

**M. Tech. Energy Management (Executive)**

***Year 2019-2021***



# **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](http://www.dauniv.ac.in)

## Executive M. Tech. (Energy Management) 2019-2021

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

### First Semester:

Code	Title	Credits (L-T-P)	Hours	Faculty
<b>CORE COURSES</b>				
EN7C-701	Solar Energy: Fundamentals, Devices and Systems	4 (3-1-0)	64	SPS
EN7C-702	New & Renewable Energy, Sources and Technologies	4 (3-1-0)	64	RNS
EN7C-703	Water and Waste Water: Pollution & Control Technologies	4 (3-1-0)	64	RC
EN7C-704	Minor Project -1	4 (0-0-8)	64	SPS/RNS/RC
<b>ELECTIVE COURSES</b>				
EN7C-705	Energy conservation and Waste Heat Recovery	4 (3-1-0)	64	Anyone to be taken from online
EN7C-706	Design Of Photovoltaic Systems	4 (3-1-0)	64	
EN7C-707	Comprehensive Viva-vice	4		
	Total Credit	24		

### Second Semester:

Code	Title	Credits (L T P)		
<b>CORE COURSES</b>				
EN7C-708	Engineering Thermodynamics, Heat Transfer and Process Integration	4 (3-1-0)	64	SPS
EN7C-709	Air and Noise Pollution: Effects and Control Technologies	4 (3-1-0)	64	RC
EN7C-710	Bio and Solid Waste Management	4 (3-1-0)	64	RNS
EN7C-711	Minor Project -2	4 (0-0-8)	64	SPS/RNS/RC
<b>ELECTIVE COURSES</b>				
EN7C-712	Introduction to Remote Sensing	4 (3-1-0)	64	Anyone to be taken from online
EN7C-713	Bio-fuel	4 (3-1-0)	64	
EN7C-714	Comprehensive Viva-vice	4		
	Total Credit	24		

### Third Semester:

Code	Title	Credits (L T P)		
<b>CORE COURSES</b>				
EN7C-801	Green Building	4 (3-1-0)	64	SPS
EN7C-802	Energy Management (Thermal & Electrical)	4 (3-1-0)		DV
EN7C-803	Sustainable development, Environmental Auditing and Environmental Impact Assessment	4 (3-1-0)	64	RC
EN7C-804	Minor Project -3	4 (0-0-8)		SPS/RNS/RC
<b>ELECTIVE COURSES</b>				
EN7C-805	Technical English for Engineers	4 (3-1-0)	64	Anyone to be taken from online
EN7C-806	Geo-environmental Engineering, Landfills Slurry, Ponds and Contamination	4 (3-1-0)		
EN7C-807	Comprehensive Viva-vice	4		
	Total Credit	24		

### Fourth Semester:

Code	Title	Credits (L T P)		
<b>CORE COURSES</b>				
EN7C-808	Energy Modeling and Project Management	4 (3-1-0)	64	RNS
EN7C-809	Electrical Power Generation, Instrumentation, Measurements, Transmission and Distribution	4 (3-1-0)	64	VF
EN7C-810	Efficient Lighting: Sources, Systems and Design Aspects	4 (3-1-0)	64	DS
EN7C-811	Minor Project -4	4 (0-0-8)		SPS/RNS/RC
<b>ELECTIVE COURSES</b>				
EN7C-812	Design Of Solar Thermal Systems	4 (3-1-0)	64	Anyone to be taken from online
EN7C-813	Noise Management And Control	4 (3-1-0)	64	
EN7C-814	Comprehensive Viva-vice	4		
	Total Credit	24		

Note: The above course contents can be modified as per requirement from time to time in accordance with University Ordinance No. 14.

### Site for Elective Courses

- 1) Waste to Energy Conversion (<https://swayam.gov.in/courses/3562-waste-to-energy-conversion>)
- 2) Life Cycle Assessment (<https://swayam.gov.in/courses/3565-life-cycle-assessment>)
- 3) Principles Of Casting Technology (<https://swayam.gov.in/courses/3555-principles-of-casting-technology>)
- 4) Project Management (<https://swayam.gov.in/courses/3584-project-management>)
- 5) Introduction To Remote Sensing (<https://swayam.gov.in/courses/3612-introduction-to-remote-sensing>)
- 6) Bioenergy (<https://swayam.gov.in/courses/3607-bioenergy>)
- 7) Technical English For Engineers (<https://swayam.gov.in/courses/3844-technical-english-for-engineers>)
- 8) Geo-environmental Engineering Landfills Slurry Ponds And Contaminated (<https://swayam.gov.in/courses/3741-geoenvironmental-engineering-landfills-slurry-ponds-and-contaminated>)
- 9) Project Planning And Control (<https://swayam.gov.in/courses/3820-project-planning-and-control>)
- 10) Design Of Photovoltaic Systems (<https://swayam.gov.in/courses/3758-design-of-photovoltaic-systems>)
- 11) Noise Management And Control (<https://swayam.gov.in/courses/3811-noise-management-and-control>)
- 12) Industrial Instrumentation (<https://swayam.gov.in/courses/3764-industrial-instrumentation>)

### EN7C- 701: Solar Energy: Fundamentals, Devices and Systems

**Credits: 4 (64 Hours)**

#### **UNIT I: Earth & Sun Relationship**

**Earth & Sun Relation:** Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.

**Available Solar:** Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.

**Solar Radiations Characteristics Coating:** Transparent and Opaque Materials, Selective

#### **UNIT II: Solar Collectors**

Flat Plate Collectors: Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors; Air Flat Plate Air Collectors: Types, Thermal Analysis.

Concentrating Collectors: Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking; Evacuated Tubular Collectors: Types, Thermal Analysis

Solar Cookers: Types, Thermal Analysis, and Testing Methods; Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

### **UNIT III: Thermal Energy Storage**

Solar Water Heating System: Components, Natural Flow, Forced Flow & Load Estimation  
Gravity Flow Systems, Mathematical Modeling.

Solar Air Heating Systems: Space Heating, Solar Drying, Load Estimation.

Solar desalination system: Design and type, Solar still, performance analysis.

### **UNIT IV: Solar Refrigeration and Desiccant**

Cooling: Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling.

### **UNIT V: Solar Power Generator**

Solar Thermal Power Generation: Basic Operating and applications, Parabolic trough Systems, Paraboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.

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

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 Jersey
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., Dordrecht.
7. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Company Ltd., New Delhi
8. M.A. Grean “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

## ***EN7C- 702: New and Renewable Energy Sources and Technologies***

**Credits: 4 (64 Hours)**

### **Unit I: Energy Scenario**

**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, Hydraulic 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](http://www.bp.com/centres/energy)
16. [www.eia.doe.gov](http://www.eia.doe.gov)
17. [www.epa.org](http://www.epa.org)
18. Bureau of Energy Efficiency- Volume 1

## **EN7C-703: 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 1<sup>st</sup> 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 2<sup>nd</sup>
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 2<sup>nd</sup> 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.

### **EN7C - 704: Minor Project -1**

**Credits: 4 (64 hours)**

In this course, students suppose to work on Energy & Environment related issue under the supervision of Expert available in the department. At the end of semester, student (s) has to submit his/her work report in the form of spiral binding, to the Examination In charge and

present it (through PPT) in front of the Examiner (s). His/ Her work would be evaluated orally by panel of 02 or more than 02 Examiner.

**\*EN7C-705: Energy conservation and Waste Heat Recovery**

**Credits: 4 (64 hours)**

**\*EN7C-706: Design of Photovoltaic Systems**

**Credits: 4 (64 hours)**

**\*Any one of the Elective Courses (EN7C-705 or EN7C-706) to be taken from the site <https://swayam.gov.in/courses> and Result has to be submitted to Examination In charge.**

**EN7C-707: Comprehensive Viva-Voce**

**Credits: 4 (64 hours)**

**Comprehensive Viva-Voce:** At the end of semester student (s) knowledge gain during the semester would be evaluated orally by panel of 04 Examiner, which include 01 External and 3 internal Examiner.

**EN7C-708: 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 Law 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.
11. S.E Jorgensen – Eco Exergy as Sustainability

## **EN7C-709: 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<sub>x</sub>, NO<sub>x</sub>, 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, 1<sup>st</sup> edition 1998 S.A. Abbasi
3. Environmental Noise Pollution And Its Control, Anmol Publication 1<sup>st</sup> 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, 12<sup>th</sup> 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 1<sup>st</sup> 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.

## **EN7C- 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

## EN7C - 711: Minor Project -2

**Credits: 4 (64 hours)**

In this course, students suppose to work on Energy & Environment related issue under the supervision of Expert available in the department. At the end of semester, student (s) has to

submit his/her work report in the form of spiral binding, to the Examination In charge and present it (through PPT) in front of the Examiner (s). His/ Her work would be evaluated orally by panel of 02 or more than 02 Examiner.

**\*EN7C-712: Introduction to Remote Sensing**

**Credits: 4 (64 hours)**

**\*EN7C-713: Bio-fuel**

**Credits: 4 (64 hours)**

**\*Any one of the Elective Courses (EN7C-712 or EN7C-713) to be taken from the site <https://swayam.gov.in/courses> and Result has to be submitted to Examination In charge.**

**EN7C-707: Comprehensive Viva-Voce**

**Credits: 4 (64 hours)**

**Comprehensive Viva-Voce:** At the end of semester student (s) knowledge gain during the semester would be evaluated orally by panel of 04 Examiner, which include 01 External and 3 internal Examiner.

**EN7C - 801: 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-, Raglewood 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.

## **EN7C- 802: Energy Management (Thermal & Electrical 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, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control.

Insulation and Refractory: Insulation Type and Application, Refractory-Types, Selection and Application of Refractory,

### **UNIT II**

Boilers: Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential,.

Steam System: Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System,

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

### **UNIT III**

Waste Heat Recovery: 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.

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

#### **UNIT IV**

##### **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 V**

##### **Electric Motors:**

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:**

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.

Energy Saving Opportunities in Fans & Blowers, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

#### **Recommended Books**

1. G. L. Witte, Phillips S.Schmidt 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 Opportunity , 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. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
8. Electrical Power Distribution in Industrial Plants by M.D. Parmar.

9. Energy Conservation in Electrical Systems, a reading material prepared by D. Buddhi.
10. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
11. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
12. B.R. Gupta, Generation of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
13. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
14. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
15. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8<sup>th</sup> edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
16. BEE VolumeI –Second Edition 2005
17. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

## **EN7C –803: 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.

### **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

### **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(II<sup>nd</sup> 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).

### **EN7C - 711: Minor Project -3**

**Credits: 4 (64 hours)**

In this course, students suppose to work on Energy & Environment related issue under the supervision of Expert available in the department. At the end of semester, student (s) has to submit his/her work report in the form of spiral binding, to the Examination In charge and present it (through PPT) in front of the Examiner (s). His/ Her work would be evaluated orally by panel of 02 or more than 02 Examiner.

### **\*EN7C-805: Technical English for Engineers**

**Credits: 4 (64 hours)**

### **\*EN7C-806: Geo-environmental Engineering, Landfills Slurry, Ponds and Contamination**

**Credits: 4 (64 hours)**

**\*Any one of the Elective Courses (EN7C-805 or EN7C-806) to be taken from the site <https://swayam.gov.in/courses> and Result has to be submitted to Examination In charge.**

### **EN7C-807: Comprehensive Viva-Voce**

**Credits: 4 (64 hours)**

**Comprehensive Viva-Voce:** At the end of semester student (s) knowledge gain during the semester would be evaluated orally by panel of 04 Examiner, which include 01 External and 3 internal Examiner.

### **EN7C – 808: 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. Bukhotaao 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

## **EN7C - 809: 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, bellows elements, vacuum gases, Bourdon tube.

#### ***Unit - III***

Temperature measurement: Thermocouples, RTDs, Thermistors, Radiation and optical pyrometer, Flow measurement: pilot tubes, turbine magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displacer, 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, 3<sup>rd</sup> Edition (2006)
7. Nuclear Energy By Raymond L. Murray 6<sup>th</sup> 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, 6<sup>th</sup> edition McGrew Hill Inc.
13. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
14. Instrumentation, Measurement and Control – D S Kumar

### **EN7C – 810: 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. Murdoce.
2. Energy Saving 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

### **EN7C - 811: Minor Project -4**

**Credits: 4 (64 hours)**

In this course, students suppose to work on Energy & Environment related issue under the supervision of Expert available in the department. At the end of semester, student (s) has to submit his/her work report in the form of spiral binding, to the Examination In charge and present it (through PPT) in front of the Examiner (s). His/ Her work would be evaluated orally by panel of 02 or more than 02 Examiner.

### **\*EN7C-812: Design of Solar Thermal Systems**

**Credits: 4 (64 hours)**

### **\*EN7C-813: Noise Management and Control**

**Credits: 4 (64 hours)**

**\*Any one of the Elective Courses (EN7C-812 or EN7C-813) to be taken from the site <https://swayam.gov.in/courses> and Result has to be submitted to Examination In charge.**

**EN7C-814: Comprehensive Viva-Voce**

**Credits: 4 (64 hours)**

**Comprehensive Viva-Voce:** At the end of semester student (s) knowledge gain during the semester would be evaluated orally by panel of 04 Examiner, which include 01 External and 3 internal Examiner.