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

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	GR 8101	Green Manufacturing Design	3	0	0	3
2	GR 8102	Green Manufacturing Practices	3	0	0	3
3		Elective I	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	GR 8201	Environmental sustainability and Impact Assessment	3	0	0	3
2	GR 8202	Statistical Techniques for Green Manufacturing	3	0	0	3
3		Elective II	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	GR 8301	Green Supply Chain Management	3	0	0	3
2	GR 8402	OR Techniques for Green Manufacturing	3	0	0	3
3	MN 8351	Lean Production	3	0	0	3
PRACTICAL						
4	GR 8311	Case Studies in Green Manufacturing Practice	0	0	3	2
		TOTAL	**9**	**0**	**3**	**11**

SEMESTER IV

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	GR 8401	Green Manufacturing Management	3	0	0	3
2	GR 8302	Optimization Techniques for Green Manufacturing	3	0	0	3
3		Elective III	3	0	0	3
PRACTICAL						
4	GR 8411	Modeling and Simulation Lab	0	0	4	2
		TOTAL	**9**	**0**	**4**	**11**

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SEMESTER V

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1		Elective IV	3	0	0	3
2		Elective V	3	0	0	3
3		Elective VI	3	0	0	3
PRACTICAL						
4	GR 8511	Project Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER VI

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	GR 8611	Project Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

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

LIST OF ELECTIVES

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	GR8001	Design for Environment	3	0	0	3
2	GR8002	Energy Management	3	0	0	3
3	GR8003	Energy Saving Machinery and Components	3	0	0	3
4	GR8004	Green Building Management	3	0	0	3
5	GR8005	Green Chemistry	3	0	0	3
6	GR8006	Green Electronics Manufacturing	3	0	0	3
7	GR8007	Green Energy system	3	0	0	3
8	GR8008	Green Quality Management	3	0	0	3
9	GR8009	Hazardous Management	3	0	0	3
10	GR8010	Re-cyclic Packaging Systems	3	0	0	3
11	GR8011	Solid Waste Management	3	0	0	3
12	GR8012	Sustainability Practice	3	0	0	3
13	GR8013	Sustainable Manufacturing Design	3	0	0	3
14	GR8014	Waste Stream Mapping	3	0	0	3

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GR 8101 GREEN MANUFACTURING DESIGN L T P C
3 0 0 3

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
Material flow and cycles – Material recycling – Emissionless manufacturing.

UNIT III GREEN DESIGN METHODS 9
Mass balance analysis – Green indicate – Design for disassembly design for recycle – Rist analysis – Material selection.

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

UNIT V SUSTAINABLE ECONOMIC ENVIRONMENT 9
Solar energy devices – wind energy resources – Full cost accounting methodology – Selection of natural friendly materials.

TOTAL: 45 PERIODS

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

REFERENCES:

1. Cairncrss and Francis – Costing the earth – Harvard Business School Press - 2009
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.

GR 8102 GREEN MANUFACTURING PRACTICES L T P C
3 0 0 3

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

UNIT I AIR POLLUTION SAMPLING AND MEASUREMENT 4
Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dixide, carbon monoxide, oxidants and ozone..

UNIT II NOISE POLLUTION & CONTROL 10
Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise,

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Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

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

Basic Elements, Causes, Industrial Fires, Explosions, Effects on Environmental, Property & Human Loss, Prevention technique, Building Design, Fire Protection System, contingency plan, Emergency preparedness, Evacuation.

UNIT V SAFETY RADIATION PROTECTION 9

Radiation fundamentals-Types of radiation lonizing and Non-lonizing 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:

1. Dornfield David, Green Manufacturing, Springer, 2012
2. Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013

REFERENCES:

1. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.

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 9

Casual network analysis – GIS and Expert systems in EIA.

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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:

1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and sustainable development – Edward Elgar Publishing (2007)
2. Robort B Gibsan, Sustainability Assessment, Earth Scan publishers (2005)
3. Simon Dresner, The principle of sustainability – Earth Scan publishers (2008)

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:

1. Levin and Rubin, Statistics for Management, Prentice Hall of India, 2001

REFERENCES:

1. Hooda, Statistics for Business and Economics, Macmillan India, 2001
2. John.E.Freunds, "Mathematical statistics with applications", Pierson Educations, 2004
3. Gupta and Kapoor, Fundamentals of Mathematical Statistics, Sultanchand, 2002.

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GR8301 GREEN SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

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

Managing supply chain processes – Analysing and monitoring systematically – Green Supply Chain Segmentation – Estimating product life cycle – Designing GSCM – Ecological standards.

UNIT IV SUPPLY NETWORK REDESIGNING 9

Problem description – Challenges – Success factors – Transferability – Transportation issues in GSCM – Increasing transportation efficiency – Retail GSCM – Optimisation of goods collection.

UNIT V LOGISTICS AND GSCM 9

Railway transport – Challenges and issues – Transport market place – Transport exchange – GSCM enablers – Intermodel terminals – Cargo securing.

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:

1. Hsiao-fan wang and Surendra M.Gupta Green supply management Product life cycle approach McGraw Hill, 2011.

PROGRESS THROUGH KNOWLEDGE

GR 8402 OR TECHNIQUES FOR GREEN MANUFACTURING L T P C
3 0 0 3

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

Graphical method – Simplex method – Maximization problems – Minimization problems Big M method – Duality in linear programming.

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UNIT II TRANSPORTATION AND ASSIGNMENT METHODS 11

Transportation problem-Methods for finding initial feasible solution – Test for optimality – Maximization problem – Unbalanced problems – Assignment problems – Maximization problems – Maximization problems – Unbalanced problems.

UNIT III THEORY OF GAMES 9

Two person zero sum game – Pure strategies – Mixed strategies – Saddle point – Principle of dominance - Max-min and minimax principles – Algebric method – Graphical method.

UNIT IV QUEUING THEORY AND SIMULATION 8

Poisson arrival – Poisson service – Single server queuing models – Multi server queuing models – Simulation – Montecarlo simulation – Random numbers.

UNIT V REPLACEMENT PROBLEMS 7

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:

1. R. Panneerselvam, Operation Research, Prentice Hall of India, 2002

REFERENCES:

1. P.K.Guptha and Manmohan, Problems in Operations Research-Sultan chand & Sons, 1994
2. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992
3. J.K. Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
4. Hamdy A.Taha, Operations Research – An Introduction, Prentice Hall of India, 1997

MN8351 LEAN PRODUCTION L T P C
3 0 0 3

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 7

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.

UNIT II CELLULAR MANUFACTURING, JIT, TPM 9

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 10

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

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UNIT IV SIX SIGMA **9**

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

UNIT V CASE STUDIES **10**

Various case studies of implementation of lean manufacturing at industries.

TOTAL: 45 PERIODS

REFERENCES:

1. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003
2. Mikell P. Groover (2002) 'Automation, Production Systems and CIM.
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.

PROGRESS THROUGH KNOWLEDGE

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 **7**

Purpose of fore casting – Forecasting methods – Opinion and judgemental method – Time series methods – Regression and correlation methods – Exponential smoothing.

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UNIT II SCHEDULING AND SEQUENCING 9

Scheduling – Single criterion rules – Critical ratio – Sequencing – Two machine problems – Johnson's algorithm – Three machine machines - Machine problems – Graphical method.

UNIT III INVENTORY CONTROL 10

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 9

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

UNIT V PLANT ENGINEERING AND WORK STUDY 10

Plant location – Plant layout – Materials handling – Method study – steps in Method study – Work measurement – Time study – Work sampling.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Dr.R. Kesavan.C. Elanchezian and T.Sundar Selwyn, Engineering Management, Eswar Press, Chennai – 2005.
2. R. Paneerselvam, Production and Operations Management, Prentice Hall of India, 2002.

REFERENCE:

1. Dr.R. Kesavan, C.Elanchezian and B.Vijayaramnath, Production Planning and Control, Anuratha Publications, Chennai – 2008.
2. Martand T. Telsang, Production Management, S.Chand & Co., 2005.
3. Thomas E.Mortan, Production and Operations Management, Vikas Publications, 2003.

GR8302 OPTIMIZATION TECHNIQUES FOR GREEN MANUFACTURING L T P C
3 0 0 3

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 5

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

UNIT II CLASSIC OPTIMIZATION TECHNIQUES 10

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

UNIT III NON-LINEAR PROGRAMMING 9

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming

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UNIT IV INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING ANDNETWORK TECHNIQUES **12**

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

UNIT V ADVANCES IN SIMULATION **9**

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 PERIODS

REFERENCES:

1. R. Panneerselvam, “Operations Research”, Prentice Hall of India Private Limited, New Delhi 1 – 2005
2. J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
3. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
4. P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994
5. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992

GR 8411 MODELING AND SIMULATION LAB **L T P C**
0 0 4 2

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.
3. Study of 3D Modelling software.
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.

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5. Preparation of Process Planning Sheet.
6. Simulation of simple mechanism using solid modeling software.
7. Routing & flow process chart.

GR 8001 DESIGN FOR ENVIRONMENT L T P C
3 0 0 3

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 10

Motivation force – Rediscovery of Ancient values – The global sustainability Agenda – The response of industry. External drivers: The voice of society – Green Expectation – Confronting climate change – Government initiatives: Stick and Carrot – Environmental Management System Standards – Sustainable Rating Schemes – Voluntary codes and principles – Business value drives.

UNIT II THE ART AND SCIENCE OF DESIGN FOR ENVIRONMENT 10

Management environmental Innovation – The rise of green market – Integrated produce development – organizing for environmental Excellence – Practising concurrent engineering – Understanding product life cycle – Principles of design for environment – Lice cycle thinking – System perspective – Indicators and Metrics – Design strategies – Analysis method – Information technology – Learning from Nature – From principle to practices.

UNIT III DESIGN RULES AND GUIDELINES 10

Design for Dematerialization – Design for Energy and material conservation – Design for source reduction – Design for servicization – Design for Detoxification – Design for release reduction – Design for hazard reduction – Design for Benign waste disposition.

UNIT IV ANALYSIS METHODS FOR DESIGN DECISIONS 8

Tangible Evaluation – Quatitative Assessment – Environmental analysis – Foot print indicators, life cycle assessment, piedictive simulation – Risk Analysis – Financial analysis – Examples for DFE decisions – The challenges of Decision making – Product life cycle Management – Case study. Example Caterpiller: New Engines from OLD - 3M responsible innovation – Towards sustainable supply chain management.

UNIT V THE REAL WORLD PRACTISE OF DESIGN FOR ENVIRONMENT 7

Electronic Equipment industries – Xerox coporation: reducting the footprint, Hewlett Packard: A green gaint – Sony Electronics: Innovation in design.

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Transportation Industry – Sustainable Mobility research – DFE in the transportation life cycle – General motors': Products and process Innovation – Toyota: the future of propulsion – Dupont: Eco efficient Automotive paint.
Chemical industries – Green and sustainable chemistry – Dow chemical : Raising the Bar – Dupont: Realizing sustainable growth – BASF: Beyond Eco-efficiency.
Medical and Pharmaceutical Industries – Johnson & Johnson: A matter of principle – Baxter – Saving and sustaining lives.
Consumer products industries – Kimberly Clark: Getting serious about DFE – Procter and Gamble: Ensuing a better quality.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Joseph Fiksel, "Design for Environment – A guide to sustainable Product Development", second edition, McGraw Hill, 2012.

REFERENCES:

1. Dorothy Mackenzie, "Green Design: Design for the Environment", L.King, 1997.
2. Joseph Fiksel, "Design for Environment: Creating Eco-efficient products and processes, McGraw Hill, 1996.

GR 8002 ENERGY MANAGEMENT L T P C
3 0 0 3

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

UNIT I ENERGY AND ENVIRONMENT 9
Introduction – Fossil fuels reserves – World energy consumption – Green house effect, Global warming – Renewable energy sources – Environmental aspects utilisation – Energy prizes – Energy policies.

UNIT II ENERGY CONSERVATION 9
Energy conservation schemes – Industrial energy use – Energy surveying and auditing – Energy index – Energy cost index – Energy conservation in engineering and process industry in thermal systems, in buildings and non-conventional energy resources schemes.

UNIT III ENERGY TECHNOLOGICES 9
Fuels and consumption – Boilers -0 Furnaces – Waste heat recovery systems – Heat pumps and refrigerators – Storage systems – Insulated pipe work systems – heat exchangers.

UNIT IV ENERGY MEASUREMENT AND MANAGEMENT 9
Energy management principles – energy resource management – Energy management information systems – Instrumentation and measurement – Computerized energy management.

UNIT V ECONOMCIS AND FINANCE 9
Costing techniques – Cost optimization – Optimal target investment schedule – Financial appraisal and profitability – Project management.

TOTAL: 45 PERIODS

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

TEXT BOOKS:

1. W.R. Murphy and G.Mc KAY "Energy Management Butterworths, London 2009

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REFERENCES:

1. O. Callaghn. P.W. “Design and Management for Energy Conservation”, 2004 Pergamon Press, Oxford.
2. David Merick, Richard Marshal, “Energy, present and future options, Vol, I and II”, 2009 John Wiley and Sons.
3. Chaigier N.A. “Energy Consumption and Environment”, 2007 McGraw Hill.
4. Ikken P.A. Swart R.J. and Zwerves, S, “Climate and Energy”, 2008
5. Ray D.A. “Industrial Energy Conservation”, 2004 Pergamaon Press.

GR 8003 ENERGY SAVING MACHINERY AND COMPONENTS L T P C
3 0 0 3

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 9

Fuel to Power : Cascade Efficiency – Electricity Billing : Components & Costs – kVA – Need & Control – Determination of kVA demand & Consumption – Time of Day Tariff – Power Factor Basics – Penalty Concept for PF – PF Correction – Demand Side Management (a brief)

UNIT II TRANSFORMERS & MOTORS 9

Transformer – Basics & Types – AVR & OLTC Concepts – Selection of Transformers – Performance Prediction - Energy Efficient Transformers - Motors : Specification & Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding & Oversizing - Energy Efficient Motors – ENCON Scope

UNIT III FANS / PUMPS / COMPRESSORS 11

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 8

Specification of Luminaries – Types – Efficacy – Selection & Application – ENCON Avenues & Economic Proposition - New Generation Luminaries (LED / Induction Lighting) – Soft Starters / Auto Star – Delta – Star Starters / APFC / Variable Speed & Frequency Drives – Time Sensors – Occupancy Sensors

UNIT V CASE STUDIES & CO2 MITIGATION 8

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
2. Study, Hemisphere, Washington, 1980
3. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
4. Handbook on Energy Efficiency, TERI, New Delhi, 2001

Attested
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5. Peters et al. Sustainable Energy, beta – test – draft Kraushaar and Ristenen, Energy and
6. Problems of a Technical Society, 1993
7. Guide book for National Certification Examination for Energynagers and Energy Auditors (Couldbe 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 BULDINGS 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 technologies, New age International, 2007.
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 carbon foot print, Kaplam Publishing Ltd., 2008.

REFERENCES:

1. Sustainable Building Design Manual, Vol.1 & 2, Teri, New Delhi, 2004.
2. Climate Responsive Architecture, Tata McGraw Hill, 2001
3. Jerry Yudelson, Green Building through Integrated Design, McGraw Hill, 2009.

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GR 8005 **GREEN CHEMISTRY** **L T P C**
3 0 0 3

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 he Green chemical reactions and manufacture green materials for a safer world.

UNIT I INTRODUCTION TO GREEN CHEMISTRY 9

The needs for green chemistry- Definition – Twelve principles of green chemistry – Synthetic chemistry – Yield and atom economy – for soap manufacturing and methane combustion – risk – reduction of risk – risk of no risks – hazard and exposure – waste prevention – combining of atom to make new molecules and compounds.

UNIT II INTERACTION OF ENVIROMENTAL SPHERES 9

Introduction to environments – five environmental spheres(atmosphere – anthrosphere – biosphere – hydrosphere – geosphere) – and their interactions - environmental pollution and its prevention – green chemistry's root in the pollution prevention act.

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

Introduction – manufacturing of materials safely without damaging the environment – chemical equations – balancing – alternate reaction path ways in green chemistry – role of green catalysts – types of chemical reactions – oxidation – reduction – stoichiometry – by mole – ratio method – industrial chemical reactions(Solvay process).

UNIT V SAFER MATERIALS FOR A SAFER WORLD 9

Introduction – chemical bonds and formation of green chemical compounds – electrons involved in chemical bonds and octet of electrons – ionic bonds – problems – ionic liquids – covalent bounds in hydrogen and other molecules – predicting covalent bonds – role of covalent bonds in green chemistry – chemical formulas – mole and percentage composition.

TOTAL: 45 PERIODS

TEXTBOOK:

1. Manahan, Stanley E., Green Chemistry and The Ten Commandments of Sustainability, Chemchar Research, Inc, Columbia, Missouri, USA, 2006.
2. Anastas, Paul T, and John C. Warner, Green Chemistry Theory and Practice, Oxford University Press, 1998.

REFERENCES:

1. Manahan, Stanley E, Fundamentals of Environmental Chemistry, 2nd edition., CRC Press/ Lewis Publishers, Boca, Raton Fl, 2000.

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2. Ahluwalia, V. K., Kidwai M. New trends in green chemistry, Kluwer Academic, Dordrecnt, The Netherlands, 2004.
3. Ahluwalia. V.K, Green Chemistry, Environmentally Benign Reactions, CRC Press, Boca, Raton, FL, 2008.
4. Lancaster,M , Green Chemistry An Introductory Text, Royal Society of chemistry, Cambridge, 2002.

GR 8006 GREEN ELECTRONICS MANUFACTURING L T P C
3 0 0 3

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 6
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 10
Introduction to green electronic materials and products – Lead (Pb) – free solder pastes, conductive adhesives, halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products. Tin Whiskers Growth in Lead-Free Electronic Assemblies – Factors Influence Whisker Growth – Ways to Mitigate Tin Whisker Risk – Use Finite Element Modeling to Assess Tin Whisker Risk – Evaluation of Tin Whisker Impact on High-Reliability Applications.

UNIT III GREEN ELECTRONICS ASSEMBLY AND RECYCLING 10
Green electronic Assembly – Soldering Process – Lead-Free Solder Tip and Bumps – Mitigate Deterioration of Lead-Free Tin Solder at Low Temperatures – Fatigue Characterization of Lead-Free Solders – Thermal Fatigue of Solder Joints, Fatigue Design of Lead-Free – Electronics – Fatigue Life Prediction Based on Field Profile, Fatigue Validation of Lead-Free Circuit – Flip-Chip Technology and Assembly process – card Assembly, surface mount technology – Management on e-waste recycle system construction, global collaboration and product disassemble technology.

UNIT IV FLIP-CHIP ASSEMBLY AND BONDING FOR LEAD-FREE ELECTRONICS 10
Flip-Chip Assembly Process – Placement and Under fill stage-FEM of Die stress – Gold stud Bump Bonding – Materials and Process Variations – Integrating Flip Chip into a Standard SMT Lead-Free Reflow soldering Techniques and Analytical Methods – Electro migration Analysis for Mean-Time-to-Failure Calculations – Gold-Tin Solder Integrating Vertical-Cavity Surface Emitting Lasers onto Integrated Circuits – Design and Processing of Flip-Chip Bonding Structures – Opto-Electronic Integration.

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UNIT V CASE STUDIES **9**

Lead-Free Electronic Design – Selection of the Package Type – Substrate or Die Attachment FR4 – Electrical Connections from Die to FR4 – Assess Impact of CTE Mismatch on Stress and Fatigue Life – Design Solder Balls for External Connection to PCB – Thermal Analysis of Flip-Chip Packaging – RLC for Flip-Chip Packages – Drop Test of Flip-Chip Packaging – Wei bull Distribution for Life Testing and Analysis of Test Data.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. John X.Wang 'Green Electronics Manufacturing', CRC Press Indian Prentice Hall, 2012
2. Sammy G Shina, 'Green Electronics Design and Manufacturing' Mc Graw Hill 2008
3. Lee Goldberg, "Green Electronics/Green Bottom Line, Newnes Publications 2000

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 **9**

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 **9**

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 **9**

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 **9**

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 **9**

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

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REFERENCES
1. Krentz, J. H., Energy Conservation and Utilisation , Allyn and Bacur Inc., 1976.
2. Gramlay, G. M., Energy , Macmillan Publishing Co., New York, 1975.
3. Rused, C. K., Elements of Energy Conservation , McGraw-Hill Book Co., 1985.
4. Loftiness, R.L. – Energy Hand Book, Van Nostrand Reinhold Company, New York, 1978.

GR8008 GREEN QUALITY MANAGEMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of QM - Definition of QM – QM Framework - Contributions of Deming, Juran and Crosby – Barriers to QM.

UNIT II QM PRINCIPLES 10

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 9

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV QM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Dale H.Besterfiled, “Total Quality Management”, Pearson Education Asia, Third Edition, Indian Reprint (2006).

REFERENCES:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “GQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition (2003).
3. Suganthi,L and Anand Samuel, “Green Quality Management”, Prentice Hall (India) Pvt. Ltd. (2006)
4. Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd. (2006)

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GR8009 **HAZARDOUS MANAGEMENT** **L T P C**
3 0 0 3

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 **9**

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 **9**

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 cyonides – Treatment and disposal techniques – Physical, chemical and bilogical processes.

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

UNIT III NUCLEAR AND RADIATION WASTES **9**

Definition – Classification – Types of exposures and injuries – Tolerance dose protection from x-ray gammaray, beta ray and neutron radiations – Wastes in mining and processing of nuclear materials – wastes generated in nuclear reactors – spent dual and other wastes collection, reprocessing, storage, transport and disposal – Decommissioning of Nuclear reactors – Health and environmental issues of nuclear wastes.

UNIT IV E-WASTES **9**

Definition, classification and sources of e-waste – collection, segregation, transport, storage, recycling and disposal of e-wastes – Health and environmental issues of e-wastes – problems in developing nations.

UNIT V SCIENTIFIC LAND FILL **9**

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.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bhide A.D., Sundaresan B.B., 'Solid Waste Management – Collection Procssing and Disposal', Mudrashilpa offset printers, Nagpur, 2001.
2. Glynm Henry and Heinke Gary W., Environmental Science and Engineering, Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Safety Manual, Edel Engineering consultancy Pvt.Ltd., Chennai, 2000.
2. Biomedical waste (Management and Handling) Rules, 1998.

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GR 8010 **RECYCLIC PACKAGING SYSTEM** **L T P C**
3 0 0 3

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**
Waste – Collection, sorting, cleaning – Recycling – Overview and growth – Characterization of waste streams – Processing facilities for recyclable materials.

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, house hold 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:

1. W.S. Allen/P.N.Baker, “Handbook of plastic Recycling”, Alkem Quality Edition, Alkem Publishing,2009.
2. John Scheirs, “Polymer Recycling”, Wiley Series in Polymer Science, 1997.
3. R.Mckinney, “Technology of paper Recycling”, Blackie Academic and professional, 1997.
4. Herbert F.Lund, “ McGraw-Hill Recycling Handbook”, 2nd Edition, 2001

GR 8011 **SOLID WASTE MANAGEMENT** **L T P C**
3 0 0 3

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**
Need for solid waste management – Integrated solid waste management – Waste prevention – Life cycle assessment – Financial issues in solid waste management.

UNIT II WASTE QUANTITIES AND CHARACTERISTICS **9**
Sources of solid waste – Quantities and composition – Physical, Chemical and Biological characteristics.

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UNIT III STORAGE AND COLLECTION 9

Storage - Collection for low-rise detatched houses – Collection from low and medium rise apartments – Collection from high rise apartments – Vehicles for collection – Transfer and Transport.

UNIT IV MATERIALS RECOVERY 9

Hand sorting – Screans – Air classifiers – Since and float separators – inclined tables – Shaking tables – Optical sorting – Sorting by differential melting temperature – Sorting by selective dissolution – Magnetic, Eddy Current, crushing technique.

UNIT V REUSE AND RECYCLING 9

Composting – Road making – Stabilization – Deactivation – Metal removal and recovery – Aqueous treatment – Biological technologies.

TOTAL: 45 PERIODS

REFERENCES:

1. Chandrappa, Ramesha – Solid work Management (2012) – Springer
2. George Tchbanoglous, Frank Kreith – Hand book of Solid Waste Management – 2002 – McGraw Hill

GR 8012 SUSTAINABILITY PRACTICE L T P C
3 0 0 3

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 9

The origins of sustainable development – Nature preservation and emergence of sustainable development - Ecology and balance of nature – Caring for earth.

UNIT II MAIN STREAM SUSTAINABLE DEVELOPMENT 9

Environmental population – Ecology modernization – Natural capital and sustainability – Mechanisms for main stream sustainable development – Deep Ecology and sustainability.

UNIT III ENVIRONMENT, DEGRADATION AND SUSTAINABILITY 9

Environmental degradation, over population and intensification – overgrazing and new range ecology - Environmental costs of development – Dams, People and resettlement.

UNIT IV ECOLOGY OF SUSTAINABILITY 9

Poverty, environment and degradation – Forest clearance and forest people – Ecology of conservation – Famine – Deforestation – Tropical deforestation.

UNIT V SUSTAINABILITY AND RISK SOCIETY 9

Risk society – Risk and environment – Environmental pollution – Manufacturing pollution – The problem of pesticides – Mainstreaming risk – Rain forest management reform – Community conservation.

TOTAL 45 PERIODS

REFERENCES:

1. Andrew Hoffman, Competitive Environmental Strategy -A Guide for the Changing Business Landscape, Island Press.

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2. Stephen Doven, Environment and Sustainability Policy : Creation, implementation, Evaluation, The Federation Press, 2005

GR 8013 SUSTAINABLE MANUFACTURING DESIGN L T P C
3 0 0 3

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 CHALLEGES 9
Definition of sustainability – Environmental, Economical and Social dimensions of sustainability - Sustainable Development Models – Strong and Weak Sustainability – Defining Development- Millennium Development Goals – Mindsets for Sustainability : Earthly, Analytical, Precautionery, Action and Collaborative– Syndromes of Global Change: Utilisation Syndromes, Development Syndromes, and Sink Syndromes – Core problems and Cross Cutting Issues of the 21 Century - Global, Regional and Local environmental issues – Social insecurity - Resource Degradation –Climate Change – Desertification

UNIT II PRINCIPLES AND FRAME WORK 9
History and emergence of the concept of sustainable development - Our Common Future - Stockholm to Rio plus 20– Rio Principles of Sustainable Development – Precautionary Principle- Polluter Pays Principle – Role of Civil Society, Business and Government -Natural Step- Peoples Earth Charter – Business Charter for Sustainable Development –UN Global Compact – Agenda 21

UNIT III SUSTAINABILE LIVELI HOOD 9
The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty -Millennium Development Goals, Indicators, Targets, Status and intervention areas - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10
Protecting and Promoting Human Health – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Urbanization and Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation – Sustainable Consumption and Production – Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8
Sustainability in global, regional and national context – Rio Plus 20 - Measuring Sustainability – limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development -Hurdles to Sustainability - Operational guidelines –- Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning – Governance - Science and Technology- Sustainability Education

TOTAL: 45 PERIODS

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REFERENCES:

1. Sayer, J. and Campbell, B., The Science of Sustainable Development : Local Livelihoods and the Global Environment (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2003.
2. Kirkby, J., O‟Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London,1993.
3. MoEF (2012), " Sustainable Development in India –stocktaking in the Run up to Rio plus 20", Ministryof environment and forests, Government of India, New Delhi.
4. United Nations. 2001. Indicators of Sustainable Development: Guidelines and Methodologies. New York: United Nations. 5 UNEP, 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/greeneconomy, ISBN: 978-92-807-3143-9 6 World Bank (2012), "Inclusive Green Growth – The pathway to Sustainable development, World Bank- Washington D

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
Resource recovery for sustainable development- Material and energy flow management and analysis - Systems and processes for reduction, reuse and recycling -Objectives of Waste Processing-Source Segregation and Hand Sorting-Waste Storage and Conveyance – Shredding – Pulping - Size Separation by Screens- Density Separation by Air Classification –magnetic and electromechanical separation processes- Design Criteria and Equipment selection.

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
Principles and Design of Anaerobic Digesters – **Process characterization and control-** The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment - Methane generation by Anaerobic Digestion- Anaerobic reactor technologies - Commercial anaerobic Technologies- Single stage and multistage digesters- Digester design and performance-Gas collection systems-Methane Generation and Recovery in Landfills – Biofuels from Biomass.

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,

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disposal- Facility design- decentralized mobile plants- Planning and construction of incineration plants.

UNIT V CASE STUDIES ON WASTE RECYCLING 8

Recycling technologies for paper, glass, metal, plastic – Used Lead Acid Battery Recycling –End of Life Vehicle Recycling – Electronic Waste Recycling – Waste Oil Recycling – Solvent Recovery - Drivers and barriers for material recycling: social, legal and economic factors - Environmental impacts of waste recycling - Design for the environment: the life cycle approach

TOTAL: 45 PERIODS

REFERENCES:

1. Aarne Veslind and Alan E Rimer (1981), "Unit operations in Resource Recovery Engineering ", Prentice Hall Inc., London
2. Manser A G R, Keeling A A (1996). Practical handbook of processing and recycling on municipal waste. Pub CRC Lewis London, ISBN 1-56670-164
3. Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein*, Modern Composting Technologies* JG Press October 2005
4. Charles R Rhyner (1995), Waste Management and Resource Recovery, Lewis Publishers
5. Gary C. Young (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons

PROGRESS THROUGH KNOWLEDGE

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