# UNIVERSITY DEPARTMENTS
ANNA UNIVERSITY  ::  CHENNAI 600 025
REGULATIONS - 2013
CURRICULUM I TO VI SEMESTERS (PART TIME)
M.E. MANUFACTURING ENGINEERING (with specialization in Green Manufacturing Engineering)

## SEMESTER I

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**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 67**

## LIST OF ELECTIVES

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OBJECTIVE:
To introduce the concept of Green Manufacturing Design to the students.

UNIT I  INTRODUCTION  9
Environmental effects of design – Environmental damage – In efficient energy use – Design for recycling.

UNIT II  ENVIRONMENTAL LIFE CYCLE ASSESSMENT  9

UNIT III  GREEN DESIGN METHODS  9

UNIT IV  DESIGN FOR ENVIRONMENT  9
Eco design – Industrial Ecology – Pollution prevention – Reduction of toxic emission.

UNIT V  SUSTAINABLE ECONOMIC ENVIRONMENT  9

TOTAL: 45 PERIODS

COURSE OUTCOME:
The students will be able to design the manufacturing systems that will be environmental friendly.

REFERENCES:

UNIT III WATER DEMAND, WATER QUALITY 10
Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT IV FIRE SAFETY 10

UNIT V SAFETY RADIATION PROTECTION 9
Radiation fundamentals—Types of radiation Ionizing and Non-Ionizing radiation, their uses and biological effects. Radioactive waste disposal radioactive soil, water and air and their fate. Treatment and disposal Liquid and solid Radioactive wastes.

TOTAL: 45 PERIODS

COURSE OUTCOME:
The students will be able to design manufacturing systems which will be environmental friendly.

TEXT BOOKS:

REFERENCES:

GR 8201 ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT L T P C
3 0 0 3

OBJECTIVE:
To introduce the concepts of Environmental Sustainability & Impact Assessment to the students

UNIT I ENVIRONMENTAL ASSESSMENT – AN OVERVIEW 9
Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive.

UNIT II ENVIRONMENTAL DECISION MAKING 9
Strategic environmental assessment and sustainability appraisal – Socio economic impact assessment.

UNIT III ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION 9
Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk.

UNIT IV TECHNICAL STUDIES AND METHODS
Casual network analysis – GIS and Expert systems in EIA.
UNIT V  SUSTAINABLE URBAN ECONOMIC DEVELOPMENT  9
Spatial economics – Knowledge economy and urban regions.  
TOTAL: 45 PERIODS

COURSE OUTCOME:
The students will be in a position to develop systems that will be able to assess the environmental sustainability and its impacts.

REFERENCES:

GR 8202  STATISTICAL TECHNIQUES FOR GREEN MANUFACTURING  L T P C
3 0 0 3

OBJECTIVE:
To train the students so that students will be able to design experimental designs and use these concepts for research design.

UNIT I  PROBABILITY THEORY  14
Random variables – “probability density mass and distribution functions” – moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications.

UNIT II  SAMPLING THEORY  9
Sampling distributions – Standard error – t, F, Chi square distributions – application.

UNIT III  ESTIMATION THEORY  5
Interval estimation for population mean, standard deviation, difference in means, ratio of standard deviations – point estimation.

UNIT IV  TESTING OF HYPOTHESIS  12
Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations – Tests based on chi square.

UNIT V  ANOVA  5
One, two factor models – Design of experiments  
TOTAL: 45 PERIODS

COURSE OUTCOME:
The students will be able to design experiments for research purposes.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- To introduce the concepts of Green supply chain Management to the students.

UNIT I NEED FOR GREEN SUPPLY CHAIN MANAGEMENT (GSCM) 9
Green supply Chains – Need for Green Supply Chains – Implications of modern supply chain management – The supply chain strategy – Ingredients of green supply chain strategy.

UNIT II MEASURING AND MONITORING GREEN SUPPLY CHAINS 9
Evaluating the impact of GSCM activities on sustainability – Economic, Environmental and social impacts of GSCM Stages of GSCM - performance measurement.

UNIT III MANAGING GREEN SUPPLY CHAIN MANAGEMENT 9

UNIT IV SUPPLY NETWORK REDESIGNING 9

UNIT V LOGISTICS AND GSCM 9

TOTAL: 45 PERIODS

COURSE OUTCOME:
- The students will be in a position to redesign supply chain management into green supply chain management.

TEXT BOOKS:
1. ‘Sustainable Supply Chain Management’ Balkan Cetinkaya and Richard Cuthbertson (2nd) – Springer 2011

REFERENCES:

OBJECTIVE:
- To introduce the concepts of operations research to students so that these concepts, can be used in Green Manufacturing

UNIT I LINEAR PROGRAMMING 10
UNIT II TRANSPORTATION AND ASSIGNMENT METHODS

UNIT III THEORY OF GAMES

UNIT IV QUEUING THEORY AND SIMULATION

UNIT V REPLACEMENT PROBLEMS
Replacement of equipment with increase of running cost with time – time value of money – Individual replacement policy – Group replacement policy - staffing problems.

TOTAL: 45 PERIODS

COURSE OUTCOME:
- The student will be in a position to optimize the resources needed for green manufacturing.

TEXT BOOKS:

REFERENCES:

MN8351 LEAN PRODUCTION

AIM:
To introduce the concepts of lean manufacturing system.

OBJECTIVES:
- To study the various tools for lean manufacturing (LM).
- To apply the above tools to implement LM system in an organization.

UNIT I INTRODUCTION TO LEAN MANUFACTURING

UNIT II CELLULAR MANUFACTURING, JIT, TPM
Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM.

UNIT III SET UP TIME REDUCTION, TQM, 5S, VSM
Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.
UNIT IV  SIX SIGMA
Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

UNIT V  CASE STUDIES
Various case studies of implementation of lean manufacturing at industries.

REFERENCES:
3. Rother M. and Shook J, 1999 ‘Learning to See: Value Stream Mapping to Add Value and Eliminate Muda’, Lean Enterprise Institute, Brookline, MA.

GR 8311  CASE STUDIES IN GREEN MANUFACTURING PRACTICE  L T P C
0 0 3 2

OBJECTIVE:
- To introduce the various live case studies from industries on Green Manufacturing to the students

COURSE OUTCOME:
- The students will be able to analyze in a systematic way the various case studies and offer solutions to problems related to Green Manufacturing.

Each student will identify a case study from industries related to Green Manufacturing practices and the case study will be presented by students with solutions to the other students.

Evaluation will be done by a panel of faculty members identified for this purpose.

GR8401  GREEN MANUFACTURING MANAGEMENT  L T P C
3 0 0 3

AIM:
- To introduce the various techniques of Manufacturing Management to the student.

OBJECTIVES:
- The students will be able to use these techniques while managing the manufacturing activity operations.

UNIT I  FORE CASTING
UNIT II SCHEDULING AND SEQUENCING

UNIT III INVENTORY CONTROL
Purpose or inventory – Basic EOQ model - Quantity discounts – P system – Q system – ABC analysis – MRP – Manufacturing batch size model – Multi item EOQ models with constraints – Aggregate planning.

UNIT IV PROJECT MANAGEMENT
Project Network analysis – Critical path method (CPM) – Programme Evaluation and Review Technique (PERT) – Project Crashing.

UNIT V PLANT ENGINEERING AND WORK STUDY

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCE:

GR8302 OPTIMIZATION TECHNIQUES FOR GREEN MANUFACTURING

AIM:
To introduce the various optimization techniques and their advancements.

OBJECTIVES:
To make use of the above techniques while modeling and solving the engineering problems of different fields.

UNIT I INTRODUCTION

UNIT II CLASSIC OPTIMIZATION TECHNIQUES

UNIT III NON-LINEAR PROGRAMMING

Attested
DIRECTOR
UNIT IV  INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES


UNIT V  ADVANCES IN SIMULATION

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

REFERENCES:

GR 8411  MODELING AND SIMULATION LAB

OBJECTIVE:
• To train the students to make use of software for modeling and simulation various applications in the field of green manufacturing engineering.

COURSE OUTCOME
• The students will be able to model and simulate various systems which are applied with relevance to green manufacturing.

MODELING LAB EXPERIMENTS
1. 2D drafting of automobile components like engine crank shaft, connecting rod etc.
2. 2D drafting of pin joints, cotter joints and bearings.
4. 3D modelling and Assembly of automobile components, Joints, Bearing, Couplings etc.

SIMULATION LAB EXPERIMENTS
1. One Dimensional FEA Problem.
   a. Truss structure analysis.
   b. Cantilever beam analysis.
   c. Temperature distribution problem.
2. Two Dimensional FEA Problems.
   a. Plane stress analysis.
   b. Axisymmetric analysis.
   c. Vibration Analysis.
3. Three Dimensional FEA Problem.
   a. 3D Shell Analysis.
   b. 3D Contact Analysis.
4. FEA Application in metal forming, Metal cutting, Casting process etc.
6. Simulation of simple mechanism using solid modeling software.

GR 8001 DESIGN FOR ENVIRONMENT

OBJECTIVE:
1. To make the students to understand the importance of Design for Environment with respect to existing and future world.
2. To make the students to understand the life cycle, concurrent and information obtained from nature.
3. To understand the guidelines and rules for various forms of design
4. To make the students to realize the decision making with respect to Environmental design
5. To understand the applications and implementation of Design & Environment.

COURSE OUTCOME:
1. To motivate the students about green movement with respect to environment, codes and business.

UNIT I THE GREEN MOVEMENT

UNIT II THE ART AND SCIENCE OF DESIGN FOR ENVIRONMENT

UNIT III DESIGN RULES AND GUIDELINES

UNIT IV ANALYSIS METHODS FOR DESIGN DECISIONS

UNIT V THE REAL WORLD PRACTISE OF DESIGN FOR ENVIRONMENT
Consumer products industries – Kimberly Clark: Getting serious about DFE – Procter and Gamble: Ensuing a better quality.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

GR 8002

ENERGY MANAGEMENT

OBJECTIVE:
To introduce the concepts of Energy conservation and management to the students.

UNIT I
ENERGY AND ENVIRONMENT

UNIT II
ENERGY CONSERVATION

UNIT III
ENERGY TECHNOLOGIES

UNIT IV
ENERGY MEASUREMENT AND MANAGEMENT

UNIT V
ECONOMICS AND FINANCE

TOTAL: 45 PERIODS

COURSE OUTCOME:
The students will be able to design and develop energy efficiency systems.

TEXT BOOKS:
REFERENCES:

GR 8003 ENERGY SAVING MACHINERY AND COMPONENTS

OBJECTIVE:
To introduce the various energy saving machineries and components to the students for the purpose conserving energy.

UNIT I BASICS OF ELECTRICAL ENERGY USAGE

UNIT II TRANSFORMERS & MOTORS

UNIT III FANS / PUMPS / COMPRESSORS
Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods ( General & Latest ) adopted for effecting ENCON – Economics of ENCON adoption in all the 3 utilities

UNIT IV ILLUMINATION & ENERGY EFFICIENCY DEVICES

UNIT V CASE STUDIES & CO2 MITIGATION
Case Study Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO2 Mitigation & Energy Conservation & Cost Factor

TOTAL: 45 PERIODS

COURSE OUTCOME:
The student will be able to design, develop and fabricate energy saving machinery and components.

REFERENCES
1. Hamies, Energy Auditing and Conservation ; Methods Measurements, management and Case
5. Peters et al. Sustainable Energy, beta – test – draft Kraushaar and Ristenen, Energy and
   (Could be downloaded from www.energymanagertraining.com )

GR8004 GREEN BUILDING MANAGEMENT L T P C 3 0 0 3

OBJECTIVE:
- To introduce the concepts of green building management.

UNIT I GREEN CONCEPTS IN BUILDINGS 9
Green Building concepts and definition – Environmental implications of buildings on water, energy,
   waste disposal and carbon emissions – Building materials, sources, methods of production, embodied
   energy, maintenance and environmental implications.

UNIT II WATER MANAGEMENT IN BUILDINGS 9
Water utilisation in buildings – Management of Sullage water sewage – Methods of waste water
   treatment and recycling – Low energy approaches to water management.

UNIT III ENERGY MANAGEMENT IN BUILDINGS 9
Energy requirements of building – Optimising the energy utility – Low energy concepts in lighting,
   ventilation and transportation of men and materials in buildings – Utility of energy efficient devices for
   lighting, heating and cooling – Methods of utilisation solar and wind energy.

UNIT IV THERMAL MANAGEMENT OF BUILDINGS 9
Thermal comfort in Buildings – Heat transfer characteristic of Building materials and building
   techniques – Implications of geographical locations and seasonal variations – Incidence of solar heat
   on buildings – Concepts of solar passive cooling and heating – Case studies on thermal management.

UNIT V MANAGEMENT OF SOLID WASTE AND BIOMASS 9
Low energy approaches in collection, storage, transport, recycling and disposal of solid wastes –
   Biomass resources for buildings – Green cover and built environment – Concepts of green
   composites.

TOTAL: 45 PERIODS

COURSE OUTCOME:
- The students will be in a position to design, develop and build more environmental friendly
   buildings.

TEXT BOOKS:
1. Jagadish K.S., Venkatramreddy B.U. and Nanjundarao K.S., Alternative Building materials and
2. Low energy Cooling for sustainable buildings, Johy Wiley & Sons, 2009
3. Dennis C Brewer, Green My Home: 10 steps to lowering energy costs and reducing your

REFERENCES:
AIM:
To facilitate the understanding of a set of principles that reduce the use (or) generation of hazardous substance in the design, manufacture, and applications of chemical products.

OBJECTIVES:
- The idea behind an elective is to expose the students to a green chemistry on cutting edge technology.
- To enable the students to understand key aspects and applications of green chemistry in academic and industries and in modern research and developments.
- To enable students understand the products and its interaction with the environments.
- To enable students understand the basic building blocks of green chemicals.
- To enable the students to understand the Green chemical reactions and manufacture green materials for a safer world.

UNIT I INTRODUCTION TO GREEN CHEMISTRY
9

UNIT II INTERACTION OF ENVIRONMENTAL SPHERES
9

UNIT III BASIC BUILDING BLOCKS OF GREEN CHEMICALS
9
Elements – atoms and atomic theory – hydrogen – helium – lithium – the second period of the periodic table – the special significance of eight outer shell electrons for green chemical synthesis – the brief periodic table to stable chemicals and sustainable development.

UNIT IV GREEN CHEMICAL REACTIONS
9

UNIT V SAFER MATERIALS FOR A SAFER WORLD
9

TOTAL: 45 PERIODS

TEXTBOOK:

REFERENCES:

GR 8006 GREEN ELECTRONICS MANUFACTURING

OBJECTIVE:
This course aims to provide students with knowledge on theories, eco-design concepts, methods and relevant hands-on experience for designing a range of sustainable green electronic products. It is expected that students will develop their ability to address relevant issues on environmental impact; product design, operating life on lead free electronics assembly.

COURSE OUTCOME:
The students will be in a position to develop electronic manufacturing systems that will be environment friendly.

UNIT I INTRODUCTION OF GREEN ELECTRONICS
Environmental concerns of the modern society – Overview of electronics industry and their relevant regulations in China, European Union and other key countries. Restriction of Hazardous substances (RoHs) – Waste Electrical and electronic equipment (WEEE) – Energy using Product (EUP) and Registration Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT II GREEN ELECTRONICS MATERIALS AND PRODUCTS

UNIT III GREEN ELECTRONICS ASSEMBLY AND RECYCLING

UNIT IV FLIP-CHIP ASSEMBLY AND BONDING FOR LEAD-FREE ELECTRONICS

16
UNIT V CASE STUDIES


TOTAL: 45 PERIODS

TEXT BOOKS:

GR 8007 GREEN ENERGY SYSTEM L T P C
3 0 0 3

OBJECTIVE
To introduce the concept of green energy generation systems.

COURSE OUTCOME
The student will be in a position to identify the green energy generation systems and will be able to introduce green energy system wherever required.

UNIT I
Energy sources; coal oil, natural gas; nuclear energy; hydro electricity, other fossil fuels; geothermal; supply and demand; depletion of resources; need for conservation; uncertainties; national and international issues.

UNIT II
Forecasting techniques, energy demand, magnitude and pattern, input and output analysis, energy modeling and optimal mix of energy sources. Energy - various forms, energy storage, structural properties of environment.

UNIT III
Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution, growth and change, patterns of consumption in developing and advances countries, commercial generation of power requirements and benefit.

UNIT IV
Chemical industries, classification, conservation in unit operation such as separation, cooling tower,drying, conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries, chloro alkali industries, conservation using optimization techniques.

UNIT V
Sources of continuous power, wind and water, geothermal, tidal and solar power, MHD, fuel cells, hydrogen as fuel. Cost analysis, capacity; production rate, system rate, system cost analysis, corporate models, production analysis and production using fuel inventories, input-output analysis, economics, tariffs.

TOTAL: 45 PERIODS
REFERENCES

GR8008 GREEN QUALITY MANAGEMENT

UNIT I INTRODUCTION

UNIT II QM PRINCIPLES
Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III QM TOOLS & TECHNIQUES I

UNIT IV QM TOOLS & TECHNIQUES II

UNIT V QUALITY SYSTEMS

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- To impart the knowledge on different kinds of waste and their management

COURSE OUTCOME:
- To understand the various types of waste and their significance and effects on the environment.
- To overcome the various issues due to the above wastes.

UNIT I HAZARDOUS WASTES
Hazardous waste definition terminology and classification – Sources of hazardous wastes – Need for hazardous waste management – Handling of hazardous waste, methods of collection, storage and transport – Sampling and analysis of hazardous materials.

UNIT II CHEMICAL AND BIOMEDICAL WASTES CHEMICAL WASTES – TOXIC MATERIALS
Chemical wastes – Toxic materials – Physical, Chemical, Physiological classification – Domestic and industrial sources – Health and environmental effects with specific reference to acids, alkalis, lead, cadmium, chromium, sulphur, mercury and cyanides – Treatment and disposal techniques – Physical, chemical and biological processes.

Biomedical wastes – Definition, sources, classification – collection, segregation – Treatment and disposal.

UNIT III NUCLEAR AND RADIATION WASTES

UNIT IV E-WASTES

UNIT V SCIENTIFIC LAND FILL
Concept and definition – Site selection and approval – Acceptable wastes for landfill – Design and construction – Liners, clay, geomembrane, HDPE, geonet, geotextile – Treatment and disposal of leachate – combined and separate treatment, site remediation – Remedial techniques.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
To introduce the concept of recycling, recycling techniques and recycling of various kinds of materials

COURSE OUTCOME:
The students will be able to decide the appropriate method for recycling of various kinds of materials

UNIT I  INTRODUCTION
9

UNIT II  RECYCLING TECHNIQUES / METHODS
9
Recycling rate, material recovery facilities – Integrating recycling with landfills – Processing equipments.

UNIT III  RECYCLING OF PAPER
9
Paper board / solid waste – Recycling of papers, pulp, construction and demolition of debris, household wastes.

UNIT IV  RECYCLING OF METALS
9
Recycling of Aluminium cans, scrap metal and steel cans, ferrous metals, Non-ferrous metals.

UNIT V  RECYCLING OF PLASTICS AND GLASS
9
Recycling of tyres, batteries, glass beverage bottles, textiles, plastic bottles, rubber materials and tyres.

TOTAL 45 PERIODS

REFERENCES:

OBJECTIVE:
To introduce the concepts of storage, collection and safe disposal of solid wastes.

COURSE OUTCOME:
The student will be in a position to develop systems for storage, collection and safe disposal of solid wastes.

UNIT I  INTRODUCTION
9

UNIT II  WASTE QUANTITIES AND CHARACTERISTICS
9
Sources of solid waste – Quantities and composition – Physical, Chemical and Biological characteristics.
UNIT III  STORAGE AND COLLECTION
Storage - Collection for low-rise detached houses – Collection from low and medium rise apartments – Collection from high rise apartments – Vehicles for collection – Transfer and Transport.

UNIT IV  MATERIALS RECOVERY

UNIT V  REUSE AND RECYCLING
Composting – Road making – Stabilization – Deactivation – Metal removal and recovery – Aqueous treatment – Biological technologies.

REFERENCES:

TOTAL: 45 PERIODS

GR 8012  SUSTAINABILITY PRACTICE
OBJECTIVES:
To introduce the various concepts of sustainability and its practices

COURSE OUTCOME:
The students will be able to develop various sustainable development practices.

UNIT I  INTRODUCTION

UNIT II  MAIN STREAM SUSTAINABLE DEVELOPMENT

UNIT III  ENVIRONMENT, DEGRADATION AND SUSTAINABILITY
Environmental degradation, over population and intensification – overgrazing and new range ecology - Environmental costs of development – Dams, People and resettlement.

UNIT IV  ECOLOGY OF SUSTAINABILITY

UNIT V  SUSTAINABILITY AND RISK SOCIETY

REFERENCES:
OBJECTIVE:
To introduce the various concepts associated with Manufacturing and Design for sustainability.

COURSE OUTCOME:
The student will be able to develop manufacturing techniques and designs that will enhance sustainability.

UNIT I  SUSTAINABILITY AND DEVELOPMENT CHALLENGES  9

UNIT II  PRINCIPLES AND FRAMEWORK  9

UNIT III  SUSTAINABLE LIVELIHOOD  9

UNIT IV  SUSTAINABLE SOCIO-ECONOMIC SYSTEMS  10

UNIT V  ASSESSING PROGRESS AND WAY FORWARD  8

TOTAL: 45 PERIODS
REFERENCES:

GR 8014 WASTE STREAM MAPPING L T P C
3 0 0 3

OBJECTIVE:
To introduce various concepts of waste stream mapping.

COURSE OUTCOME:
The student will be able to identify the various waste streams and reduce the wastages.

UNIT I MECHANICAL PROCESSING FOR MATERIAL RECYCLING 10

UNIT II BIOLOGICAL PROCESSING FOR RESOURCE RECOVERY 10
Mechanisms of Biological Processing – Aerobic Processing of Organic fraction - Composting methods and processes - factors affecting - Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control- Vermiculture: definition, scope and importance - common species for culture - Environmental requirements - culture methods- Applications of vermiculture- Potentials and constraints for composting in India- Largescale and decentralized plants.

UNIT III BIO-CHEMICAL CONVERSION OF WASTE TO ENERGY 9

UNIT IV THERMO-CHEMICAL CONVERSION OF WASTE TO ENERGY 8
Principles and Design of Energy Recovery Facilities -Types and principles of energy conversion processes - Incinerator design - Mass Burn and RDF Systems- Composition and calorific value of fuels and waste, Determination of the stoichiometric air consumption, Calculation of the flue gas composition - grate firing designs, boiler design, removal of bottom ash, heat recovery- Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans - Alternative thermal processes: co-incineration, pyrolysis, gasification, plasma arc - Process characterization and control- waste heat recovery- Bottom ash: Quantity, quality, treatment, utilization,
disposal- Facility design- decentralized mobile plants- Planning and construction of incineration plants.

UNIT V CASE STUDIES ON WASTE RECYCLING


TOTAL: 45 PERIODS

REFERENCES:
3. Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein, Modern Composting Technologies JG Press October 2005