrogen Energy

Production**,** Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications. (04)

Recommended Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E& FN Spon (1986).

2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).

3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.

4. E.R. Berman, Geothermal Energy;'Noyes DATA Corpor_tion, New Jersey, 1975.

5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.

6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.

7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963

8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.

9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980

10. D.L. Wise, Fuel Gas Production trom biomass Vol. I-IV, CRC press, Boca Raton.

11. F. Kreith, Handbook of Solid waste Management, McMillan Inc.

12. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, VoL 2, solid waste processing & recovery. The Humane press, Cliton, New Jersey.

13. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.

14. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.

15. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994.

16. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy

17. Leon freris- Renewable energy

18. Da Rosa – Fundamental of renewable energy

EN-703: Heat Transfer and Process Integration

Credits: 3 (48 hours)

Unit I

Basic Heat Transfer Concept And Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction:

Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection:

Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation :

Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting , Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M.Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)

EN – 704: Engineering Thermodynamics: Quantity and Quality Aspects

Credits: 1½ (24 Hours)

UNIT I

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

UNIT II

The First Law of Thermodynamics:
Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:
Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

UNIT III

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium
Thermodynamics Analysis of Process

Reference Books

7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (:znd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-705: Water and Waste Water: Pollution and Control Technologies

3 Credits (48 hours)

UNIT I

Fundamentals: Definition, Classification, Sources Water quality Standards.

Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants. (8)

Water Treatment: Surface water: Water Purification Processes In Natural Systems (Physical, Chemical, Bio-Chemical Processes) And Its Application, Response Of Stream To Bio-Degradable Organic Wastes. (4)

UNIT II

Water Treatment Methods: Principles and Design

Unit Operations – Aeration Systems

Sedimentation – types of settling and settling equations, design criteria and design of settling tanks.

Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.

Filtration – theory, types, filter backwash, operational problems and trouble shooting. (10)

UNIT III

Unit processes.

Water Softening- Principles and design- Ions causing hardness, various methods. (2)

Waste Water Treatment : Principles and Design

Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis. (2)

Mass Loading Factors, Impacts, Estimation And Their Unit Loading. (4)

UNIT IV

'**Principle of Biological Treatment**; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency. (4)

Theoretical principles and design

Aerobic Suspended Growth Systems

Activated Sludge, Aerated Lagoon, (8)

Principles and design of stabilization ponds

Aerobic Attached Growth

Trickling Filters, (2)

UNIT V

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants (4)

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. (2)

Numerical problems

Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
7. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. "Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
11. "Manual on Sewerage and Sewage Development", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.

EN-706: Air and Noise Pollution: Effects and Control Technologies

3 Credits (48 hours)

UNIT I

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control. (08)

UNIT II

Air Pollution & Control: Definition, Air Quality, Classification Of Air Pollutants, Air Pollution Episodes.

UNIT III

Air Pollution Monitoring

Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_2, No_x, CO, Oxidants and Ozone.

UNIT IV

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths.

Air pollution control technologies for particulates and gaseous contaminants.

Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT V

Global Concerns

Light Pollution

Thermal Pollution (08)

Recommended Books

1. Understanding Environmental Pollution Marquita K.
2. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
3. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
4. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
5. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
6. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
7. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
8. T K Ray, Air Pollution Control in Industries , Vol-1,2
9. J.N.B, Air Pollution and Plant Life.
10. Robert Jennings Heinson, Air Pollution.

EN- 707: Energy Conservation (Thermal Systems)

3: Credits (48 hours)

UNIT I

Fuel Analysis

Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces

Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractories

Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractories, Case Studies.

UNIT III

Boilers:

Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers:

Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System:

Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration

Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery:

Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.

Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies. (6)

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.

5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta , Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar , Anderlind , A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman , Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 708: Energy Conservation (Electrical Systems)

3 Credits (48 hours)

UNIT I

Electrical Systems and bill analysis: ECO (Energy Conservation Opportunities)

Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill/Bill Analysis: ECO (Energy Conservation Opportunities)

Electricity billing, electrical load management, maximum demand control.

Power Factor:

Power factor, improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors.

Lighting Systems:

Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.

UNIT II

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).

Transformers and Electric Distribution:

Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT IV

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

UNIT V

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System:

Factors affecting selection, Energy performance assessment of diesel conservation avenues

Cooling Tower:

Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities

EN –709: Energy Auditing Techniques
Credit 1½ (24 Hours)

UNIT I

Energy Audit

Definition, Need and Objectives.

Types of Energy Audit

Internal Audit, External Audit, Walk through Energy Audit, Preliminary Energy Audit, Detailed Energy Audit, Investment Grade Energy Audit, Industrial Energy Audit, Utility (Services) Energy Audit, Commercial Energy Audit, Residential Energy Audit.

UNIT II

Energy Audit Strategies

Monitoring and Control, Questioning the Need, Minimizing the Need of End Use, Minimizing the Losses, Operating the Equipment at Optimum Efficiency, Operating the Most Efficient Equipments from Set of Equipments, Minimizing the Idle Redundant Running, Proper Maintenance of the Equipment, Substitution with Efficient Equipment, Substitution with more Efficient Equipment, Substitution with more Efficient Process, Energy Storage, Fuel Substitutions, Quality Control and Recycling.

Basic Components of Energy Audit

Preparing for Audit Visit, Instrumentation, Data Collection Techno-economic Analysis, Safety Considerations.

UNIT III

Energy Audit Instruments

Combustion Analysis, Temperature Management, Pressure Measurement, Flow Measurement, Humidity Measurement, Energy and Power Measurement, Light Level Measurement, Infrared Equipment, Tachometer & Stroboscope, P.F. Meter, Ultrasonic flow meter, and Steam & Air Leak Detector.

UNIT IV

Important Survey Items

Buildings, Lightings, HVAC, Furnaces & Ovens, Boilers and Steam Lines, Air Compressor and Compressed Air Distribution Lines, Chillers and Chilled Water Distribution Lines, Process Water Generation and Distribution Lines, Electrical Distributions Transformers and Lines, Pumps, Fans and Blowers, Cooling Towers, Electrical Motors, Waste Heat Sources, Material Transport, Peak Load Equipments.

UNIT IV

Methodologies of Conducting Energy Audit

Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Post Audit Analysis

Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures, Outlines of Energy Audit Report Format

Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA.
Useful Forms for Data Collections.
Useful Charts for Quick Estimations.
Checklists for each Devices and Distribution Lines.
Thumb Rules and Specific Energy Indices for Devices and Processes

Case Studies

Recommended Books

1. Instructions to Energy Auditors, Vol. - I & Vol. - II –
   National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
2. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
3. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
4. BEE VolumeI –Second Edition 2005
5. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN –710: Environmental Auditing Techniques and Environmental Impact Assessment

1½ Credit (24 Hours)

UNIT I

Elements of Environmental Impact Assessment: Introduction

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA (08)

UNIT II

The Interlinking

Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries. (08)

Case Studies (08)

Concepts of the Environmental Audit

UNIT III

Definition, Benefits, Objectives.

Legislation

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments.

Need for Environmental Audit
Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.
- Control Mechanism
    - Waste water reduction

        - Air emission reduction
    - Preparation of Audit Report
    - Form V Case Studies

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 711: Energy Modeling & Project Management.

3 Credits (48 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets:

Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing:

Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning:

Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis. Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management:

Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Project Management:

Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring. Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Financial Management:

Investment-need, Appraisal and criteria, Financial analysis techniques-Simple pay back period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs. and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Network Analysis:

PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.
10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. roductivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN – 712: Efficient Lighting: Sources, Systems And Design Aspects

3 Credits (48 Hours)

Unit I

Lighting (6)

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II

Eye (6)

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic (3)

Correlated Colour Temperature Glare, Brightness, Contrast, Colour Rendering, Photometric Analysis.

Unit III

Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's (9)

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement (9)

Unit IV

Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard. (8)

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 713: Green Building Technologies

3 Credits (48 Hours)

Unit I

Green Building Design Strategies and Building Codes:

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II

Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense

Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV

Heat Transmission in Buildings:
Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V

Modeling of Building: Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application.

ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments,

Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.

Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology

Case Studies

Recommended Books

1. M.S.Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN - 714: Electric Power Generation Transmission and Distribution
Credits 3 (48 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

Unit II

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phasor Diagram Power in Balanced Three-Phase Circuit.

Types of Conductors, Skin Effect, Corona Losses, Basics of Transmission & Distribution System, Layout of Substation and Component of Substation.

Impedance of Transmission Lines, Capacitance of Transmission Lines, Representation of Power Systems. Bundle Conductors.

Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit III

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses.

Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power,Danpat Rai and Sons. .
   Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
4. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
5. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
6. Nuclear Energy By Raymond L. Murray 6th Edition (2008)

EN-715: Global and Indian Energy Scenario

Credits 1½ (24 Hours)

Unit I

Introduction:
Role of energy in Socio-economic development: Energy & Socio-economic aspects.

Global Scenario of Energy:
Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands.

Unit II

Energy Resources:
Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc. World Reserves of fossil fuels and their possibility of substitution by other fuels

Unit III

Energy Security:
Energy for security and Energy needs and demands of developing countries Security of Energy,

Future Energy Options:
Sustainable Development, Energy Consumption and its impact on environmental climatic change.

Unit IV

Indian Energy Scenario
Energy resources & Consumption:
Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption

Unit V

Energy Needs of Growing Economy:
Sector-wise need of energy for economic growth

Energy and Environment:
Energy Consumption and its impact on Environment, Role of Renewable Energy sources in Sustainable development.

Energy Policy Issues
Reforms in Energy

Recommended Books and relevant Literature site

1. TERI Energy Data Year Books.
2. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council
3. Statistics have been drawn from BP Statistical Review of World Energy, June 2003, International Energy Outlook, March 2002, Energy Information administration, Office of integrated analysis and forecasting, US department of energy, Washington
4. Planning commission statistics
5. The Energy and Resources Institute (TERI)
6. www.bp.com/centres/energy
7. www.eia.doe.gov
8. www.epa.org
9. Bureau of Energy Efficiency- Volume 1

EN- 716: Instrumentation, Measurements and Control

Credits: 3
(48 Hours)

UNIT - I

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer, classification and selection of transducers.

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, pressure measurement: manometers; diaphragm, below elements. Introduction to vacuum gases, Bendron tube, Introduction of capacitive and Inductive transducer.

UNIT - II

Temperature measurement: Thermocouples, RTCs, Thermistors, Radiation and ptical pyrometry, flow measurement: pitot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

UNIT - III

Registers, Memories, microprocessor 8085: Block diagram, Pin out Diagram, Fetching and Executing Instructions, B.C. D Arithmetic 16 bit data operations.

UNIT - IV

Control systems: Feedback and non-feed back systems, feedback characteristics of control system. Block diagram, flow graph, Mason gain formula, regenerative feed back. Introduction to PID control, Hydraulic v/s Pneumatic Systems,

Stability analysis of control systems, Rentu Hermit's criteria on Root loci, relative stability.

Case Studies

Recommended Books

1. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
2. Krishna kant, Micro – Processors Data Acquisition.
3. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
4. I.J. Nagrath and M. Gopal, Control Systems Engineering, Wiley Eastern Ltd., New Delhi (1990).
5. S. Malvino, Digital Computer Electronics, Tata McGraw Hill, New Delhi.
6. Doeblin – Measurement System McGrew Hill Book Co., (1981).
7. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
8. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
   Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut

EN – 717: Computer Applications: Energy Software

Credits 1½ (24 Hours)

UNIT – I:

TRNSYS

Introduction, Use and application of various Energy System designing and simulation Programme. PREBID, BIDWIN, PRESIM, TRNSHELL & TRNSED. (5)

UNIT – II

DESIGN BUILDER

Introduction, DesignBuilder Interface**,** Create Building Geometry, Drawing Option ,Modal Options, Introduction to Modal Datas ,Data Management, Exerciser on Geometry and Modal Data., Heating & Cooling Design Calculation, Simulation using Hourly Weather data, timing- schedules, profiles, Holidays. Glazing & Solar Shading, Delighting, Natural ventilation, Simple HVAC, Design Builder Compact HVAC. (5)

UNIT – III

RET Screen &ECOTECT

Introduction and Modal Flow Chart, Energy Modal, Cost analysis, GHG Emission Reduction Analysis, Sensitivity and Risk Analysis. (5)

UNIT IV

ENERGY MANAGEMENT INFORMATION SYSTEM (EMIS)

Introduction, Components, Design and Development issues, Concept of Energy Data, Energy Reporting, role of metering and measurement etc. (5)

UNIT –V

USE AND APPLICATION OF OFFICE AUTOMATION TOOLS

Like MS Office (MS Word, MS Excel, MS Power Point, MS Access), Lotus Notes etc. (4)

Recommended Books

1. Turba, Information Technology, Wiley & Sons
2. Dennis P Curtin, Information Technology, TMH
3. Whitten, System Analysis & Design, TMH
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada
5. Manuals of TRNSYS
6. Manuals of Design Builder

EN- 718: Bio and Fossil Fuels Technology

Credits 3 (48 hours)

Unit I

Biomass & Biomass management

Biomass availability, Characteristics of Biomass or organic wastes, Energy Plantation.
Waste Biomass /Organic utilization Technology options.
Potential, Process and technologies, characteristics of Briquettes and their use

Unit II

Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of Feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & Gas storage systems.

Unit III

Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output Gas production, properties of output gases (mainly producer gas), Design of criterion, design of a Gasifier.
Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV

Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications. Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V

Solid Fuels:

Clean coal technology, Underground combustion and gasification of coal, Carbon Capture and storage

Liquid Fuels: D G set for generation of Electricity

Gaseous Fuels:

Natural gases, methane from coal mines, manufactured gases, producer gas, water gas, biogas, refinery gas, LPG; Cleaning and purification of gaseous fuels.

Case Studies

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi

2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.

3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore

4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy

5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi

6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden

7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.

8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co.Ltd. 1984

9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,

10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988

11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.

12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990

13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984

EN –719: Energy Conservation opportunities In Process Of Designated Industries

Credits 3 (48 hours)

Industrial/Commercial Buildings

Buildings Envelope and Load reduction techniques, Utilities,.

Case Studies: Green building, Energy efficient building etc

Energy Saving Measures In Energy Intensive Process Industry

Pulp and Paper, Sugar, Textile, Fertilizer and Textile and their Case Studies.

Chemical, Petroleum Refineries, Petrochemical Processes, Chlor-Alkali and their Case Studies.

Aluminum, Iron and Steel, Cement and their Case Studies.

Railways, Ports, Transport Sector, Power Stations and their Case Studies.

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi
9. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
10. Carig,B. Saith, Energy Management Principles, Applications, Benefit and Saving, Per n Press, New York.
11. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
12. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
13. N.L Lens, Waste gas Treatment for Resource Recovery.
14. S.N.Ghosh and Yadav, Energy conservation and environment control and cement industries.

EN -720: Solid Waste Management

Credit 3 (48 hours)

Unit I
Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation And Environmental Impact. (06)

Unit II
Generation And Disposal Methods

Resources, Disposal and Recovery, Material and Products in Solid Waste. (06)

Unit III
Characterization Of Different Types Of Solid Waste

Municipal Solid Waste, Agro – Waste, Others (08)

Unit IV
Hazardous Waste

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Unit V
Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration Technology, Incineration, Landfill, Refused Derived Fuels (08)

Case Studies (06)

Recommended Books

1. "Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
2. Handbook of Environmental Engineering Vol. 2, Lawrence K. Wang and Worman C. Pereira, THE HUMAN Press, Clifton, New Jersey, (1990)
3. Hazardous Waste Management – Charles A. Wentz
4. T V Ramchandra- Management of Municipal Waste

EN 721: Sustainable Development

3 Credits (48 Hrs)

UNIT I

Introduction to Sustainability: Criteria, Definitions, Challenges of Sustainability, Meaning of The Brundtland Commissions:Principles, perspectives, Inter generational and intra generational Equity, Agenda 21, Earth Summit – 1972, Vienna Convention – 1985, Montreal Protocol,

UNIT II

Kyoto Protocol, Conference of Parties (COP), UNCED Rio Earth Summit – 1992, UNCED Rio Earth Summit – 1992, Rio Earth Summit + 5, Johannesburg Summit 2002. Environment, Economics and Ethics–Dimensions of Sustainable Development. Prototype Carbon Fund (PCF). Rio Earth Summit +20

UNIT III

Concept and definition: climate and climate change, component of climate system, greenhouse gases and their effect source of green house gases: sources effects and factors.
Convention: the UN convention on climate change (UNFCCC), IPCCC, UNEP, UNDP: Objectives and goals

UNIT IV

World scenario: Effects of greenhouse gases on the continents of the world (Sea level temperature, Agriculture, human health, forestry, ecosystem and water resource world population) and techno economic analysis (GDP) gross domestic production.

UNIT V

Review of ISO 14001 in Environmental Management.

Environmental Aspects/Impacts, Performance, Continual improvement, Interested parties, Elements of ISO 14001 According to Deming, Environmental Policy, Planning, Implementation, Checking/Corrective Action, Management Review.

Assembly of Company Environmental Policy Statements.

Recommended Books

1. Clean Development Mechanism, reference two Winrock international India.
2. Sustainable Development in practices, Case Studies for engineering and Scientist, Editor Adisa azapagic, Slobodan perdan, ronald clift, Jhon Wiley (2004).
3. UNFCCC. 2007. Database on local coping strategies. http://maindb.unfccc.int/public/adaptation/
4. Pandey G.N. 1997, Environmental Management, Vikas Publishing House Pvt. Ltd.

EN – 801: Energy Conservation Laboratory

Credits 3 (48 Hours)

1. Determine the Ultimate analysis of the given sample.
2. Determine the proximate analysis of the given sample.
3. Determine the calorific value for the given sample.
4. Determine the percentage of excess air required for given fuel.
5. Determination of Stack Gas Composition by flue gas analyzer:
    a) Percentage of CO_2 or O_2 in flue gas.
    b) Percentage of CO in flue gas
    c) Temperature of flue gas.
6. Determine the water parameter:
    a) Total dissolved solids (TDS)
    b) pH
7. Determine the radiation & convection loss of the given surface.
8. Determine the heat loss due to the opening in boiler or furnace.
9. Determine the motor loading by following method:
    a) Input Power Method
    b) Line Current Method
    c) Slip Method
10. Determine the Efficiency of the motor by field test method.
11. Determine the Efficiency of the given fan.
12. Determine the Efficiency of the given Blower.
13. Calculate the actual free Air Delivery (FAD) & Percentage of Leakages of a given air compressor system.
14. Determine the Pump Efficiency of the given pump.
15. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition unit:
    a) Window AC (Conventional)
    b) Split AC (Conventional)
    c) Split AC (Energy Efficient AC)
16. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
17. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
18. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.

EN – 802: Heat Transfer Laboratory

Credits 3 (48 Hours)

1. To determine the heat transfer coefficient in natural convection.
2. To measure the heat transfer coefficient in forced convection.
3. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
4. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode. (Water to water)
5. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode. (Water to air)
6. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode. (Shall and Tube)
7. To determine heat transfer coefficient for drop and film wise condensation.
8. To study the pool boiling phenomenon and to determine critical heat flux.
9. To determine the performance heat pipe.
10. To study and calibrate the thermocouples.
11. To determine Stefan Boltzmann constant of radiant heat transfer.
12. To measure the emissivity of the test surface in comparison to black surface.
13. Effectiveness of a heat exchanger with storage
14. To determine thermal conductivity of a metallic rod.
15. To determine thermal conductivity of an insulating power.
16. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 803: Biomass/Biogas Laboratory

Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids & volatile Solids for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
5. Determination of Chemical Oxygen Demand for a Given Slurry or Liquid Sample.
6. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
7. Determination of Fats/oil Content in a given oil seed Biomass Sample.
8. Determination of Carbohydrates in a given organic Biomass Sample.
9. Determination of Calorific Value of a solid and liquid Biomass Sample.
10. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
11. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
12. To study the Demonstration & Working of Gas Chromotograph and its use for Analysis of Different Environmental Parameters.
13. Determination of Lignin, Cellulose, Hemicellulose in a Given Biomass a Sample.
14. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
15. Determination of Crude Protein in a Given Biomass Sample.
16. Study of Gasifier and its performance evaluation.
17. Characterization of liquid biomass and its comparison with diesel
18. Preparation of bio-diesel and determination of it physical properties
19. Performance study of CI engine with different fuel
20. Preparation of alcohol and its Performance study with SI engine

EN - 804: Solar Thermal and Photovoltaic Laboratory

Credits 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. To Determine the Heat Loon Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built In Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker Determination of First and Second Figure of Merit.
6. Performance Evaluation of a Single Basin Solar Still.
7. Concentrated Solar Cooker: Determination of F_0 and FU_l.
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Performance evaluation of wind generators.

PHOTOVOLTAIC

1. Power Load Characteristic of a Photovoltaic Cell.
2. Power Output Vs Exposed Area.
3. Power Output Vs Azimuthal and Tilt Angle
4. Spectral Response of a PV Cell.
5. PV System Performance
6. To Study the Effect of Solar Irradiance on Module Output.
7. To Study the Effect of Temperature on Module Output.

Annexure 1

M. Tech. Energy Management (Regular)

Year 2014-2016

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,

Indore-452 017(M.P)

Ph: 0731-2460309, 2462366, Fax: 0731-2467378

Web: www. dauniv.ac.in

M.TECH. (ENERGY MANAGEMENT) 2014-2016

Eligibility Graduate Degree in Engineering or M Sc. Physics with minimum of 55% marks
Duration 4 Semesters
Seats 18

COURSE	COURSE TITLE	Crs.	Hrs	SEM	Faculty
Core Theory Course		L+T+P			
EN-701	Solar Energy: Fundamentals, Devices and Systems	3+1+0	64	I	SPS/ PS
EN-702	New & Renewable Energy, Sources and Technologies	3+1+0	64	I	RNS
EN-703	Engineering Thermodynamics, Heat Transfer and Process Integration	3+1+0	64	II	SPS/PS
EN-704	Pollutions (Air, Noise, Water and Waste Water) and Control Technologies	3+1+0	64	II	RC
EN-705	Energy Management (Thermal)	3+1+0	64	III	SPS
EN-706	Energy Management (Electrical Systems)	3+1+0	64	III	RS/BB
EN-707	Efficient Lighting: Sources, Systems and Design Aspects	3+1+0	64	III	RS/BB
EN-708	Green Building Technologies	3+1+0	64	II	SPS
EN-709	Bio and Solid Waste Management	3+1+0	64	II	RNS
Elective Theory Courses					
EN-710	Sustainable development, Environmental Auditing and Environmental Impact Assessment	4+0+0	64	II	RC
EN-711	Energy Modeling and Project Management	3+1+0	64	II	RNS/ PS
EN-712	Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution	3+1+0	64	I	RS/BB
EN-713	Energy Conservation Opportunities in Process of Designated Industries	3+1+0	64	III	RS
EN-714	Computer Application: Energy & Environment Software	1+1+2	64	III	SR
	TOTAL CREDITS (THEORY)	**56**	896		
EN-801	Heat Transfer and Energy Conservation Laboratory	3	48	I	RNS/RS
EN-802	Biomass and Environmental laboratory	3	48	II	SPS/RC
EN-803	Solar Thermal and Photo - Voltaic Laboratory	3	48	II	SPS/PS
	TOTAL CREDITS (LABORATORY)	**09**	144		
EN-805	Field Visits	3	-	I &III	
EN-806	Seminar	3	-	I	SR/ RS/BB
EN-807	Digital Video Review	3	-	II	Nilam
EN-808	Mini Project	09	-	III	SPS/RNS / RC
EN-809	Major Project	25	-	IV	SPS/RNS / RC
	Comprehensive Viva-vice	12(4+4+4)	-	I+ II+ III	
	TOTAL CREDITS (OTHERS)	**44**	-		
	GRAND TOTAL	**120**			

CORE THEORY COURSE

EN 701: Solar Energy: Fundamentals, Devices and Systems

Credits: 4 (64 Hours)

UNIT I

Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II.

Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III.

Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow & Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.

Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**

Solar Power Generator

i. Solar Thermal Power Generation	:	Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	:	Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	:	Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	:	Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 4 (64 hours)

Unit I

World Energy Scenario:

Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Sustainable Development, Role of Renewable Energy sources in Sustainable development, Energy Consumption and its impact on environmental climatic change.

Indian Energy Scenario:

Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

UNIT - II

Wind Energy:

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, Wind Farms, wind mills & their applications, Cost economics, case studies.

UNIT - III

Small Scale Hydroelectric (Mini & Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems, Hydrolic Ram and its Applications.

UNIT - IV

Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

UNIT - V

Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems) and Application areas, Hydrogen energy production, storage & application.

UNIT - VI
Direct Energy Conversion
Fuel Cells
Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration .

Hydrogen Energy
Production**,** Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Recommended Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E & FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy; 'Noyes DATA Corporation, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980
10. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy
11. Leon freris- Renewable energy
12. Da Rosa – Fundamental of renewable energy
13. TERI Energy Data Year Books.
14. Planning commission statistics
15. www.bp.com/centres/energy
16. www.eia.doe.gov
17. www.epa.org
18. Bureau of Energy Efficiency- Volume 1

EN-703: Engineering Thermodynamics, Heat Transfer and Process Integration

Credits: 4 (64 hours)

Unit I

Basic Heat Transfer Concept and Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction:

Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection:

Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation:

Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting, Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

UNIT V

Engineering Thermodynamics: Quantity and Quality Aspects

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

The First Law of Thermodynamics:

Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:

Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium, Thermodynamics Analysis of Process

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M.Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)
7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (2nd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-704: Pollutions and Control Technologies

Credits 4: (64 hours)

UNIT I

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

UNIT II

Air Pollution & Control: Definition, Air Quality, Classification Of Air Pollutants, Air Pollution Episodes, Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_x, NO_x, CO, Oxidants and Ozone.

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths. Air pollution control technologies for particulates and gaseous contaminants. Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT III

Fundamentals: Definition, Classification, Sources Water quality Standards.
Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants.
Water Treatment: Surface water: Water Purification Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) And Its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT IV

Water Treatment Methods: Principles and Design

Unit Operations – Aeration Systems
Sedimentation – types of settling and settling equations, design criteria and design of settling tanks.
Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.
Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT V

Water Softening- Principles and design- Ions causing hardness, various methods, Principles and Design of Waste Water Treatment device.
Objectives of wastewater treatment**,** characteristics, flow variations, types of reactors and reactors analysis, Mass Loading Factors, Impacts, Estimation and their Unit Loading.

UNIT VI

'**Principle of Biological Treatment**; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency, Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Trickling Filters.

UNIT VII

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
7. Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
11. Manual on Sewerage and Sewage Development", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.
12. Understanding Environmental Pollution Marquita K.
13. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
14. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
15. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
16. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
17. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
18. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
19. T K Ray, Air Pollution Control in Industries , Vol-1,2
20. J.N.B, Air Pollution and Plant Life.
21. Robert Jennings Heinson, Air Pollution

EN- 705: Energy Management (Thermal)

Credits 4: (64 hours)

UNIT I

Fuel Analysis

Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces

Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractory

Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractory, Case Studies.

UNIT III

Boilers:

Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers:

Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System:

Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration

Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery:

Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.

Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta, Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar, Anderlind, A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman, Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 706: Energy Management (Electrical)

Credits 4: (64 hours)

UNIT I

Energy Auditing Techniques: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

Material and Energy Balance: Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used,

Methodologies of Conducting Energy Audit: Preliminary & Detailed Energy Audit Methodology: Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Energy Audit Report: Outlines of Energy Audit Report Format, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures,

Government Notification & Scheme: Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA, Useful Forms for Data Collections, Useful Charts for Quick Estimations, Checklists for each Devices and Distribution Lines, Thumb Rules and Specific Energy Indices for Devices and Processes

UNIT II

Basic Electrical Systems: Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill Analysis: ECO (Energy Conservation Opportunities)

Electricity tariff and components, load Management & Demand Side Control, power factor improvement & its benefit, selection and location of capacitors, Performance Assessment of capacitors & Capacitor Bank.

Lighting Systems: Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.

Transformers and Electric Distribution: Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).

Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT V

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

Cooling Tower: Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

UNIT VI

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System:

Factors affecting selection, Energy performance assessment of diesel conservation avenues

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities
14. Instructions to Energy Auditors, Vol. - I & Vol. - II –
15. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
16. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
17. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
18. BEE VolumeI –Second Edition 2005
19. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN – 707: Efficient Lighting: Sources, Systems And Design Aspects

Cr. 4 (64 Hours)

Unit I

Lighting

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II

Eye

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic

Correlated Color Temperature Glare, Brightness, Contrast, Color Rendering, Photometric Analysis.

Unit III

Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement

Unit IV

Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard.

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 708: Green Building Technologies

Cr. 4 (64 Hours)

Unit I

Green Building Design Strategies and Building Codes:
Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II

Thermal Comfort:
Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense
Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV

Heat Transmission in Buildings:
Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V

Modeling of Building: Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application.
ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments,
Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.
Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology
Case Studies

Recommended Books

1. M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN- 709: Bio and Solid Waste Management

Credits 4 (64 hours)

Unit I

Biomass & Biomass management

Biomass availability, Characteristics of biomass or organic wastes, Energy Plantation, Waste Biomass/Organic utilization Technology options, Potential, Process and technologies, characteristics of Briquettes and their use.

Unit II

Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & gas storage systems.

Unit III

Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output gas production, properties of output gases (mainly producer gas), Design of a Gasifier.

Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV

Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications.

Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V

Characterization of Different Types of Solid Waste

Municipal Solid Waste, Agro Waste, Others.

Hazardous Waste:

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation and Environmental Impact.

Unit VI

Waste Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration technology, Incineration, Landfill, Refused Derived Fuels.

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi
2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore
4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy
5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi
6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.
8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co. Ltd. 1984
9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,
10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988
11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.
12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984
14. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid waste processing & recovery. The Humane press, Cliton, New Jersey.
15. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.
16. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.
17. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994
18. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
19. Hazardous Waste Management – Charles A. Wentz
20. T V Ramchandra- Management of Municipal Waste

ELECTIVE THEORY COURSES

EN –710: Sustainable development, Environmental Auditing and Environmental Impact Assessment

Cr. 4 (64 Hours)

UNIT I

Elements of Environmental Impact Assessment:

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA

UNIT II

The Interlinking:

Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries.

Case Studies

UNIT III

Concepts of the Environmental Audit:

Definition, Benefits, Objectives.

Legislation:

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments, Need for Environmental Audit, Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.
- Control Mechanism
    - Waste water reduction
    - Air emission reduction
- Preparation of Audit Report
- Form V Case Studies

UNIT V

Introduction to Sustainability: Criteria, Definitions, Challenges of Sustainability, Meaning of The Brundtland Commissions:Principles, perspectives, Inter generational and intra generational Equity, Agenda 21, Earth Summit – 1972, Vienna Convention – 1985, Montreal Protocol,

Kyoto Protocol, Conference of Parties (COP), UNCED Rio Earth Summit – 1992, UNCED Rio Earth Summit – 1992, Rio Earth Summit + 5, Johannesburg Summit 2002. Environment, Economics and Ethics–Dimensions of Sustainable Development. Prototype Carbon Fund (PCF).

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 711: Energy Modeling & Project Management.

Cr. 4 (64 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets:

Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing:

Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning:

Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis, Energy action planning, Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management:

Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Financial Management:

Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs, and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Project Management:

Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring, Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Network Analysis:

PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.
10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. Productivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN - 712: Electric Power Generation, Instrumentation, measurements, Transmission and Distribution

Cr. 4 (64 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

UNIT - II

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer,

Classification of transducers:

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, capacitive and Inductive transducer, selection of transducers

Pressure measurement: manometers; diaphragm, below elements, vacuum gases, Bendron tube,

UNIT - III

Temperature measurement: Thermocouples, RTCs, Thermistors, Radiation and optical pyrometer,

Flow measurement: pitot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

Unit IV

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phasor Diagram Power in Balanced Three-Phase Circuit.

Types of Conductors, Skin Effect, Corona Losses, Basics of Transmission & Distribution System, Layout of Substation and Component of Substation.

Impedance of Transmission Lines, Capacitance of Transmission Lines, Representation of Power Systems. Bundle Conductors.

Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit V

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses.

Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power,Danpat Rai and Sons. .
4. Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
5. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
6. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
7. Nuclear Energy By Raymond L. Murray 6th Edition (2008).
8. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
9. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
10. Doeblin – Measurement System McGrew Hill Book Co., (1981).
11. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
12. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
13. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
14. Instrumentation, Measurement and Control – D S Kumar

EN –713: Energy Conservation opportunities in Process of Designated Industries

Cr. 4 (64 hours)

Industrial/Commercial Buildings

Buildings Envelope and Load reduction techniques, Utilities.

Case Studies: Green building, Energy efficient building etc

Energy Saving Measures in Energy Intensive Process Industry

Pulp and Paper, Sugar, Textile, Fertilizer and Textile and their Case Studies.
Chemical, Petroleum Refineries, Petrochemical Processes, Chlor-Alkali and their Case Studies.

Aluminum, Iron and Steel, Cement and their Case Studies.

Railways, Ports, Transport Sector, Power Stations and their Case Studies.

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi
9. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
10. Carig,B. Saith, Energy Management Principles, Applications, Benefit and Saving, Per n Press, New York.
11. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
12. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
13. N.L Lens, Waste gas Treatment for Resource Recovery.
14. S.N. Ghosh and Yadav, Energy conservation and environment control and cement industries.

EN -714: Computer Application: Energy and Environment Software
Cr. 4 (64 hours)

Unit I: Introduction to Office Automation Tools

Use and applications of MS office automation tools like MS Word, MS Excel, MS Power point, MS Access.

Unit II: Energy Management Information Systems

Introduction, Components, Concept of energy data, Design and development issues, Energy reporting, Role of metering and measurement etc.

Unit III: RET Screen

Introduction and Modal Flow Chart, Energy modal, Cost analysis, GHG emission reduction analysis, Sensitivity and Risk analysis.

Unit IV: TRNSYS

Introduction, Use and Application of various energy system, designing and simulation programs such as PREBID, BIDWIN, PRESIM, TRNSHELL, TRNSED.

Unit V: Design Builder

Introduction, Design builder interface, Create building geometry, drawing options, modal options, Introduction to modal data, Data Management, Exercises on Geometry and Model data, Heating and Cooling Design calculations, Simulation using Hourly weather data, timing schedules, profiles, holidays. Glazing & Solar shading, Day lighting, Natural ventilation, simple HVAC, Design Builder Compact HVAC.

Unit VI: Programming in MATLAB

Introduction to MATLAB, Tutorial lessons, Matrices and Vectors-Scalars and vectors, Multidimensional matrices and arrays, Matrix Manipulation, Matrix and array operations, Matlab Graphics- Introduction, 2D-Plots, Multiple plots, specialized 2D plots and 3D plots. Control structure, Writing programs and Functions.

Unit VI: Screen View: Introduction, tutorial, technical description

Unit VI: Rapid Impact Assessment MATRIX (RIAM):

Introduction**,** The shortcomings in existing EIA methods, Possible solutions to improve EIA, The Rapid Impact Assessment Matrix, Assessment criteria, Environmental components, Ranges.

About Screen View:

Screen View is a user friendly interface for the U.S. EPA screening model, SCREEN 3 for Air Quality Planning and Standards Emissions.

About RIAM S/w

DHI Water & Environment has developed a tool called the Rapid Impact Assessment Matrix (**RIAM**) that helps to organize an Environmental Impact Assessment.

RIAM allows full transparency of the decisions made in an EIA. **RIAM** provides a holistic investigation covering four categories of environmental issues:

Physical and chemical issues, biological and ecological issues, sociological and cultural issues, economic and operational issues

Recommended Books

1. Using MS – Office 2000- Woody Leonhard
2. The complete guide to MS – Office –Ron Monsfield
3. Turba, Information Technology, Wiley & Sons
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada
5. Manuals of TRNSYS
6. Manuals of Design Builder
7. SCREEN3 Model User's Guide
8. RIAM Model User's Guide

EN – 801: Heat Transfer and Energy Conservation Laboratory

Credits 3 (48 Hours)

1. Determine the percentage of excess air required for given fuel.
2. Determination of Stack Gas Composition by flue gas analyzer:
   a) Percentage of CO2 or O2 in flue gas.
   b) Percentage of CO in flue gas
   c) Temperature of flue gas.
3. Determine the radiation, convection loss and opening in boiler or furnace
4. Determine the Efficiency and loading of motor
5. Determine the Efficiency of the given Blower, fan and Pump.
6. Determine the performance of Air compressor system
7. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition units (Window AC Conventional, Split AC Conventional), Split AC Energy Efficient. 8.
8. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
9. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
10. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.
11. To determine the heat transfer coefficient in natural convection and forced convection.
12. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
13. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to water).
14. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to air).
15. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Shall & Tube).
16. To determine heat transfer coefficient for drop and film wise condensation.
17. To determine the performance of heat pipe.
18. To determine thermal conductivity of an insulating power.
19. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 802: Biomass and Environmental Laboratory
Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids, volatile Solids and calorific value for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
6. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.
5. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
6. Determination of Fats/oil Content and Carbohydrates in a given oil seed Biomass Sample.
7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.
8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
9. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
10. Estimation the calorific value of gaseous fuel using orsate apparatus and comparing your result with Junker gas calorimeter.
11. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.
12. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
13. Determination of Crude Protein in a Given Biomass Sample.
14. Study of Gasifier and its performance evaluation with solid and loose biomass.
15. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel
16. Preparation of bio-diesel and determination of it physical properties
17. Performance study of CI engine with different fuel
18. Preparation of alcohol and its Performance study with SI engine

EN - 803: Solar Thermal and Photovoltaic Laboratory

Cr. 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. Determination of Heat Loss Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built In Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker (First and Second Figure of Merit).
6. Performance Evaluation of a Single Basin Solar Still.
7. Thermal Testing of Concentrated Solar Cooker (F_0 and FU_l.)
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Power Load Characteristic of a Photovoltaic Cell.
11. Power Output Vs Exposed Area.
12. Power Output Vs Azimuthal and Tilt Angle
13. Spectral Response of a PV Cell.
14. PV System Performance
15. Study the Effect of Solar Irradiance and ambient air Temperature on Module Output.
16. Calibration of Thermocouples and RTD.
19. Calibration of Pyranometers.
20. Determination of geographical N-S direction.

M. Tech. Energy Management (Regular)

Year 2015-2017

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,

Indore-452 001(M.P)

Ph: 0731-2460309, 2462366, Fax: 0731-2467378

Web: www. dauniv.ac.in

M.TECH. (ENERGY MANAGEMENT) 2015-2017

Eligibility Graduate Degree in Engineering or M Sc. Physics with minimum of 55% marks
Duration 4 Semesters
Seats 18

COURSE	COURSE TITLE	Crs.	Hrs	SEM	Faculty
Core Theory Course		L+T+P			
EN-701	Solar Energy: Fundamentals, Devices and Systems	2+1+0	48	I	SPS/ PS
EN-702	New & Renewable Energy, Sources and Technologies	2+1+0	48	I	RNS
EN-703	Engineering Thermodynamics, Heat Transfer and Process Integration	2+1+0	48	II	SPS/Rs
EN-704	Air, Noise, Water and Waste Water: Pollutions and Control Technologies	2+1+0	48	II	RC
EN-705	Energy Management (Thermal)	2+1+0	48	III	SPS
EN-706	Energy Management (Electrical Systems)	2+1+0	48	I	RS/BB
EN-707	Efficient Lighting: Sources, Systems and Design Aspects	2+1+0	48	III	RS/BB
EN-708	Green Building Technologies	2+1+0	48	III	SPS
EN-709	Bio and Solid Waste Management	2+1+0	48	II	RNS
	TOTAL CREDITS (Core course)	27	432		
Elective Theory Courses					
EN-710	Sustainable development, Environmental Auditing and Environmental Impact Assessment	3+0+0	48	I	RC
EN-711	Energy Modeling and Project Management	2+1+0	48	II	RNS/ PS
EN-712	Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution	2+1+0	48	III	RS/BB
	TOTAL CREDITS (Elective/ Choice based course))	**9**	144		
EN-801	Heat Transfer and Energy Conservation Laboratory	0+0+3	48	I	RNS/RS
EN-802	Biomass and Environmental laboratory	0+0+3	48	III	SPS/RC
EN-803	Solar Thermal and Photo - Voltaic Laboratory	0+0+3	48	II	SPS/PS
EN-804	Energy & Environment Software Application	0+0+3	48	I	SR
	TOTAL CREDITS (LABORATORY)	**12**	144		
EN-805	Field Visits (Lab)	0+0+3	-	II	
EN-806	Seminar	1	-	III	SR/ RS/ BB
EN-807	Mini Project	0+0+4	-	III	SPS/RNS/ RC
EN-808	Major Project	0+0+12	-	IV	SPS/RNS/ RC
	Comprehensive Viva-vice	16(4+4+ 4+4)	-	I+ II+ III+IV	External+ Internal
	TOTAL CREDITS (OTHERS)	**38**	-		
	GRAND TOTAL	**84**			

CORE THEORY COURSE

EN 701: Solar Energy: Fundamentals, Devices and Systems

Credits: 3 (48 Hours)

UNIT I: Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II: Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III:
Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow & Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.
Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**

Solar Power Generator

i. Solar Thermal Power Generation	:	Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	:	Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	:	Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	:	Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 3 (48 Hours)

Unit I: World Energy Scenario

Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Sustainable Development, Role of Renewable Energy sources in Sustainable development, Energy Consumption and its impact on environmental climatic change.

Indian Energy Scenario:

Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

***UNIT – II* Wind Energy**

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, Wind Farms, wind mills & their applications, Cost economics, case studies.

UNIT – III Small Scale Hydroelectric (Mini & Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems, Hydrolic Ram and its Applications

UNIT – IV Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

UNIT - V Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems

UNIT – VI Direct Energy Conversion

Fuel Cells

Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration.

Hydrogen Energy

Production, Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Recommended Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E & FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy; 'Noyes DATA Corporation, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980
10. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy
11. Leon freris- Renewable energy
12. Da Rosa – Fundamental of renewable energy
13. TERI Energy Data Year Books.
14. Planning commission statistics
15. www.bp.com/centres/energy
16. www.eia.doe.gov
17. www.epa.org
18. Bureau of Energy Efficiency- Volume 1

EN-703: Engineering Thermodynamics, Heat Transfer and Process Integration

Credits: 3 (48 Hours)

Unit I

Basic Heat Transfer Concept and Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction: Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection: Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation: Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting, Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

UNIT V

Engineering Thermodynamics: Quantity and Quality Aspects

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

The First Law of Thermodynamics:

Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:

Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium, Thermodynamics Analysis of Process

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M.Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)
7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (2nd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-704: Air, Noise, Water and Waste Water: Pollutions and Control Technologies

Credits: 3 (48 Hours)

UNIT I

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

UNIT II

Air Pollution & Control: Definition, Air Quality, Classification Of Air Pollutants, Air Pollution Episodes, Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_x, NO_x, CO, Oxidants and Ozone.

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths. Air pollution control technologies for particulates and gaseous contaminants. Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT III

Fundamentals: Definition, Classification, Sources Water quality Standards.
Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants.
Water Treatment: Surface water: Water Purification Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) And Its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT IV

Water Treatment Methods: Principles and Design

Unit Operations – Aeration Systems
Sedimentation – types of settling and settling equations, design criteria and design of settling tanks.
Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.
Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT V

Water Softening- Principles and design- Ions causing hardness, various methods, Principles and Design of Waste Water Treatment device.
Objectives of wastewater treatment**,** characteristics, flow variations, types of reactors and reactors analysis, Mass Loading Factors, Impacts, Estimation and their Unit Loading.

UNIT VI

'**Principle of Biological Treatment**; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency, Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Trickling Filters.

UNIT VII

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
7. Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
11. Manual on Sewerage and Sewage Development", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.
12. Understanding Environmental Pollution Marquita K.
13. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
14. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
15. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
16. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
17. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
18. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
19. T K Ray, Air Pollution Control in Industries , Vol-1,2
20. J.N.B, Air Pollution and Plant Life.
21. Robert Jennings Heinson, Air Pollution

EN- 705: Energy Management (Thermal system)

Credits: 3 (48 Hours)

UNIT I

Fuel Analysis

Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces

Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractory

Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractory, Case Studies.

UNIT III

Boilers:

Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers:

Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System:

Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration

Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery:

Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.

Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta, Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar, Anderlind, A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman, Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 706: Energy Management (Electrical System)

Credits: 3 (48 Hours)

UNIT I

Energy Auditing Techniques: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

Material and Energy Balance: Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used,

Methodologies of Conducting Energy Audit: Preliminary & Detailed Energy Audit Methodology: Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Energy Audit Report: Outlines of Energy Audit Report Format, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures,

Government Notification & Scheme: Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA, Useful Forms for Data Collections, Useful Charts for Quick Estimations, Checklists for each Devices and Distribution Lines, Thumb Rules and Specific Energy Indices for Devices and Processes

UNIT II

Basic Electrical Systems: Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill Analysis: ECO (Energy Conservation Opportunities)
Electricity tariff and components, load Management & Demand Side Control, power factor improvement & its benefit, selection and location of capacitors, Performance Assessment of capacitors & Capacitor Bank.

Lighting Systems: Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.
Transformers and Electric Distribution: Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).
Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT V

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

Cooling Tower: Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

UNIT VI

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System:

Factors affecting selection, Energy performance assessment of diesel conservation avenues

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities
14. Instructions to Energy Auditors, Vol. - I & Vol. - II –
15. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
16. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
17. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
18. BEE VolumeI –Second Edition 2005
19. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN – 707: Efficient Lighting: Sources, Systems and Design Aspects

Cr. 3 (48 Hours)

Unit I : Lighting

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II; Eye

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic

Correlated Color Temperature Glare, Brightness, Contrast, Color Rendering, Photometric Analysis.

Unit III : Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement

Unit IV: Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard.

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 708: Green Building Technologies

Cr. 3 (48 Hours)

Unit I: Green Building Design Strategies and Building Codes

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III **Heating Cooling Concepts**

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense
Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV Heat Transmission in Buildings:

Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V Modeling of Building:

Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application. ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments, Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.

Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology
Case Studies

Recommended Books

1. M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN- 709: Bio and Solid Waste Management

Credits: 3 (48 Hours)

Unit I: Biomass & Biomass management

Biomass availability, Characteristics of biomass or organic wastes, Energy Plantation, Waste Biomass/Organic utilization Technology options, Potential, Process and technologies, characteristics of Briquettes and their use.

Unit II : Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & gas storage systems.

Unit III: Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output gas production, properties of output gases (mainly producer gas), Design of a Gasifier.

Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV: Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications.

Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V: Characterization of Different Types of Solid Waste

Municipal Solid Waste, Agro Waste, Others.

Hazardous Waste:

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation and Environmental Impact.

Unit VI: Waste Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration technology, Incineration, Landfill, Refused Derived Fuels .

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi
2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore
4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy
5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi
6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.
8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co. Ltd. 1984
9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,
10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988
11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.
12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984
14. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid waste processing & recovery. The Humane press, Cliton, New Jersey.
15. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.
16. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.
17. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994
18. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
19. Hazardous Waste Management – Charles A. Wentz
20. T V Ramchandra- Management of Municipal Waste

ELECTIVE THEORY COURSES

EN –710: Sustainable development, Environmental Auditing and Environmental Impact Assessment

Cr. 3 (48 Hours)

UNIT I

Elements of Environmental Impact Assessment:

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA

UNIT II

The Interlinking:

Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries.

Case Studies

UNIT III

Concepts of the Environmental Audit:

Definition, Benefits, Objectives.

Legislation:

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments, Need for Environmental Audit, Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.
- Control Mechanism
  - Waste water reduction
  - Air emission reduction
- Preparation of Audit Report
- Form V Case Studies

UNIT V

Introduction to Sustainability: Criteria, Definitions, Challenges of Sustainability, Meaning of The Brundtland Commissions:Principles, perspectives, Inter generational and intra generational Equity, Agenda 21, Earth Summit – 1972, Vienna Convention – 1985, Montreal Protocol,

Kyoto Protocol, Conference of Parties (COP), UNCED Rio Earth Summit – 1992, UNCED Rio Earth Summit – 1992, Rio Earth Summit + 5, Johannesburg Summit 2002. Environment, Economics and Ethics–Dimensions of Sustainable Development. Prototype Carbon Fund (PCF).

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 711: Energy Modeling & Project Management.

Cr. 3 (48 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets:

Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing:

Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning:

Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis, Energy action planning, Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management:

Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Financial Management:

Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs, and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Project Management:

Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring, Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Network Analysis:

PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.
10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. Productivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN - 712: Electric Power Generation, Instrumentation, measurements, Transmission and Distribution

Cr. 3 (48 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

Unit - II

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer,

Classification of transducers:

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, capacitive and Inductive transducer, selection of transducers

Pressure measurement: manometers; diaphragm, below elements, vacuum gases, Bendron tube.

Unit - III

Temperature measurement: Thermocouples, RTCs, Thermistors, Radiation and optical pyrometer,

Flow measurement: pitot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

Unit IV

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phasor Diagram Power in Balanced Three-Phase Circuit. Types of Conductors, Skin Effect, Corona Losses, Basics of Transmission & Distribution System, Layout of Substation and Component of Substation. Impedance of Transmission Lines, Capacitance of Transmission Lines, Representation of Power Systems. Bundle Conductors. Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit V

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses. Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power,Danpat Rai and Sons. .
4. Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
5. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
6. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
7. Nuclear Energy By Raymond L. Murray 6th Edition (2008).
8. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
9. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
10. Doeblin – Measurement System McGrew Hill Book Co., (1981).
11. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
12. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
13. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
14. Instrumentation, Measurement and Control – D S Kumar

EN – 801: Heat Transfer and Energy Conservation Laboratory
Credits 3 (48 Hours)

1. Determine the percentage of excess air required for given fuel.
2. Determination of Stack Gas Composition by flue gas analyzer:
   a) Percentage of CO_2 or O_2 in flue gas.
   b) Percentage of CO in flue gas
   c) Temperature of flue gas.
3. Determine the radiation, convection loss and opening in boiler or furnace
4. Determine the Efficiency and loading of motor
5. Determine the Efficiency of the given Blower, fan and Pump.
6. Determine the performance of Air compressor system
7. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition units (Window AC Conventional, Split AC Conventional), Split AC Energy Efficient. 8.
8. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
9. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
10. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.
11. To determine the heat transfer coefficient in natural convection and forced convection.
12. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
13. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to water).
14. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to air).
15. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Shall & Tube).
16. To determine heat transfer coefficient for drop and film wise condensation.
17. To determine the performance of heat pipe.
18. To determine thermal conductivity of an insulating power.
19. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 802: Biomass and Environmental Laboratory

Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids, volatile Solids and calorific value for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
6. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.
5. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
6. Determination of Fats/oil Content and Carbohydrates in a given oil seed Biomass Sample.
7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.
8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
9. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
10. Estimation the calorific value of gaseous fuel using orsate apparatus and comparing your result with Junker gas calorimeter.
11. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.
12. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
13. Determination of Crude Protein in a Given Biomass Sample.
14. Study of Gasifier and its performance evaluation with solid and loose biomass.
15. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel
16. Preparation of bio-diesel and determination of it physical properties
17. Performance study of CI engine with different fuel
18. Preparation of alcohol and its Performance study with SI engine
19. Calibration of thermocouples
20. Estimation of Heavy Metals by AAS method from a given effluent

EN - 803: Solar Thermal and Photovoltaic Laboratory

Cr. 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. Determination of Heat Loss Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built in Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker (First and Second Figure of Merit).
6. Performance Evaluation of a Single Basin Solar Still.
7. Thermal Testing of Concentrated Solar Cooker (F_0 and FU_l.)
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Power Load Characteristic of a Photovoltaic Cell.
11. Power Output Vs Exposed Area.
12. Power Output Vs Azimuthal and Tilt Angle
13. Spectral Response of a PV Cell.
14. PV System Performance
15. Study the Effect of Solar Irradiance and ambient air Temperature on Module Output.
16. Calibration of Thermocouples and RTD.
19. Calibration of Pyranometers.
20 Determination of geographical N-S direction.

EN-804: Energy and Environment Software Applications

Cr. 3 (48 Hours)

Recommended Books

S. No.	List of Experiments
1.	Create a letter which you intent to print or e-mail multiple times, sending each copy to a different recipient (use of mail merge).
2.	Hyperlink your word document to (i) Link other word file in the existing word document. (ii) Link word/phrase to another word/phrase within the same document. (iii) Create a link to a web page in the existing document.
3.	Create bookmarks in word document by Name as well as by Location.
4.	Insert page numbers in word document such that first five pages carry Roman numbers and rest of the pages are numbered 1,2,3 and so on.
5.	Create a basic spreadsheet by entering numbers, text, apply formulas, functions, special formatting, sorting, filtering and demonstrate the ease of creating charts, trend line fitting etc.
6.	Create a 2 storey building 20*30 m with pitched roof. Add a dormer window in the middle of sloping roof using an outline block. Set the vertical walls of the dormer window at 1.5 m and make the sloping roof 1.5 m long at 45 degrees. Convert the dormer window outline block to a building block and add a window 1m * 1m. Now cut a hole in the sloping roof of the main roof block and merge the two blocks. Visualize the building and look inside.
7.	Design simple 10*30 m building with long dimension running North to South. Divide building into 4 zones. Set the activity at building level as Office_OpenOff. Set activity for Zone 3 as Office_Reception. Set the activity for Zone 4 as Office_Store. At building level select the lighting template as T8 Fluorescent, triphosphor high frequency control gear. Set the lighting energy as 16 W/m^2. Note schedule Office_OpenOff_Light has been inherited from the activity. Select luminaries type as surface mount. Turn on lighting control and set control type to linear and % area covered by lighting area1 to 40%. Now go to Zone 3, reception. Select lighting template as fluorescent compact. Accept default 23 W/m^2 and set luminaire type as recessed. Turn off lighting control. Now go to zone 4, store. Select lighting template as metal halide. Set luminaries type to suspend. Turn off lighting.
8.	Design a 2 storey building and create openings such as Windows, vents, doors, holes etc.
9.	Create a project for a location and a create a new building using default options and draw a block 20m * 10m with the longer façade facing North and South. Keep the default Office_OpenOff activity and use defaults for constructions, openings and lighting. At building level go to the HVAC tab and Load the Packaged Direct Expansion HVAC template. Set the Mechanical ventilation Outside air definition method to 1-By Zone. Set the Mechanical ventilation Outside air delivery to be 2 ac/h. Leave the Mechanical ventilation Operation schedule to be Office_OpenOff_Occ. At building level go to the Activity tab and open the Environmental Conditions header and leave the heating setpoint at 22° C and the cooling setpoint at 24° C. Click on the simulation tab and select hourly and daily results in the Simulation Options dialog and press O.K. to start the simulation. Analyze the results.
10	Create an input file using text editor in trnsys environment to calculate the collectors useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
11	Create an input file using graphical user interface in trnsys environment to calculate the collector's useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
12	Determine the environmental score of a project/plan by considering environmental components in each of four categories using RIAM software.
13	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for solar water heating system (SWH) using RETScreen software.
14	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for PV applications using RET Screen software.

Recommended Books

1. Using MS – Office 2000- Woody Leonhard
2. The complete guide to MS – Office –Ron Monsfield
3. Turba, Information Technology, Wiley & Sons
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada
5. Manuals of TRNSYS
6. Manuals of Design Builder
7. SCREEN3 Model User's Guide
8. RIAM Model User's Guide

M. Tech. Energy Management (Regular)

Year 2016-2018

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

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Indore-452 001(M.P)

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M.TECH. (ENERGY MANAGEMENT) 2016-2018

Eligibility Graduate Degree in Engineering or M Sc. Physics with minimum of 55% marks
Duration 4 Semesters
Seats 18

COURSE	COURSE TITLE	Crs.	Hrs	SEM	Faculty
Core Theory Course		L+T+P			
EN-701	Solar Energy: Fundamentals, Devices and Systems	2+1+0	48	I	SPS
EN-702	New & Renewable Energy, Sources and Technologies	2+1+0	48	I	RNS
EN-703	Engineering Thermodynamics, Heat Transfer and Process Integration	2+1+0	48	II	SPS
EN-704	Air, Noise, Water and Waste Water: Pollutions and Control Technologies	2+1+0	48	II	RC
EN-705	Energy Management (Thermal)	2+1+0	48	III	SPS
EN-706	Energy Management (Electrical Systems)	2+1+0	48	I	SPS
EN-707	Efficient Lighting: Sources, Systems and Design Aspects	2+1+0	48	III	SPS
EN-708	Green Building Technologies	2+1+0	48	III	SPS
EN-709	Bio and Solid Waste Management	2+1+0	48	II	RNS
	TOTAL CREDITS (Core course)	27	432		
Elective Theory Courses					
EN-710	Sustainable development, Environmental Auditing and Environmental Impact Assessment	3+0+0	48	I	RC
EN-711	Energy Modeling and Project Management	2+1+0	48	II	RNS
EN-712	Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution	2+1+0	48	III	RS/BB
	TOTAL CREDITS (Elective/ Choice based course))	**9**	144		
EN-801	Heat Transfer and Energy Conservation Laboratory	0+0+3	48	I	RNS
EN-802	Biomass and Environmental laboratory	0+0+3	48	III	SPS/RC
EN-803	Solar Thermal and Photo - Voltaic Laboratory	0+0+3	48	II	SPS
EN-804	Energy & Environment Software Application	0+0+3	48	I	SR
	TOTAL CREDITS (LABORATORY)	**12**	144		
EN-805	Field Visits (Lab)	0+0+3	-	II	SPS/RNS/ RC
EN-806	Seminar	1	-	III	SPS/RNS/ RC
EN-807	Mini Project	0+0+4	-	III	SPS/RNS/ RC
EN-808	Major Project	0+0+12	-	IV	SPS/RNS/ RC
	Comprehensive Viva-vice	16(4+4+	-	I+ II+	External+

		4+4)		III+IV	Internal
	TOTAL CREDITS (OTHERS)	**38**	-		
	GRAND TOTAL	**84**			

CORE THEORY COURSE

EN 701: Solar Energy: Fundamentals, Devices and Systems

Credits: 3 (48 Hours)

UNIT I: Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II: Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III:
Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow & Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.
Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**
Solar Power Generator

i. Solar Thermal Power Generation	:	Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	:	Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	:	Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	:	Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P Agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 3 (48 Hours)

Unit I: World Energy Scenario

Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Sustainable Development, Role of Renewable Energy sources in Sustainable development, Energy Consumption and its impact on environmental climatic change.

Indian Energy Scenario:

Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

***UNIT – II* Wind Energy**

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, Wind Farms, wind mills & their applications, Cost economics, case studies.

UNIT – III Small Scale Hydroelectric (Mini & Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems, Hydrolic Ram and its Applications

UNIT – IV Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

UNIT – V Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems

UNIT – VI Direct Energy Conversion

FUEL CELLS

Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration.

HYDROGEN ENERGY

Production, Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Recommended Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E & FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy; 'Noyes DATA Corporation, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980
10. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy
11. Leon freris- Renewable energy
12. Da Rosa – Fundamental of renewable energy
13. TERI Energy Data Year Books.
14. Planning commission statistics
15. www.bp.com/centres/energy
16. www.eia.doe.gov
17. www.epa.org
18. Bureau of Energy Efficiency- Volume 1

EN-703: Engineering Thermodynamics, Heat Transfer and Process Integration

Credits: 3 (48 Hours)

Unit I

Basic Heat Transfer Concept and Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction: Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection: Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation: Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting, Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

UNIT V

Engineering Thermodynamics: Quantity and Quality Aspects

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

The First Law of Thermodynamics:

Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:

Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium, Thermodynamics Analysis of Process

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M. Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)
7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (2nd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-704: Air, Noise, Water and Waste Water: Pollutions and Control Technologies

Credits: 3 (48 Hours)

UNIT I : Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

UNIT II: Air Pollution & Control:

Definition, Air Quality, Classification Of Air Pollutants, Air Pollution Episodes, Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_x, NO_x, CO, Oxidants and Ozone.

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths. Air pollution control technologies for particulates and gaseous contaminants. Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT III: Fundamentals: Definition, Classification, Sources Water quality Standards.
Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants.
Water Treatment: Surface water: Water Purification Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) And Its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT IV: Water Treatment Methods: Principles and Design

Unit Operations – Aeration Systems
Sedimentation – types of settling & settling equations, design criteria & design of settling tanks.
Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.
Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT V: Water Softening- Principles and design- Ions causing hardness, various methods, Principles and Design of Waste Water Treatment device.

Objectives of wastewater treatment**,** characteristics, flow variations, types of reactors and reactors analysis, Mass Loading Factors, Impacts, Estimation and their Unit Loading.

UNIT VI: 'Principle of Biological Treatment: Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency, Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Trickling Filters.

UNIT VII: Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.
Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
7. Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
11. Manual on Sewerage and Sewage Development", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.
12. Understanding Environmental Pollution Marquita K.
13. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
14. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
15. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
16. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
17. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
18. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
19. T K Ray, Air Pollution Control in Industries , Vol-1,2
20. J.N.B, Air Pollution and Plant Life.
21. Robert Jennings Heinson, Air Pollution

EN- 705: Energy Management (Thermal system)

Credits: 3 (48 Hours)

UNIT I

Fuel Analysis: Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces: Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractory: Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractory, Case Studies.

UNIT III

Boilers: Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers: Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System: Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration: Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery: Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.
Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta, Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar, Anderlind, A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman, Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 706: Energy Management (Electrical System)

Credits: 3 (48 Hours)

UNIT I

Energy Auditing Techniques: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

Material and Energy Balance: Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used,

Methodologies of Conducting Energy Audit: Preliminary & Detailed Energy Audit Methodology: Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Energy Audit Report: Outlines of Energy Audit Report Format, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures,

Government Notification & Scheme: Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA, Useful Forms for Data Collections, Useful Charts for Quick Estimations, Checklists for each Devices and Distribution Lines, Thumb Rules and Specific Energy Indices for Devices and Processes

UNIT II

Basic Electrical Systems: Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill Analysis: ECO (Energy Conservation Opportunities)

Electricity tariff and components, load Management & Demand Side Control, power factor improvement & its benefit, selection and location of capacitors, Performance Assessment of capacitors & Capacitor Bank.

Lighting Systems: Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.

Transformers and Electric Distribution: Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).

Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT V :

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

Cooling Tower: Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

UNIT VI

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System: Factors affecting selection, Energy performance assessment of

diesel conservation avenues

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities
14. Instructions to Energy Auditors, Vol. - I & Vol. - II –
15. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
16. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
17. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
18. BEE VolumeI –Second Edition 2005
19. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN – 707: Efficient Lighting: Sources, Systems and Design Aspects

Cr. 3 (48 Hours)

Unit I : Lighting

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II; Eye

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic

Correlated Color Temperature Glare, Brightness, Contrast, Color Rendering, Photometric Analysis.

Unit III : Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement

Unit IV: Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard.

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 708: Green Building Technologies

Cr. 3 (48 Hours)

Unit I: Green Building Design Strategies and Building Codes

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III Heating Cooling Concepts

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense
Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV Heat Transmission in Buildings:

Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V Modeling of Building:

Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application. ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments, Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.

Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology
Case Studies

Recommended Books

1. M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN- 709: Bio and Solid Waste Management

Credits: 3 (48 Hours)

Unit I: Biomass & Biomass management

Biomass availability, Characteristics of biomass or organic wastes, Energy Plantation, Waste Biomass/Organic utilization Technology options, Potential, Process and technologies, characteristics of Briquettes and their use.

Unit II: Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & gas storage systems.

Unit III: Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output gas production, properties of output gases (mainly producer gas), Design of a Gasifier.

Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV: Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications.

Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V: Characterization of Different Types of Solid Waste, Municipal Solid Waste, Agro Waste, Others.

Hazardous Waste:

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation and Environmental Impact.

Unit VI: Waste Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration technology, Incineration, Landfill, Refused Derived Fuels.

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi
2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore
4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy
5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi
6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.
8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co. Ltd. 1984
9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,
10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988
11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.
12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984
14. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid waste processing & recovery. The Humane press, Cliton, New Jersey.
15. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.
16. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.
17. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994
18. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
19. Hazardous Waste Management – Charles A. Wentz
20. T V Ramchandra- Management of Municipal Waste

ELECTIVE THEORY COURSES

EN –710: Sustainable development, Environmental Auditing and Environmental Impact Assessment

Cr. 3 (48 Hours)

UNIT I

Elements of Environmental Impact Assessment:

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA

UNIT II

The Interlinking: Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries.

UNIT III

Concepts of the Environmental Audit: Definition, Benefits, Objectives.

Legislation:

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments, Need for Environmental Audit, Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

Water Consumption, Guidelines to Environmental Safe Layouts to Minimize Losses & Waste, Control Mechanism, Waste water reduction, Air emission reduction , Preparation of Audit Report, Form V Case Studies

UNIT V

Introduction to Sustainability: Criteria, Definitions, Challenges of Sustainability, Meaning of The Brundtland Commissions:Principles, perspectives, Inter generational and intra generational Equity, Agenda 21, Earth Summit – 1972, Vienna Convention – 1985, Montreal Protocol,

Kyoto Protocol, Conference of Parties (COP), UNCED Rio Earth Summit – 1992, UNCED Rio Earth Summit – 1992, Rio Earth Summit + 5, Johannesburg Summit 2002. Environment, Economics and Ethics–Dimensions of Sustainable Development. Prototype Carbon Fund (PCF).

Case Studies

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.

3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 711: Energy Modeling & Project Management.

Cr. 3 (48 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets: Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing: Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning: Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis, Energy action planning, Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management: Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs, and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Project Management: Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring, Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Network Analysis: PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.

10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. Productivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN - 712: Electric Power Generation, Instrumentation, measurements, Transmission and Distribution

Cr. 3 (48 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

Unit - II

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer,

Classification of transducers:

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, capacitive and Inductive transducer, selection of transducers

Pressure measurement: manometers; diaphragm, below elements, vacuum gases, Bendron tube.

Unit - III

Temperature measurement: Thermocouples, RTCs, Thermistors, Radiation and optical pyrometer,

Flow measurement: pilot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

Unit IV

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phasor Diagram Power in Balanced Three-Phase Circuit. Types of Conductors, Skin Effect, Corona Losses, Basics of Transmission & Distribution System, Layout of Substation and Component of Substation. Impedance of Transmission Lines, Capacitance of Transmission Lines, Representation of Power Systems. Bundle Conductors. Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit V

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses. Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power,Danpat Rai and Sons. .
4. Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
5. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
6. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
7. Nuclear Energy By Raymond L. Murray 6th Edition (2008).
8. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
9. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
10. Doeblin – Measurement System McGrew Hill Book Co., (1981).
11. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
12. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
13. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
14. Instrumentation, Measurement and Control – D S Kumar

EN – 801: Heat Transfer and Energy Conservation Laboratory
Credits 3 (48 Hours)

1. Determine the percentage of excess air required for given fuel.
2. Determination of Stack Gas Composition by flue gas analyzer:
   a) Percentage of CO_2 or O_2 in flue gas.
   b) Percentage of CO in flue gas
   c) Temperature of flue gas.
3. Determine the radiation, convection loss and opening in boiler or furnace
4. Determine the Efficiency and loading of motor
5. Determine the Efficiency of the given Blower, fan and Pump.
6. Determine the performance of Air compressor system
7. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition units (Window AC Conventional, Split AC Conventional), Split AC Energy Efficient. 8.
8. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
9. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
10. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.
11. To determine the heat transfer coefficient in natural convection and forced convection.
12. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
13. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to water).
14. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to air).
15. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Shall & Tube).
16. To determine heat transfer coefficient for drop and film wise condensation.
17. To determine the performance of heat pipe.
18. To determine thermal conductivity of an insulating power.
19. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 802: Biomass and Environmental Laboratory

Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, Ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids, volatile Solids and calorific value for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
6. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.
5. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
6. Determination of Fats/oil Content and Carbohydrates in a given oil seed Biomass Sample.
7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.
8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
9. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
10. Estimation the calorific value of gaseous fuel using orsate apparatus and comparing your result with Junker gas calorimeter.
11. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.
12. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
13. Determination of Crude Protein in a Given Biomass Sample.
14. Study of Gasifier and its performance evaluation with solid and loose biomass.
15. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel
16. Preparation of bio-diesel and determination of it physical properties
17. Performance study of CI engine with different fuel
18. Preparation of alcohol and its Performance study with SI engine
19. Calibration of thermocouples
20. Estimation of Heavy Metals by AAS method from a given effluent

EN - 803: Solar Thermal and Photovoltaic Laboratory

Cr. 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. Determination of Heat Loss Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built in Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker (First and Second Figure of Merit).
6. Performance Evaluation of a Single Basin Solar Still.
7. Thermal Testing of Concentrated Solar Cooker (F_0 and FU_l.)
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Power Load Characteristic of a Photovoltaic Cell.
11. Power Output Vs Exposed Area.
12. Power Output Vs Azimuthal and Tilt Angle
13. Spectral Response of a PV Cell.
14. PV System Performance
15. Study the Effect of Solar Irradiance and ambient air Temperature on Module Output.
16. Calibration of Thermocouples and RTD.

19. Calibration of Pyranometers.

20 Determination of geographical N-S direction.

EN-804: Energy and Environment Software Applications

Cr. 3 (48 Hours)

Recommended Books

S. No.	List of Experiments
1.	Create a letter which you intent to print or e-mail multiple times, sending each copy to a different recipient (use of mail merge).
2.	Hyperlink your word document to (i) Link other word file in the existing word document. (ii) Link word/phrase to another word/phrase within the same document. (iii) Create a link to a web page in the existing document.
3.	Create bookmarks in word document by Name as well as by Location.
4.	Insert page numbers in word document such that first five pages carry Roman numbers and rest of the pages are numbered 1,2,3 and so on.
5.	Create a basic spreadsheet by entering numbers, text, apply formulas, functions, special formatting, sorting, filtering and demonstrate the ease of creating charts, trend line fitting etc.
6.	Create a 2 storey building 20*30 m with pitched roof. Add a dormer window in the middle of sloping roof using an outline block. Set the vertical walls of the dormer window at 1.5 m and make the sloping roof 1.5 m long at 45 degrees. Convert the dormer window outline block to a building block and add a window 1m * 1m. Now cut a hole in the sloping roof of the main roof block and merge the two blocks. Visualize the building and look inside.
7.	Design simple 10*30 m building with long dimension running North to South. Divide building into 4 zones. Set the activity at building level as Office_OpenOff. Set activity for Zone 3 as Office_Reception. Set the activity for Zone 4 as Office_Store. At building level select the lighting template as T8 Fluorescent, triphosphor high frequency control gear. Set the lighting energy as 16 W/m^2. Note schedule Office_OpenOff_Light has been inherited from the activity. Select luminaries type as surface mount. Turn on lighting control and set control type to linear and % area covered by lighting area1 to 40%. Now go to Zone 3, reception. Select lighting template as fluorescent compact. Accept default 23 W/m^2 and set luminaire type as recessed. Turn off lighting control. Now go to zone 4, store. Select lighting template as metal halide. Set luminaries type to suspend. Turn off lighting.
8.	Design a 2 storey building and create openings such as Windows, vents, doors, holes etc.
9.	Create a project for a location and a create a new building using default options and draw a block 20m * 10m with the longer façade facing North and South. Keep the default Office _Open Off activity and use defaults for constructions, openings and lighting. At building level go to the HVAC tab and Load the Packaged Direct Expansion HVAC template. Set the Mechanical ventilation Outside air definition method to 1-By Zone. Set the Mechanical ventilation Outside air delivery to be 2 ac/h. Leave the Mechanical ventilation Operation schedule to be Office _Open Off_Occ. At building level go to the Activity tab and open the Environmental Conditions header and leave the heating setpoint at 22° C and the cooling setpoint at 24° C. Click on the simulation tab and select hourly and daily results in the Simulation Options dialog and press O.K. to start the simulation. Analyze the results.
10.	Create an input file using text editor in trnsys environment to calculate the collectors useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
11.	Create an input file using graphical user interface in trnsys environment to calculate the collector's useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
12.	Determine the environmental score of a project/plan by considering environmental components in each of four categories using RIAM software.
13.	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for solar water heating system (SWH) using RET Screen software.
14.	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for PV applications using RET Screen software.

Recommended Books

1. Using MS – Office 2000- Woody Leonhard
2. The complete guide to MS – Office –Ron Monsfield
3. Turba, Information Technology, Wiley & Sons
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada
5. Manuals of TRNSYS
6. Manuals of Design Builder
7. SCREEN3 Model User's Guide
8. RIAM Model User's Guide

M. Tech. Energy Management (Regular)

Year 2017-2019

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,

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Ph: 0731-2460309, 2462366, Fax: 0731-2467378

Web: www. dauniv.ac.in

M.TECH. (ENERGY MANAGEMENT) 2017-2019

Eligibility Graduate Degree in Engineering or M Sc. Physics with minimum of 55% marks
Duration 4 Semesters
Seats 18

COURSE	COURSE TITLE	Crs.	Hrs	SEM	Faculty
Core Theory Course		L+T+P			
EN-701	Solar Energy: Fundamentals, Devices and Systems	2+1+0	48	I	SPS
EN-702	New & Renewable Energy, Sources and Technologies	2+1+0	48	I	RNS
EN-703	Engineering Thermodynamics, Heat Transfer and Process Integration	2+1+0	48	II	SPS
EN-704	Water and Waste Water: Pollution & Control Technologies	2+1+0	48	II	RC
EN-705	Air and Noise Pollution: Effects and Control Technologies	2+1+0	48	II	RC
EN-706	Energy Management (Thermal)	2+1+0	48	III	SPS
EN-707	Energy Management (Electrical Systems)	2+1+0	48	I	SPS
EN-708	Efficient Lighting: Sources, Systems and Design Aspects	2+1+0	48	III	SPS
EN-709	Green Building Technologies	2+1+0	48	III	SPS
EN-710	Bio and Solid Waste Management	2+1+0	48	II	RNS
	TOTAL CREDITS (Core course)	**30**	480		
Elective Theory Courses					
EN-711	Sustainable development, Environmental Auditing and Environmental Impact Assessment	3+0+0	48	I	RC
EN-712	Energy Modeling and Project Management	2+1+0	48	II	RNS
EN-713	Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution	2+1+0	48	III	RNS
	TOTAL CREDITS (Elective/ Choice based course))	**9**	144		
EN-801	Heat Transfer and Energy Conservation Laboratory	0+0+3	48	I	RNS
EN-802	Biomass and Environmental laboratory	0+0+3	48	III	SPS/RC
EN-803	Solar Thermal and Photo - Voltaic Laboratory	0+0+3	48	II	SPS
EN-804	Energy & Environment Software Application	0+0+3	48	I	RC
	TOTAL CREDITS (LABORATORY)	**12**	192		
EN-805	Field Visits (Lab)	0+0+3	-	II	SPS/RNS/ RC
EN-806	Seminar	2	-	III	SPS/RNS/ RC
EN-807	Mini Project	0+0+4	-	III	SPS/RNS/ RC
EN-808	Major Project	0+0+12	-	IV	SPS/RNS/ RC
	Comprehensive Viva-vice	**16**(4+4+ 4+4)	-	I+ II+ III+IV	External+ Internal
	TOTAL CREDITS (OTHERS)	**37**	-		
	GRAND TOTAL	**88**			

CORE THEORY COURSE

EN 701: Solar Energy: Fundamentals, Devices and Systems

Credits: 3 (48 Hours)

UNIT I: Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II: Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III:
Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow & Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.
Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**

Solar Power Generator

i. Solar Thermal Power Generation	:	Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	:	Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	:	Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	:	Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P Agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 3 (48 Hours)

Unit I: World Energy Scenario

Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Sustainable Development, Role of Renewable Energy sources in Sustainable development, Energy Consumption and its impact on environmental climatic change.

Indian Energy Scenario:

Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

***UNIT – II* Wind Energy**

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, Wind Farms, wind mills & their applications, Cost economics, case studies.

UNIT – III Small Scale Hydroelectric (Mini & Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems, Hydrolic Ram and its Applications

UNIT – IV Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

UNIT – V Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems

UNIT – VI Direct Energy Conversion

FUEL CELLS

Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration.

HYDROGEN ENERGY

Production, Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Recommended Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E & FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy; 'Noyes DATA Corporation, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980
10. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy
11. Leon freris- Renewable energy
12. Da Rosa – Fundamental of renewable energy
13. TERI Energy Data Year Books.
14. Planning commission statistics
15. www.bp.com/centres/energy
16. www.eia.doe.gov
17. www.epa.org
18. Bureau of Energy Efficiency- Volume 1

EN-703: Engineering Thermodynamics, Heat Transfer and Process Integration

Credits: 3 (48 Hours)

Unit I

Basic Heat Transfer Concept and Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction: Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection: Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation: Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting, Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

UNIT V

Engineering Thermodynamics: Quantity and Quality Aspects

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

The First Law of Thermodynamics:

Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:

Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium, Thermodynamics Analysis of Process

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M. Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)
7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (2nd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-704: Water and Waste Water: Pollution and Control Technologies

Credits: 3 (48 Hours)

UNIT I

Fundamentals: Definition, Classification, Sources Water quality Standards.
Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants.
Surface Water Treatment: Water Purification, Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) and Its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT II

Water Treatment Methods: Principles and Design, Aeration Systems, types of settling and settling equations, design criteria and design of settling tanks.
Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.
Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT III

Unit processes, Water Softening- Principles and design- Ions causing hardness, various methods.
Waste Water Treatment: Principles and Design, Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis. Mass Loading Factors, Impacts, Estimation and Their Unit Loading.

UNIT IV

'Principle of Biological Treatment; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency.
Theoretical principles and design : Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Aerobic Attached Growth, Trickling Filters,

UNIT V

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants
Sludge Processing: separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Numerical problems and Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S. Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.

7. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. "Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.

EN-705: Air and Noise Pollution: Effects and Control Technologies

3: Credits (48 hours)

UNIT I

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

UNIT II

Air Pollution & Control: Definition, Air Quality, Classification of Air Pollutants, Air Pollution Episodes.

UNIT III

Air Pollution Monitoring

Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_x, NO_x, CO, Oxidants and Ozone.

UNIT IV

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths.

Air pollution control technologies for particulates and gaseous contaminants.

Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT V

Global Concerns, Light Pollution and Thermal Pollution

Recommended Books

1. Understanding Environmental Pollution Marquita K.
2. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
3. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
4. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
5. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
6. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
7. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
8. T K Ray, Air Pollution Control in Industries , Vol-1,2
9. J.N.B, Air Pollution and Plant Life.
10. Robert Jennings Heinson, Air Pollution.

EN- 706: Energy Management (Thermal System)

Credits: 3 (48 Hours)

UNIT I

Fuel Analysis: Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces: Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractory: Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractory, Case Studies.

UNIT III

Boilers: Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers: Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System: Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration: Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery: Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.
Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta, Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar, Anderlind, A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman, Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 707: Energy Management (Electrical System)

Credits: 3 (48 Hours)

UNIT I

Energy Auditing Techniques: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

Material and Energy Balance: Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used,

Methodologies of Conducting Energy Audit: Preliminary & Detailed Energy Audit Methodology: Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Energy Audit Report: Outlines of Energy Audit Report Format, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures,

Government Notification & Scheme: Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA, Useful Forms for Data Collections, Useful Charts for Quick Estimations, Checklists for each Devices and Distribution Lines, Thumb Rules and Specific Energy Indices for Devices and Processes

UNIT II

Basic Electrical Systems: Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill Analysis: ECO (Energy Conservation Opportunities)

Electricity tariff and components, load Management & Demand Side Control, power factor improvement & its benefit, selection and location of capacitors, Performance Assessment of capacitors & Capacitor Bank.

Lighting Systems: Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.

Transformers and Electric Distribution: Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).

Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT V :

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

Cooling Tower: Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

UNIT VI

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System: Factors affecting selection, Energy performance assessment of

diesel conservation avenues

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities
14. Instructions to Energy Auditors, Vol. - I & Vol. - II –
15. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
16. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
17. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
18. BEE VolumeI –Second Edition 2005
19. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN – 708: Efficient Lighting: Sources, Systems and Design Aspects

Cr. 3 (48 Hours)

Unit I : Lighting

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II; Eye

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic

Correlated Color Temperature Glare, Brightness, Contrast, Color Rendering, Photometric Analysis.

Unit III : Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement

Unit IV: Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard.

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 709: Green Building Technologies

Cr. 3 (48 Hours)

Unit I: Green Building Design Strategies and Building Codes

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III Heating Cooling Concepts

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense
Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV Heat Transmission in Buildings:

Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V Modeling of Building:

Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application. ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments, Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.

Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology
Case Studies

Recommended Books

1. M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN- 710: Bio and Solid Waste Management

Credits: 3 (48 Hours)

Unit I: Biomass & Biomass management

Biomass availability, Characteristics of biomass or organic wastes, Energy Plantation, Waste Biomass/Organic utilization Technology options, Potential, Process and technologies, characteristics of Briquettes and their use.

Unit II: Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & gas storage systems.

Unit III: Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output gas production, properties of output gases (mainly producer gas), Design of a Gasifier.

Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV: Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications.

Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V: Characterization of Different Types of Solid Waste, Municipal Solid Waste, Agro Waste, Others.

Hazardous Waste:

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation and Environmental Impact.

Unit VI: Waste Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration technology, Incineration, Landfill, Refused Derived Fuels.

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi
2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore
4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy
5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi
6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.
8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co. Ltd. 1984
9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,
10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988
11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.
12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984
14. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid waste processing & recovery. The Humane press, Cliton, New Jersey.
15. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.
16. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.
17. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994
18. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
19. Hazardous Waste Management – Charles A. Wentz
20. T V Ramchandra- Management of Municipal Waste

ELECTIVE THEORY COURSES

EN –711: Sustainable development, Environmental Auditing and Environmental Impact Assessment

Cr. 3 (48 Hours)

UNIT I

Elements of Environmental Impact Assessment:

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA

UNIT II

The Interlinking: Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries.

UNIT III

Concepts of the Environmental Audit: Definition, Benefits, Objectives.

Legislation:

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments, Need for Environmental Audit, Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.
- Control Mechanism
  - Waste water reduction
  - Air emission reduction
- Preparation of Audit Report
- Form V Case Studies
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UNIT V

ntroduction to Sustainability: Criteria, Definitions, Challenges of Sustainability, Meaning of The Brundtland Commissions:Principles, perspectives, Inter generational and intra generational Equity, Agenda 21, Earth Summit – 1972, Vienna Convention – 1985, Montreal Protocol,

Kyoto Protocol, Conference of Parties (COP), UNCED Rio Earth Summit – 1992, UNCED Rio Earth Summit – 1992, Rio Earth Summit + 5, Johannesburg Summit 2002. Environment, Economics and Ethics–Dimensions of Sustainable Development. Prototype Carbon Fund (PCF).

Case Studies
Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 712: Energy Modeling & Project Management.

Cr. 3 (48 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets: Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing: Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning: Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis, Energy action planning, Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management: Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs, and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Project Management: Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring, Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Network Analysis: PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.
10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. Productivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN - 713: Electric Power Generation, Instrumentation, measurements, Transmission and Distribution

Cr. 3 (48 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

Unit - II

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer,

Classification of transducers:

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, capacitive and Inductive transducer, selection of transducers

Pressure measurement: manometers; diaphragm, below elements, vacuum gases, Bendron tube.

Unit - III

Temperature measurement: Thermocouples, RTCs, Thermist ors, Radiation and optical pyrometer,

Flow measurement: pilot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

Unit IV

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phase Diagram Power in Balanced, Three-Phase Circuit. Basics of Transmission & Distribution System, Impedance of Transmission Lines, Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit V

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses. Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power, Danpat Rai and Sons. .
4. Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
5. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
6. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
7. Nuclear Energy By Raymond L. Murray 6th Edition (2008).
8. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
9. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
10. Doeblin – Measurement System McGrew Hill Book Co., (1981).
11. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
12. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
13. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
14. Instrumentation, Measurement and Control – D S Kumar

EN – 801: Heat Transfer and Energy Conservation Laboratory
Credits 3 (48 Hours)

1. Determine the percentage of excess air required for given fuel.
2. Determination of Stack Gas Composition by flue gas analyzer:
   a) Percentage of CO_2 or O_2 in flue gas.
   b) Percentage of CO in flue gas
   c) Temperature of flue gas.
3. Determine the radiation, convection loss and opening in boiler or furnace
4. Determine the Efficiency and loading of motor
5. Determine the Efficiency of the given Blower, fan and Pump.
6. Determine the performance of Air Compressor System
7. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition units (Window AC Conventional, Split AC Conventional), Split AC Energy Efficient. 8.
8. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
9. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
10. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.
11. To determine the heat transfer coefficient in natural convection and forced convection.
12. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
13. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to water).
14. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to air).
15. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Shall & Tube).
16. To determine heat transfer coefficient for drop and film wise condensation.
17. To determine the performance of heat pipe.
18. To determine thermal conductivity of an insulating power.
19. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 802: Biomass and Environmental Laboratory

Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, Ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids, volatile Solids and calorific value for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
6. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.
5. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
6. Determination of Fats/oil Content and Carbohydrates in a given oil seed Biomass Sample.
7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.
8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
9. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
10. Estimation the calorific value of gaseous fuel using orsate apparatus and comparing your result with Junker gas calorimeter.
11. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.
12. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
13. Determination of Crude Protein in a Given Biomass Sample.
14. Study of Gasifier and its performance evaluation with solid and loose biomass.
15. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel
16. Preparation of bio-diesel and determination of it physical properties
17. Performance study of CI engine with different fuel
18. Preparation of alcohol and its Performance study with SI engine
19. Calibration of thermocouples
20. Estimation of Heavy Metals by AAS method from a given effluent

EN - 803: Solar Thermal and Photovoltaic Laboratory

Cr. 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. Determination of Heat Loss Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built in Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker (First and Second Figure of Merit).
6. Performance Evaluation of a Single Basin Solar Still.
7. Thermal Testing of Concentrated Solar Cooker (F_0 and FU_l.)
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Power Load Characteristic of a Photovoltaic Cell.
11. Power Output Vs Exposed Area.
12. Power Output Vs Azimuthal and Tilt Angle
13. Spectral Response of a PV Cell.
14. PV System Performance
15. Study the Effect of Solar Irradiance and ambient air Temperature on Module Output.
16. Calibration of Thermocouples and RTD.
19. Calibration of Pyranometers.
20 Determination of geographical N-S direction.

EN-804: Energy and Environment Software Applications

Cr. 3 (48 Hours)

Recommended Books

S. No.	List of Experiments
1.	Create a letter which you intent to print or e-mail multiple times, sending each copy to a different recipient (use of mail merge).
2.	Hyperlink your word document to (i) Link other word file in the existing word document. (ii) Link word/phrase to another word/phrase within the same document. (iii) Create a link to a web page in the existing document.
3.	Create bookmarks in word document by Name as well as by Location.
4.	Insert page numbers in word document such that first five pages carry Roman numbers and rest of the pages are numbered 1,2,3 and so on.
5.	Create a basic spreadsheet by entering numbers, text, apply formulas, functions, special formatting, sorting, filtering and demonstrate the ease of creating charts, trend line fitting etc.
6.	Create a 2 storey building 20*30 m with pitched roof. Add a dormer window in the middle of sloping roof using an outline block. Set the vertical walls of the dormer window at 1.5 m and make the sloping roof 1.5 m long at 45 degrees. Convert the dormer window outline block to a building block and add a window 1m * 1m. Now cut a hole in the sloping roof of the main roof block and merge the two blocks. Visualize the building and look inside.
7.	Design simple 10*30 m building with long dimension running North to South. Divide building into 4 zones. Set the activity at building level as Office_OpenOff. Set activity for Zone 3 as Office_Reception. Set the activity for Zone 4 as Office_Store. At building level select the lighting template as T8 Fluorescent, triphosphor high frequency control gear. Set the lighting energy as 16 W/m^2. Note schedule Office_OpenOff_Light has been inherited from the activity. Select luminaries type as surface mount. Turn on lighting control and set control type to linear and % area covered by lighting area1 to 40%. Now go to Zone 3, reception. Select lighting template as fluorescent compact. Accept default 23 W/m^2 and set luminaire type as recessed. Turn off lighting control. Now go to zone 4, store. Select lighting template as metal halide. Set luminaries type to suspend. Turn off lighting.
8.	Design a 2 storey building and create openings such as Windows, vents, doors, holes etc.
9.	Create a project for a location and a create a new building using default options and draw a block 20m * 10m with the longer façade facing North and South. Keep the default Office _Open Off activity and use defaults for constructions, openings and lighting. At building level go to the HVAC tab and Load the Packaged Direct Expansion HVAC template. Set the Mechanical ventilation Outside air definition method to 1-By Zone. Set the Mechanical ventilation Outside air delivery to be 2 ac/h. Leave the Mechanical ventilation Operation schedule to be Office _Open Off_Occ. At building level go to the Activity tab and open the Environmental Conditions header and leave the heating setpoint at 22° C and the cooling setpoint at 24° C. Click on the simulation tab and select hourly and daily results in the Simulation Options dialog and press O.K. to start the simulation. Analyze the results.
10.	Create an input file using text editor in trnsys environment to calculate the collectors useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
11.	Create an input file using graphical user interface in trnsys environment to calculate the collector's useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
12.	Determine the environmental score of a project/plan by considering environmental components in each of four categories using RIAM software.
13.	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for solar water heating system (SWH) using RET Screen software.
14.	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for PV applications using RET Screen software.

Recommended Books

1. Using MS – Office 2000- Woody Leonhard
2. The complete guide to MS – Office –Ron Monsfield
3. Turba, Information Technology, Wiley & Sons
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada
5. Manuals of TRNSYS
6. Manuals of Design Builder
7. SCREEN3 Model User's Guide
8. RIAM Model User's Guide

M. Tech. Energy Management (Regular)

Year 2018-2020

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,

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Ph: 0731-2460309, 2462366, Fax: 0731-2467378

Web: www. dauniv.ac.in

M.TECH. (ENERGY MANAGEMENT) 2018-2020

Eligibility Graduate Degree in Engineering or M Sc. Physics with minimum of 55% marks
Duration 4 Semesters
Seats 18

COURSE	COURSE TITLE	Crs.	Hrs	SEM	Faculty
Core Theory Course		L+T+P			
EN-701	Solar Energy: Fundamentals, Devices and Systems	3+1+0	64	I	SPS
EN-702	New & Renewable Energy, Sources and Technologies	3+1+0	64	I	RNS
EN-703	Engineering Thermodynamics, Heat Transfer and Process Integration	3+1+0	64	II	SPS
EN-704	Water and Waste Water: Pollution & Control Technologies	3+1+0	64	II	RC
EN-705	Air and Noise Pollution: Effects and Control Technologies	3+1+0	64	II	RC
EN-706	Energy Management (Thermal)	3+1+0	64	III	SPS
EN-707	Energy Management (Electrical Systems)	3+1+0	64	I	SPS
EN-708	Efficient Lighting: Sources, Systems and Design Aspects	3+1+0	64	III	SPS
EN-709	Green Building Technologies	3+1+0	64	III	SPS
EN-710	Bio and Solid Waste Management	3+1+0	64	II	RNS
	TOTAL CREDITS (Core course)	**40**	640		
Elective Theory Courses					
EN-711	Sustainable development, Environmental Auditing and Environmental Impact Assessment	3+0+0	48	I	RC
EN-712	Energy Modeling and Project Management	2+1+0	48	II	RNS
EN-713	Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution	2+1+0	48	III	RNS
	TOTAL CREDITS (Elective/ Choice based course))	**9**	144		
EN-801	Heat Transfer and Energy Conservation Laboratory	0+0+3	48	I	RNS
EN-802	Biomass and Environmental laboratory	0+0+3	48	III	SPS/RC
EN-803	Solar Thermal and Photo - Voltaic Laboratory	0+0+3	48	II	SPS
EN-804	Energy & Environment Software Application	0+0+3	48	I	RC
	TOTAL CREDITS (LABORATORY)	**12**	192		
EN-805	Field Visits (Lab)	0+0+2	-	II	SPS/RNS/ RC
EN-806	Seminar	1	-	III	SPS/RNS/ RC
EN-807	Mini Project	0+0+4	-	III	SPS/RNS/ RC
EN-808	Major Project	0+0+12	-	IV	SPS/RNS/ RC
	Comprehensive Viva-vice	**16**(4+4+ 4+4)	-	I+ II+ III+IV	External+ Internal

	TOTAL CREDITS (OTHERS)	**35**	-		
	GRAND TOTAL	**96**			

10 seats are available for GATE qualified candidates. * Scholarship @Rs.12,400/ month for GATE qualified candidates

CORE THEORY COURSE

EN 701: Solar Energy: Fundamentals, Devices and Systems

Credits: 4 (64 Hours)

UNIT I: Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II: Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III:
Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow & Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.
Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**
Solar Power Generator

i. Solar Thermal Power Generation	:	Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	:	Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	:	Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	:	Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P Agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 4 (64 Hours)

Unit I: World Energy Scenario

Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Sustainable Development, Role of Renewable Energy sources in Sustainable development, Energy Consumption and its impact on environmental climatic change.

Indian Energy Scenario:

Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

***UNIT – II* Wind Energy**

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, Wind Farms, wind mills & their applications, Cost economics, case studies.

UNIT – III Small Scale Hydroelectric (Mini & Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems, Hydrolic Ram and its Applications

UNIT – IV Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

UNIT – V Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems

UNIT – VI Direct Energy Conversion

FUEL CELLS

Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration.

HYDROGEN ENERGY

Production, Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Recommended Books

1. Twidell & AW. Wier, Renewable Energy Resources, English Language book, Society *I* E & FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy; 'Noyes DATA Corporation, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980
10. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy
11. Leon freris- Renewable energy
12. Da Rosa – Fundamental of renewable energy
13. TERI Energy Data Year Books.
14. Planning commission statistics
15. www.bp.com/centres/energy
16. www.eia.doe.gov
17. www.epa.org
18. Bureau of Energy Efficiency- Volume 1

EN-703: Engineering Thermodynamics, Heat Transfer and Process Integration

Credits: 4 (64 Hours)

Unit I

Basic Heat Transfer Concept and Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction: Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection: Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation: Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting, Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

UNIT V

Engineering Thermodynamics: Quantity and Quality Aspects

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

The First Law of Thermodynamics:

Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:

Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium, Thermodynamics Analysis of Process

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M. Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)
7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (2nd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-704: Water and Waste Water: Pollution and Control Technologies
Credits: 4 (64 Hours)

UNIT I

Fundamentals: Definition, Classification, Sources Water quality Standards.
Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants.
Surface Water Treatment: Water Purification, Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) and Its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT II

Water Treatment Methods: Principles and Design, Aeration Systems, types of settling and settling equations, design criteria and design of settling tanks.
Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.
Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT III

Unit processes, Water Softening- Principles and design- Ions causing hardness, various methods.
Waste Water Treatment: Principles and Design, Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis. Mass Loading Factors, Impacts, Estimation and Their Unit Loading.

UNIT IV

'Principle of Biological Treatment; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency.
Theoretical principles and design : Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Aerobic Attached Growth, Trickling Filters,

UNIT V

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants
Sludge Processing: separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Numerical problems and Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S. Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.

7. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. "Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.

EN-705: Air and Noise Pollution: Effects and Control Technologies

Credits: 4 (64 Hours)

UNIT I

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

UNIT II

Air Pollution & Control: Definition, Air Quality, Classification of Air Pollutants, Air Pollution Episodes.

UNIT III

Air Pollution Monitoring

Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_x, NO_x, CO, Oxidants and Ozone.

UNIT IV

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths.

Air pollution control technologies for particulates and gaseous contaminants.

Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT V

Global Concerns, Light Pollution and Thermal Pollution

Recommended Books

1. Understanding Environmental Pollution Marquita K.
2. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
3. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
4. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
5. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
6. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
7. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
8. T K Ray, Air Pollution Control in Industries , Vol-1,2
9. J.N.B, Air Pollution and Plant Life.
10. Robert Jennings Heinson, Air Pollution.

EN- 706: Energy Management (Thermal System)

Credits: 4 (64 Hours)

UNIT I

Fuel Analysis: Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces: Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractory: Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractory, Case Studies.

UNIT III

Boilers: Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers: Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System: Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration: Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery: Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.
Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta, Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar, Anderlind, A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman, Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 707: Energy Management (Electrical System)

Credits: 4 (64 Hours)

UNIT I

Energy Auditing Techniques: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

Material and Energy Balance: Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used,

Methodologies of Conducting Energy Audit: Preliminary & Detailed Energy Audit Methodology: Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Energy Audit Report: Outlines of Energy Audit Report Format, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures,

Government Notification & Scheme: Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA, Useful Forms for Data Collections, Useful Charts for Quick Estimations, Checklists for each Devices and Distribution Lines, Thumb Rules and Specific Energy Indices for Devices and Processes

UNIT II

Basic Electrical Systems: Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill Analysis: ECO (Energy Conservation Opportunities)

Electricity tariff and components, load Management & Demand Side Control, power factor improvement & its benefit, selection and location of capacitors, Performance Assessment of capacitors & Capacitor Bank.

Lighting Systems: Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.

Transformers and Electric Distribution: Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).

Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT V :

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

Cooling Tower: Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

UNIT VI

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System: Factors affecting selection, Energy performance assessment of

diesel conservation avenues

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities
14. Instructions to Energy Auditors, Vol. - I & Vol. - II –
15. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
16. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
17. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
18. BEE VolumeI –Second Edition 2005
19. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN – 708: Efficient Lighting: Sources, Systems and Design Aspects

Credits: 4 (64 Hours)

Unit I : Lighting

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II; Eye

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic

Correlated Color Temperature Glare, Brightness, Contrast, Color Rendering, Photometric Analysis.

Unit III : Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement

Unit IV: Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard.

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 709: Green Building Technologies

Credits: 4 (64 Hours)

Unit I: Green Building Design Strategies and Building Codes

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III Heating Cooling Concepts

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense
Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;
Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV Heat Transmission in Buildings:

Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V Modeling of Building:

Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application. ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments, Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.

Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology
Case Studies

Recommended Books

1. M S Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN- 710: Bio and Solid Waste Management

Credits: 4 (64 Hours)

Unit I: Biomass & Biomass management

Biomass availability, Characteristics of biomass or organic wastes, Energy Plantation, Waste Biomass/Organic utilization Technology options, Potential, Process and technologies, characteristics of Briquettes and their use.

Unit II: Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & gas storage systems.

Unit III: Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output gas production, properties of output gases (mainly producer gas), Design of a Gasifier.

Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV: Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications.

Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V: Characterization of Different Types of Solid Waste, Municipal Solid Waste, Agro Waste, Others.

Hazardous Waste:

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation and Environmental Impact.

Unit VI: Waste Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration technology, Incineration, Landfill, Refused Derived Fuels.

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi
2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore
4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy
5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi
6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.
8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co. Ltd. 1984
9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,
10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988
11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.
12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984
14. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid waste processing & recovery. The Humane press, Cliton, New Jersey.
15. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.
16. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.
17. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994
18. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
19. Hazardous Waste Management – Charles A. Wentz
20. T V Ramchandra- Management of Municipal Waste

ELECTIVE THEORY COURSES

EN –711: Sustainable development, Environmental Auditing and Environmental Impact Assessment

Cr. 3 (48 Hours)

UNIT I

Elements of Environmental Impact Assessment:

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA

UNIT II

The Interlinking: Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries.

UNIT III

Concepts of the Environmental Audit: Definition, Benefits, Objectives.

Legislation:

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments, Need for Environmental Audit, Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.
- Control Mechanism
  - Waste water reduction
  - Air emission reduction
- Preparation of Audit Report
- Form V Case Studies

UNIT V

Introduction to Sustainability: Criteria, Definitions, Challenges of Sustainability, Meaning of The Brundtland Commissions:Principles, perspectives, Inter generational and intra generational Equity, Agenda 21, Earth Summit – 1972, Vienna Convention – 1985, Montreal Protocol,

Kyoto Protocol, Conference of Parties (COP), UNCED Rio Earth Summit – 1992, UNCED Rio Earth Summit – 1992, Rio Earth Summit + 5, Johannesburg Summit 2002. Environment, Economics and Ethics–Dimensions of Sustainable Development. Prototype Carbon Fund (PCF).

Case Studies

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 712: Energy Modeling & Project Management.

Cr. 3 (48 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets: Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing: Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning: Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis, Energy action planning, Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Application of LP model in transportation, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management: Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs, and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Project Management: Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring, Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Network Analysis: PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.
10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. Productivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN - 713: Electric Power Generation, Instrumentation, measurements, Transmission and Distribution

Cr. 3 (48 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

Unit - II

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer,

Classification of transducers:

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, capacitive and Inductive transducer, selection of transducers

Pressure measurement: manometers; diaphragm, below elements, vacuum gases, Bendron tube.

Unit - III

Temperature measurement: Thermocouples, RTCs, Thermist ors, Radiation and optical pyrometer,

Flow measurement: pilot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

Unit IV

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phase Diagram Power in Balanced, Three-Phase Circuit. Basics of Transmission & Distribution System, Impedance of Transmission Lines, Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit V

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses. Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power, Danpat Rai and Sons. .
4. Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
5. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
6. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
7. Nuclear Energy By Raymond L. Murray 6th Edition (2008).
8. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
9. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
10. Doeblin – Measurement System McGrew Hill Book Co., (1981).
11. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
12. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
13. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
14. Instrumentation, Measurement and Control – D S Kumar

EN – 801: Heat Transfer and Energy Conservation Laboratory

Credits 3 (48 Hours)

1. Determine the percentage of excess air required for given fuel.
2. Determination of Stack Gas Composition by flue gas analyzer:
   a) Percentage of CO_2 or O_2 in flue gas.
   b) Percentage of CO in flue gas
   c) Temperature of flue gas.
3. Determine the radiation, convection loss and opening in boiler or furnace
4. Determine the Efficiency and loading of motor
5. Determine the Efficiency of the given Blower, fan and Pump.
6. Determine the performance of Air Compressor System
7. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition units (Window AC Conventional, Split AC Conventional), Split AC Energy Efficient. 8.
8. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
9. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
10. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.
11. To determine the heat transfer coefficient in natural convection and forced convection.
12. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
13. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to water).
14. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Water to air).
15. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode (Shall & Tube).
16. To determine heat transfer coefficient for drop and film wise condensation.
17. To determine the performance of heat pipe.
18. To determine thermal conductivity of an insulating power.
19. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 802: Biomass and Environmental Laboratory

Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, Ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids, volatile Solids and calorific value for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
6. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.
5. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
6. Determination of Fats/oil Content and Carbohydrates in a given oil seed Biomass Sample.
7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.
8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
9. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
10. Estimation the calorific value of gaseous fuel using orsate apparatus and comparing your result with Junker gas calorimeter.
11. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.
12. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
13. Determination of Crude Protein in a Given Biomass Sample.
14. Study of Gasifier and its performance evaluation with solid and loose biomass.
15. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel
16. Preparation of bio-diesel and determination of it physical properties
17. Performance study of CI engine with different fuel
18. Preparation of alcohol and its Performance study with SI engine
19. Calibration of thermocouples
20. Estimation of Heavy Metals by AAS method from a given effluent

EN - 803: Solar Thermal and Photovoltaic Laboratory

Cr. 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. Determination of Heat Loss Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built in Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker (First and Second Figure of Merit).
6. Performance Evaluation of a Single Basin Solar Still.
7. Thermal Testing of Concentrated Solar Cooker (F_0 and FU_l.)
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Power Load Characteristic of a Photovoltaic Cell.
11. Power Output Vs Exposed Area.
12. Power Output Vs Azimuthal and Tilt Angle
13. Spectral Response of a PV Cell.
14. PV System Performance
15. Study the Effect of Solar Irradiance and ambient air Temperature on Module Output.
16. Calibration of Thermocouples and RTD.

19. Calibration of Pyranometers.

20 Determination of geographical N-S direction.

EN-804: Energy and Environment Software Applications

Cr. 3 (48 Hours)

Recommended Books

S. No.	List of Experiments
1.	Create a letter which you intent to print or e-mail multiple times, sending each copy to a different recipient (use of mail merge).
2.	Hyperlink your word document to (i) Link other word file in the existing word document. (ii) Link word/phrase to another word/phrase within the same document. (iii) Create a link to a web page in the existing document.
3.	Create bookmarks in word document by Name as well as by Location.
4.	Insert page numbers in word document such that first five pages carry Roman numbers and rest of the pages are numbered 1,2,3 and so on.
5.	Create a basic spreadsheet by entering numbers, text, apply formulas, functions, special formatting, sorting, filtering and demonstrate the ease of creating charts, trend line fitting etc.
6.	Create a 2 storey building 20*30 m with pitched roof. Add a dormer window in the middle of sloping roof using an outline block. Set the vertical walls of the dormer window at 1.5 m and make the sloping roof 1.5 m long at 45 degrees. Convert the dormer window outline block to a building block and add a window 1m * 1m. Now cut a hole in the sloping roof of the main roof block and merge the two blocks. Visualize the building and look inside.
7.	Design simple 10*30 m building with long dimension running North to South. Divide building into 4 zones. Set the activity at building level as Office_OpenOff. Set activity for Zone 3 as Office_Reception. Set the activity for Zone 4 as Office_Store. At building level select the lighting template as T8 Fluorescent, triphosphor high frequency control gear. Set the lighting energy as 16 W/m^2. Note schedule Office_OpenOff_Light has been inherited from the activity. Select luminaries type as surface mount. Turn on lighting control and set control type to linear and % area covered by lighting area1 to 40%. Now go to Zone 3, reception. Select lighting template as fluorescent compact. Accept default 23 W/m^2 and set luminaire type as recessed. Turn off lighting control. Now go to zone 4, store. Select lighting template as metal halide. Set luminaries type to suspend. Turn off lighting.
8.	Design a 2 storey building and create openings such as Windows, vents, doors, holes etc.
9.	Create a project for a location and a create a new building using default options and draw a block 20m * 10m with the longer façade facing North and South. Keep the default Office _Open Off activity and use defaults for constructions, openings and lighting. At building level go to the HVAC tab and Load the Packaged Direct Expansion HVAC template. Set the Mechanical ventilation Outside air definition method to 1-By Zone. Set the Mechanical ventilation Outside air delivery to be 2 ac/h. Leave the Mechanical ventilation Operation schedule to be Office _Open Off_Occ. At building level go to the Activity tab and open the Environmental Conditions header and leave the heating setpoint at 22° C and the cooling setpoint at 24° C. Click on the simulation tab and select hourly and daily results in the Simulation Options dialog and press O.K. to start the simulation. Analyze the results.
10.	Create an input file using text editor in trnsys environment to calculate the collectors useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
11.	Create an input file using graphical user interface in trnsys environment to calculate the collector's useful energy gain and the required auxiliary heat input for a Solar Water Heating System. The system consists of a flat-plate collector, a pump, a constant temperature water supply, and an auxiliary heater designed to supply 60° C water at all times.
12.	Determine the environmental score of a project/plan by considering environmental components in each of four categories using RIAM software.
13.	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for solar water heating system (SWH) using RET Screen software.
14.	Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for PV applications using RET Screen software.

Recommended Books

1. Using MS – Office 2000- Woody Leonhard
2. The complete guide to MS – Office –Ron Monsfield
3. Turba, Information Technology, Wiley & Sons
4. A Handbook to EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada
5. Manuals of TRNSYS
6. Manuals of Design Builder
7. SCREEN3 Model User's Guide
8. RIAM Model User's Guide

Reviewed the curriculum of M Tech (Energy management) as per ordinance (31) by the Departmental Committee

Revision in the syllabus was done in the different year in view of the UGC norms, student feedback and Intentional/ National scenario. The content of the courses were separated or merged in the different courses as per the requirement. All the modifications of last five year is summarized in the below table.

SN.	**2013-14 syllabus (Base year) Total credits: 113**	**2014-15 syllabus Total credits: 120**	**Percentage Changed on Cr. basis**
1		• One new Course Computer Application: Energy & Environment Software of 4 credits was introduced • Sustainable development topic was added in Environmental Auditing and Environmental Impact Assessment.	6.19%
2	**2014-15 syllabus Total credits: 120**	**2015-16 syllabus Total credits: 84**	
		• Major changes has been taken in the syllabus • 36 credit (30%) has been reduced to meet the requirement of CBCS • Water and Waste Water: Pollution and Control Technologies & Air and Noise Pollution: Effects and Control Technologies have been merged and content is reduced to make it of 3cr. • Energy Auditing Techniques paper content has been merged in Energy Conservation (Electrical Systems) and content is reduced to make it of 3 credits. • Electrical Power Generation, Transmission and Distribution paper content has been merged in Instrumentation, Measurements and Controls and content is reduced to make it of 3 credits. Name was changed as Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution • Bio and Fossil Fuels Technology paper content has been merged in Solid Waste Management and content is reduced to make it of 3 credits. Name was changed as Bio & Solid Waste Management	30%
3	**2015-16 syllabus Total credits: 84**	**2016-17 syllabus Total credits: 84**	
		No change in the syllabus	0 %
4	**2016-17 syllabus Total credits: 84**	**2017-18 syllabus Total credits: 88**	
	Water and Waste Water: Pollution & Control Technologies & Air and Noise	This paper was changed into two papers of 6 credit (3 credit each) named as • Water and Waste Water: Pollution and Control Technologies • Air and Noise Pollution: Effects and Control Technologies	4.76%

P.T.O

	Pollution: Effects and Control Technologies were 3 credits.		
5	**2017-18 syllabus Total credits: 88**	**2018-19 syllabus Total credits: 96**	
	Total cr. of theory core courses was of 30 credits.	Total credit of theory core courses increased from 30 to 40cr.	9.09%

Reviewed the curriculum of M Phil (Energy and Environment) as per ordinance by the Departmental Committee

Changes in the courses of M Phil were done as per the decision of UGC/ Coordination committee of MP. All the modifications of last two year is summarized in the below table.

SN.	**2013-14 syllabus (Base year) Total credits: 60**	**2014-15 syllabus Total credits: 90**	**Percentage Changed on Cr. basis**
1	The duration of the course was one year	• The duration of the course was one and half years • All the papers and their credit were remain same except major project was 46 credits instead of 24 credits.	50%

R. Chaudhary

Dr. S. P. Singh
Head
School of Energy & Environmental Studies
Devi Ahilya University Campus,
Khandwa Road, INDORE-452 001 (INDIA)

Minutes of Board of Studies (BOS) Meeting

School of Energy & Environmental Studies, DAVV Indore, BOS meeting was held in the office at 3.0 pm on 30th April 2014.

The following Member were present

Prof. S.P. Singh, Head, SEES, D.A.V.V., Indore	: Chairman
Prof. R.N. Singh, SEES, D.A.V.V, Indore	: Member
Dr. Rubina Chaudhary, Reader, SEES, D.A.V.V, Indore	: Member

The following agenda was taken into consideration by the board member.

Agenda 1: Discussion on Modification of syllabus of M Tech (Energy Management) program.

Decision: It was anonymously decided that Revision in the syllabus was required. It was done in the view of the UGC norms, student feedback and Intentional/ National scenario. As per the 2013-14 syllabus was taken as a base for the revision of 2014-15 syllabus. In M Tech (Energy Management) syllabus:

- Computer Application: Energy & Environment Software of 4 credits course was introduced
- Sustainable development topic was merged with Environmental Auditing and Environmental Impact Assessment course.

Agenda 2: Discussion on course duration of M. Phil (Energy and Environment) program

Decision: As per the decision of UGC/ Coordination committee of MP the duration of the M. Phil (Energy and Environment) program was extend from one year to one and half years. All the papers and their credits were remaining same except major project was continued to 3rd semester (46 credits instead of 24 credits). Total credit of the program was made 90 credits.

(Chairman) **(Member)** 30-1-14 **(Member)** 30.4.2014.

M. Phil. (Energy and Environment)

Year 2013-2014

Syllabus

School of Energy & Environmental Studies,
Devi Ahilya Vishwavidyalaya,
Takshashila Campus, Khandwa Road, Indore-452 017(M.P)
Ph: 0731-2460309, 2462366, Fax: 0731-2467378. www. dauniv.ac.in

M. Phil. (ENERGY AND ENVIRONMENT)
YEAR: 2013-2014

Eligibility Post Graduate Degree in Environmental Science or Engineering with minimum of 55% marks or equivalent degree.
Duration 2 Semesters
Seats 13

COURSE No.	COURSE TITLE	CREDITS
CORE THEORY COURSES		
Semester - I		
EE-701	Review of Related Literature	06
EE-702 (A)	Research Methodology (Theory)	04
EE-702 (B)	Research Methodology (Practical / Techniques and Tools)	04
EE-703	Computer Applications	04
EE-704	Pollution and Control Technologies	04
EE-705	Sustainable Management Tools: Energy and Environment	04
-	Comprehensive Viva Voce	04
	TOTAL CREDITS (THEORY)	30
Semester - II		
PRACTICAL COURSES		
EE-801	Seminar	03
EE-802	Term Paper / Assignments	03
EE-803	Dissertation/Major Project	20
-	Comprehensive Viva Voce	04
	TOTAL CREDITS (PROJECT)	**30**
	GRAND TOTAL	**60**

EE-702 (A) Research Methodology: Theory

4 Credits (64 Hrs)

UNIT I

Foundation of Research: Motivation and objectives – Research methods Vs Methodology. Types of research – Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.

UNIT II

Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

UNIT III

Theory of Sampling - Population and sample Preliminary Ideas of Random, Stratifies, Systematic and Multistage including allocation of resources- Parameter and statistics – Sampling distribution and standard Error.

UNIT IV

Theory of Testing Hypothesis: Meaning, Basic concepts, Null hypothesis – Alternate Hypothesis – Two types of errors levels of significance of a test – power of a Test. Limitations of Tests of hypothesis. Student T test, F test, Z test, ANOVA Table, Chi Square test est.

UNIT VI

Correlation and Regression – Persons Coefficient for Raw and frequency. Data - Spearman's Rank Correlation Coefficient – Regression lines and their use – curve fitting – principle of Least squares- fitting of straight line – length – weight Relationship and Bertrand Growth equation – operational Research and its application, Measurement in Research.

UNIT VII

Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling. Energy and Environmental System modeling

Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, formats of publications in Research journals.

Recommended Books:

1. Environmental systems- Benett R.J.
2. Studies in Environmental Mathematics- Sinha D.K. Mishra A.
3. Mathematical Model
4. ing- Kapur S.N.
5. Research methodology Methods & Techniques - C R Kothari

EE 702 (B) Research Methodologies: Practical/ Technique and Tools
4 Credits (64 Hrs)

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1. Read up the following article which highlights the elements of productive thinking:

P. S. Blackawton et. al., "Blackawton bees", *Biology Lett.*. doi:10.1098/rsbl.2010.1056, published online on 22nd December 2010.

Comments on

- General Thinking Strategies of Author.
- Critical thinking in detail, internet may be used
- Other way of graphical representation of data.
- Other possible solutions apart from the given by the Author for the same problem.

2. Take some burning environment problems and make

- Oral communication
- Written communication
- Discuss among your classmate about the problems
- Write a summary of the discussion material,
- List the references of your oral presentation in proper format, assuming they are being put in a thesis.

3. Estimate the Knowledge skill of SEES student using different Sampling Methods.

4. Analysis the given data using ---------- and discuss the limitation of each test in context of given data.

- T test,
- F test,
- Z test,
- ANOVA Table,
- Square test est.

5. Develop the Correlation and Regression model on the given data

6. Plot the Curve on given data using different curve fitting techniques.

7. Application of operational Research Technique

8. Understanding the skills of Report/ Thesis writing

EE – 703: Computer Applications

(04 credits)

Unit I: Introduction to MS Office Automation Tools

Use and application of MS office automation tools like MS Word, MS Excel, MS Power point, MS Access.

Unit II: MATLAB-I

Introduction to MATLAB, Tutorial lessons, Matrices and Vectors-Scalars and vectors, Multidimensional matrices and arrays, Matrix Manipulation, Matrix and array operations,

Unit III: MATLAB-II

Matlab Graphics- Introduction, 2D-Plots, Multiple plots, specialized 2D plots and 3D plots. Control structure, Writing programs and Functions.

Unit IV: Application of MATLAB in design of Energy Systems

Photovoltaic system, Biogas based systems, Biomass based systems.

Unit V: Application of MATLAB in design of Environmental Systems

Waste Water systems, Air pollution systems, noise pollution systems, solid waste management systems

Recommended Books:

1. Using MS-Office2000-Woody Leonhard.
2. The Computer Guide to MS Office – Ron Monsfield.
3. Environmental Systems – Benett R.J.
4. Studies in Environmental Mathematics –Sinha D. K. and Mishra A.
5. A Handbook of EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada.
6. Getting started with MATLAB 7 A Quick Introduction for Scientists and Engineers – Rudra Pratap.
7. MATLAB and its applications in Engineering- RK Bansal, AK Goel, MK Sharma.

EE-704: Pollution and Control Technologies

4 Credits (64 hours)

UNIT I: WATER POLLUTION

Fundamentals: Definition, Classification, Sources Water quality Standards.

Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants

Water Treatment: Surface water: Water Purification Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) and its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT II: WATER TREATMENT METHODS

Water Treatment Methods: Principles and Design

Unit Operations – Aeration Systems

Sedimentation – types of settling and settling equations, design criteria and design of settling tanks.

Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.

Filtration – theory, types, filter backwash, operational problems and trouble shooting.

Unit processes - disinfection – different types, disinfectants, factors affecting disinfection, methods of disinfection, chemistry of chlorination.

Water Softening- Principles and design- Ions causing hardness, various methods.

UNIT III: WASTE WATER TREATMENT

Waste Water Treatment: Principles and Design

Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis.

Mass Loading Factors, Impacts, Estimation and their unit loading

UNIT IV: KINETICS OF BIOLOGICAL TREATMENT SYSTEMS

Biokinetic constants and their determination, batch and continuous systems.

Theoretical principles and design – Attached growth system – trickling filter, bio-towers and Rotating Biological Contactors

Biological Unit Processes: Principle of Biological Treatment, Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency.

Theoretical principles and design

Aerobic Suspended Growth Systems: Activated Sludge, Aerated Lagoon

Principles and design of stabilization ponds

Aerobic Attached Growth: Trickling Filters

UNIT – V: ANAEROBIC TREATMENT

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types Of Industrial Effluent Treatment Plants

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

Advanced Wastewater Treatment– Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal, Wastewater disinfection

Numerical problems

UNIT – VI: AIR POLLUTION

Classification, Characterization of Pollutants And Their Sources, Vehicular Pollution, Dispersion of Pollutants, Photochemistry, Effect of Air Pollutant on Ecosystems, Control Devices For Particulate & Gaseous Contaminants (Electrostatic Precipitator), Bag Filters, Scrubbers, Cyclones, Incinerator, Adsorption, Absorption Condensation, Controls For Moving Sources, EURO I – V Norms And Specification, Global Concern.

UNIT – VII: SOLID WASTE MANAGEMENT

Waste Management**:** Different Option, Integrated Waste Management Strategies, Collection, Transportation And Environmental Impact.

Generation And Disposal Methods**:** Resources, Disposal and Recovery, Material and Products in Solid Waste.

Characterization of Different Types of Solid Waste, Municipal Solid Waste, Agro – Waste, Others

Case Studies

Recommended Books

1. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
2. Environmental Engineering - Howard S. Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
3. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi
4. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
5. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
6. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999
7. Manual on Sewerage and Sewage Development, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993
8. Environmental Pollution and its control, Jeffrey J. and P.A. Vesilind
9. Air Pollution, M.N. Rao & H.V.N. Rao, Tata McGraw Hill Publication, New Delhi, 12th Ed. 1998
10. Handbook of solid waste management, Frank Kerith, McGraw Hill Inc. USA, 1994

EE – 705: Sustainable Management Tools: Energy and Environment

4 Credits 64 Hrs

UNIT – I: INTRODUCTION TO SUSTAINABILITY

Criteria, Definitions, Challengers of Sustainability, Meaning of Brundtland Definition Of Sustainable Development. Rio Declaration (1992). Agenda 21. Environment, Economics and Ethics – Dimensions of Sustainable Development. Examples of Sustainable and Unsustainable Technologies. United Nations Framework Convention on Climate Change (UNFCCC), Sustainable Development. Kyoto Protocol, Conference of Parties (COP),

UNIT – II: DESCRIPTION OF SUSTAINABLE TECHNOLOGIES

Environmental Impact Assessment:
Principles, Origin And Development of EIA Environmental Impact Analysis, Essential Components of EIA, Project Screening, Baseline Study, Impact Identification, Impact Prediction, Evaluation And Mitigation, Methodology Matrix Method, Network, Overlay,

UNIT - III THE INTERLINKING

Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan For Selected Industries, Case Studies

UNIT - IV ENVIRONMENTAL AUDITING

Concepts of the Environmental Audit: Definition, Benefits, Objectives.

Legislation: Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments.
Need for Environmental Audit
Guidelines for Environmental Audit

Methodology:

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.

- Control Mechanism
    - Waste water reduction
    - Air emission reduction
- Preparation of Audit Report
- Form V

UNIT – V: WASTE MINIMIZATION

Waste Minimization of the following Industries such as, Pulp and Paper, Distillery, Sugar, Fertilizer, Dairy, Textile, Oil Refineries Pharmaceutical and Electroplating, Cement and Tannery.

UNIT – VI: SOLAR ENERGY

Basics of Clean Energy Sources, Conventional and Non Conventional Energy Sources, Problems to Environment from These Sources, Quality and Quantity of Their Magnitude, Comparative Study of Different Pollution Problems in Our Country, Future Scenario of Environmental Degradation Due To Conventional Sources.

Solar Radiation, Earth Sun Relationship (Angles and Models, Earth and Sun Relation), Measurement, Solar Cookers, Solar Collectors, Flat Plate Collectors for Water, Flat Plate Collectors for Air, Concentrating Collectors

UNIT – VII: CLEAN ENERGY TECHNOLOGY

Biomass: Thermo – Chemical Processes: Direct Combustion, Pyrolysis, Gasification Systems, Application, Limitations and Environmental Problems.

Bio-Chemical Processes: Fermentation, Alcohol Production Potential, Uses and Application, Limitation, Benefits; Conversion of bio-diesel, Uses, Application, Limitation and Benefit

Bio – Methanation: Factors Feed Materials Availability, Uses and Application Limitation, Waste to Energy Generation, Landfill Gases, Agrochemical Method To Produce Alternative Fuels.

Wind energy: Potential and Availability, Characteristics of Wind, Estimation and Measurement, Wind Machines, Uses and Applications, Limitations

Wave Energy: Tidal, OTEC: Basic Principle & Systems, Applications and Limitations.

Mini and Micro Hydro Systems, Application, Hydraulic RAM and its Application.

Geothermal Energy: Hot Rocks and Acquifer; Potential Systems, Application and Limitation, Environmental Problems and Remedies.

Hydrogen energy, Clean Coal Technologies, Fuel Cell and Its Applications

Recommended Books

1) Environmental Impact of Industries on Sub Urban Environment S.A. Abbasi, Discovery Publishing House, New Delhi.
2) Global Environmental Negotiations Ist Green, Anil Agrwal And Sunita, CSE, Delhi
3) Environmental Policy in International Context Prospects by Blowers, Andrews, Glas, Scholar Publisher Distributor.
4) Environmental Impact Assessment by Clark Brain, Biset, Mansenn.
5) Chemical Instrumentation Analysis, Chatwal Anand
6) Handbook Of Analytical Instrumentation, R.S. Khandpur, TATA McGraw Hill, New Delhi (1997)
7) Pandey G.N. 1997, Environmental Management, Vikas Publishing House Pvt. Ltd.
8) Sustainable Development in practices, Case Studies for engineering and Scientist, Editor Adisa azapagic, Slobodan perdan, ronald clift, Jhon Wiley (2004).
9) Renewable Energy Resources, John W Twidell & Anthony d Weir, Published by E & F N Spon Ltd, London
10) Non- Conventional Energy Sources; G D Rai, Published by Khanna Publishers, New Delhi
11) Renewable Energy Engineering & Technology – A Knowledge compendium Edited by V V N Kishore; Published by TERI Press, New Delhi
12) Fundamental of Renewable Energy Sources; G N Tewari & M K Ghosal, Published by Narora Publishing House, New Delhi
13) Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
14) J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jersey, U.S.A
15) H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht

M. Phil. (Energy and Environment)

Year 2014-2015

Syllabus

School of Energy & Environmental Studies,

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,Indore-452 017(M.P)

Ph: 0731-2460309, 2462366, Fax: 0731-2467378. www. dauniv.ac.in

M. Phil. (ENERGY AND ENVIRONMENT)
YEAR: 2014-2015

Eligibility Post Graduate Degree in Environmental Science or Engineering with minimum of 55% marks or equivalent degree.
Duration 3 Semesters
Seats 13

COURSE No.	COURSE TITLE	CREDITS
CORE THEORY COURSES		
Semester - I		
EE-701	Review of Related Literature	06
EE-702 (A)	Research Methodology (Theory)	04
EE-702 (B)	Research Methodology (Practical / Techniques and Tools)	04
EE-703	Computer Applications	04
EE-704	Pollution and Control Technologies	04
EE-705	Sustainable Management Tools: Energy and Environment	04
-	Comprehensive Viva Vice	04
	TOTAL CREDITS (THEORY)	30
Semester - II		
EE-801	Seminar	03
EE-802	Term Paper / Assignments	03
EE-803	Dissertation/Major Project	20
-	Comprehensive Viva Voce	04
	TOTAL CREDITS (PROJECT)	**30**
Semester - III		
EE-803	Final Dissertation/Major Project	26
-	Comprehensive Viva Vice	04
	TOTAL CREDITS (PROJECT)	**30**
	GRAND TOTAL	**90**

Note: The Dissertation/Major Project work would start from 2nd semester and completed in the 3rd semester.

EE-701: Review Paper

Credits 6 (96 Hours)

Students supposed to prepare a Review Paper. Title of the review paper may be mutually decided by student and concern Supervisor. At the end of the Semester Review Paper needs to be presented in front of DRC and concern supervisor.

EE-702 (A) Research Methodology: Theory

4 Credits (64 Hrs)

UNIT I

Foundation of Research: Motivation and objectives – Research methods Vs Methodology. Types of research – Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.

UNIT II

Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

UNIT III

Theory of Sampling - Population and sample Preliminary Ideas of Random, Stratifies, Systematic and Multistage including allocation of resources- Parameter and statistics – Sampling distribution and standard Error.

UNIT IV

Theory of Testing Hypothesis: Meaning, Basic concepts, Null hypothesis – Alternate Hypothesis – Two types of errors levels of significance of a test – power of a Test. Limitations of Tests of hypothesis. Student T test, F test, Z test, ANOVA Table, Chi Square test est.

UNIT VI

Correlation and Regression – Persons Coefficient for Raw and frequency. Data - Spearman's Rank Correlation Coefficient – Regression lines and their use – curve fitting – principle of Least squares- fitting of straight line – length – weight Relationship and Bertrand Growth equation – operational Research and its application,Measurement in Research.

UNIT VII

Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling. Energy and Environmental System modeling

Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, formats of publications in Research journals.

Recommended Books:

1. Environmental systems- Benett R.J.
2. Studies in Environmental Mathematics- Sinha D.K. Mishra A.
3. Mathematical Modeling- Kapur S.N.
4. Research methodology Methods & Techniques - C R Kothari

EE 702 (B) Research Methodologies: Practical/ Technique and Tools
4 Credits (64 Hrs)

1. Read up the following article which highlights the elements of productive thinking:

P. S. Blackawton et. al., "Blackawton bees", *Biology Lett.*. doi:10.1098/rsbl.2010.1056, published online on 22nd December 2010.

Comments on

- General Thinking Strategies of Author.
- Critical thinking in detail, internet may be used
- Other way of graphical representation of data.
- Other possible solutions apart from the given by the Author for the same problem.

2. Take some burning environment problems and make

- Oral communication
- Written communication
- Discuss among your classmate about the problems
- Write a summary of the discussion material,
- List the references of your oral presentation in proper format, assuming they are being put in a thesis.

3. Estimate the Knowledge skill of SEES student using different Sampling Methods.

4. Analysis the given data using ---------- and discuss the limitation of each test in context of given data.

- T test,
- F test,
- Z test,
- ANOVA Table,
- Square test est.

5. Develop the Correlation and Regression model on the given data

6. Plot the Curve on given data using different curve fitting techniques.

7. Application of operational Research Technique

8. Understanding the skills of Report/ Thesis writing

EE – 703: Computer Applications

(04 credits)

Unit I: Introduction to MS Office Automation Tools

Use and application of MS office automation tools like MS Word, MS Excel, MS Power point, MS Access.

Unit II: MATLAB-I

Introduction to MATLAB, Tutorial lessons, Matrices and Vectors-Scalars and vectors, Multidimensional matrices and arrays, Matrix Manipulation, Matrix and array operations

Unit III: MATLAB-II

Matlab Graphics- Introduction, 2D-Plots, Multiple plots, specialized 2D plots and 3D plots. Control structure, Writing programs and Functions.

Unit IV: Application of MATLAB in design of Energy Systems

Photovoltaic system, Biogas based systems, Biomass based systems.

Unit V: Application of MATLAB in design of Environmental Systems

Waste Water systems, Air pollution systems, noise pollution systems, solid waste management systems

Recommended Books:

1. Using MS-Office2000-Woody Leonhard.
2. The Computer Guide to MS Office – Ron Monsfield.
3. Environmental Systems – Benett R.J.
4. Studies in Environmental Mathematics –Sinha D. K. and Mishra A.
5. A Handbook of EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada.
6. Getting started with MATLAB 7 A Quick Introduction for Scientists and Engineers – Rudra Pratap.
7. MATLAB and its applications in Engineering- RK Bansal, AK Goel, MK Sharma.

EE – 703: Computer Applications

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5. A Handbook of EMIS, Published by the Office of Energy Efficiency of Natural Resources Canada.
6. Getting started with MATLAB 7 A Quick Introduction for Scientists and Engineers – Rudra Pratap.
7. MATLAB and its applications in Engineering- RK Bansal, AK Goel, MK Sharma.

EE-704: Pollution and Control Technologies

4 Credits (64 hours)

UNIT I: WATER POLLUTION

Fundamentals: Definition, Classification, Sources Water quality Standards.

Water Chemistry:Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants

Water Treatment: Surface water:Water Purification Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) and its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT II: WATER TREATMENT METHODS

Water Treatment Methods:Principles and Design

Unit Operations – Aeration Systems

Sedimentation – types of settling and settling equations, design criteria and design of settling tanks.

Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.

Filtration – theory, types, filter backwash, operational problems and trouble shooting.

Unit processes - disinfection – different types, disinfectants, factors affecting disinfection, methods of disinfection, chemistry of chlorination.

Water Softening- Principles and design- Ions causing hardness, various methods.

UNIT III: WASTE WATER TREATMENT

Waste Water Treatment: Principles and Design

Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis.

Mass Loading Factors, Impacts, Estimation andtheir unit loading

UNIT IV: KINETICS OF BIOLOGICAL TREATMENT SYSTEMS

Biokinetic constants and their determination, batch and continuous systems.

Theoretical principles and design – Attached growth system – trickling filter, bio-towers and Rotating Biological Contactors

Biological Unit Processes: Principle of Biological Treatment, Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency.

Theoretical principles and design

Aerobic Suspended Growth Systems: Activated Sludge, Aerated Lagoon

Principles and design of stabilization ponds

Aerobic Attached Growth: Trickling Filters

UNIT – V: ANAEROBIC TREATMENT

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types Of Industrial Effluent Treatment Plants

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

Advanced Wastewater Treatment– Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal, Wastewater disinfection

Numerical problems

UNIT – VI: AIR POLLUTION

Classification, Characterization of Pollutants And Their Sources, Vehicular Pollution, Dispersion of Pollutants, Photochemistry, Effect of Air Pollutant on Ecosystems, Control Devices For Particulate & Gaseous Contaminants (Electrostatic Precipitator), Bag Filters, Scrubbers, Cyclones, Incinerator, Adsorption, Absorption Condensation, Controls For Moving Sources, EURO I – V Norms And Specification, Global Concern.

UNIT – VII: SOLID WASTE MANAGEMENT

Waste Management**:** Different Option, Integrated Waste Management Strategies, Collection, Transportation And Environmental Impact.

Generation And Disposal Methods**:** Resources, Disposal and Recovery, Material and Products in Solid Waste.

Characterization of Different Types of Solid Waste, Municipal Solid Waste, Agro – Waste, Others

Case Studies

Recommended Books

1. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
2. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
3. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi
4. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
5. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
6. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999
7. Manual on Sewerage and Sewage Development, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993
8. Environmental Pollution and its control, Jeffrey J. and P.A. Vesilind
9. Air Pollution, M.N. Rao & H.V.N. Rao, Tata McGraw Hill Publication, New Delhi, 12th Ed. 1998
10. Handbook of solid waste management, Frank Kerith, McGraw Hill Inc. USA, 1994

EE – 705: Sustainable Management Tools: Energy and Environment
4 Credits 64 Hrs

UNIT – I: INTRODUCTION TO SUSTAINABILITY

Criteria, Definitions, Challengers of Sustainability, Meaning of Brundtland Definition Of Sustainable Development. Rio Declaration (1992). Agenda 21. Environment, Economics and Ethics – Dimensions of Sustainable Development. Examples of Sustainable and Unsustainable Technologies. United Nations Framework Convention on Climate Change (UNFCCC), Sustainable Development. Kyoto Protocol, Conference of Parties (COP),

UNIT – II: DESCRIPTION OF SUSTAINABLE TECHNOLOGIES

Environmental Impact Assessment:
Principles, Origin And Development of EIA Environmental Impact Analysis, Essential Components of EIA, Project Screening, Baseline Study, Impact Identification, Impact Prediction, Evaluation And Mitigation, Methodology Matrix Method, Network, Overlay,

UNIT - III THE INTERLINKING

Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan For Selected Industries, Case Studies

UNIT - IV ENVIRONMENTAL AUDITING

Concepts of the Environmental Audit: Definition, Benefits, Objectives.

Legislation: Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments.
Need for Environmental Audit
Guidelines for Environmental Audit

Methodology:

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.

- Control Mechanism
    - Waste water reduction
    - Air emission reduction
- Preparation of Audit Report
- Form V

UNIT – V:WASTE MINIMIZATION

Waste Minimization of the following Industries such as, Pulp and Paper, Distillery, Sugar, Fertilizer, Dairy, Textile, Oil Refineries Pharmaceutical and Electroplating, Cement and Tannery.

UNIT – VI: SOLAR ENERGY

Basics of Clean Energy Sources, Conventional and Non Conventional Energy Sources, Problems to Environment from These Sources, Quality and Quantity of Their Magnitude, Comparative Study of Different Pollution Problems in Our Country, Future Scenario of Environmental Degradation Due To Conventional Sources.

Solar Radiation, Earth Sun Relationship (Angles and Models, Earth and Sun Relation), Measurement, Solar Cookers, Solar Collectors, Flat Plate Collectors for Water, Flat Plate Collectors for Air, Concentrating Collectors

UNIT – VII: CLEAN ENERGY TECHNOLOGY

Biomass: Thermo – Chemical Processes: Direct Combustion, Pyrolysis, Gasification Systems, Application, Limitations and Environmental Problems.

Bio-Chemical Processes: Fermentation, Alcohol Production Potential, Uses and Application, Limitation, Benefits; Conversion of bio-diesel, Uses, Application, Limitation and Benefit

Bio – Methanation: Factors Feed Materials Availability, Uses and Application Limitation, Waste to Energy Generation, Landfill Gases, Agrochemical Method To Produce Alternative Fuels.

Wind energy: Potential and Availability, Characteristics of Wind, Estimation and Measurement, Wind Machines, Uses and Applications, Limitations

Wave Energy: Tidal, OTEC: Basic Principle & Systems, Applications and Limitations.

Mini and Micro Hydro Systems, Application, Hydraulic RAM and its Application.

Geothermal Energy: Hot Rocks and Acquifer; Potential Systems, Application and Limitation, Environmental Problems and Remedies.

Hydrogen energy, Clean Coal Technologies, Fuel Cell and Its Applications

Recommended Books

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2) Global Environmental Negotiations Ist Green, Anil Agrwal And Sunita, CSE, Delhi
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12) Fundamental of Renewable Energy Sources; G N Tewari & M K Ghosal, Published by Narora Publishing House, New Delhi
13) Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
14) J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jersey, U.S.A
15) H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht

EE-801: Seminar

Credits 3 (48 Hours)

Students supposed to prepare Two (02) Seminars on recent topics related to Energy and environment and submit a hard copy {(Numbers of copy suppose to be submitted: 04 (Loose Binding)} of the same. Title of the Seminar may be mutually decided by student and concern Supervisor. At the end of the Semester, Seminar should be presented in front of Departmental Committee and concern supervisor.

EE-802: Term Paper/ Assignment

Credits 3 (48 Hours)

Student will have to write a term paper under the guidance of a faculty member, on the subject/ topic mutually decided by student and concern Supervisor and submit a hard copy{(Numbers of copy suppose to be submitted: 04 (Loose Binding)} of the same. It should cover basic concept of the research and issues of investigation. At the end of the Semester Term Paper should be presented in front of Departmental Committee and concern supervisor.

Or

An assignment has to be submitted in the form of Hard & Soft Copy on the subject/ topic decided by concern Supervisor and submit a hard copy {(Numbers of copy suppose to be submitted: 04 (Loose Binding)} of the same. At the end of the Semester Assignment should be presented in front of Departmental Committee and concern supervisor.

EE-803 Mid Term Dissertation/Project Presentation

The dissertation shall comprise of individual and original work by a student under the guidance of a faculty member and /or Co-supervisor (Consultant/ Scientist) on a topic which shall preferably related to an area of his/her interest. The dissertation shall carry a weight of twenty credits and shall be awarded grades as per University.

Prior to submission of final report, the students have to prepare their Synopsis with due consultation of their respective Supervisor. Topic or guide once finalized will not be changed (under extreme condition can be changed by Departmental Committee only). Only those students would be allowed to submit their final dissertation who maintain regularity in their attendance and remain in constant touch with their respective Supervisor. The students have to strictly follow the following pattern of their Synopsis and Dissertation/ Thesis submission.

Format of Synopsis

1. Title

2. Need of the project

3. Introduction

4. Review of literature

5. Objectives

6. Methodology

7. Expected Outcomes

Format of Final Thesis/ Dissertation

1. Title

2. Introduction

3. Review of Literature

4. Objectives

5. Methodology

6. Analysis of data

7. Result & Discussions

8. Conclusion

9. Suggestions

10. References

Note: Numbers of final Thesis/ dissertation copy suppose to be submitted: 04 (Hard Binding)

Cover page Color of final Thesis/ dissertation: