ANNA UNIVERSITY : : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

M.E. MANUFACTURING ENGINEERING (WITH SPECIALIZATION IN GREEN MANUFACTURING ENGINEERING) (PART - TIME)

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

VISION OF THE DEPARTMENT

To develop disciplined, socially committed and technically competent Production Engineers with Creativity, Comprehension and Managerial skills to design and manufacture innovative cost effective quality products for the benefit of mankind.

MISSION OF THE DEPARTMENT

1. Train the students who will be able to design and manufacture Innovative, Environment Friendly, Ergonomic and Cost Effective Quality Products and Services.
2. Improve the technical quality of the students to meet the challenges, competitions and opportunities in production engineering.
3. Prepare the students who will be able to solve socially relevant engineering problems and other complex problems by means of inculcating Managerial Skills.
4. Enhance the department industry / research centre interaction by means of training, internship and student projects to solve industrial problems.

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M.E. MANUFACTURING ENGINEERING (WITH SPECIALIZATION IN GREEN MANUFACTURING ENGINEERING) (PART - TIME)

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

I. The graduates acquire ability to create environmental oriented models, design and analyze essential production operational skills, mechanism and automation system.

II. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to presume position of scientific and/or managerial leadership in their career paths towards green manufacturing.

III. The graduates apply their consciousness of moral, professional responsibilities and motivation to practice life-long learning in a team work environment.

PROGRAMME OUTCOMES (PO)

1. Graduate will demonstrate strong basics in mathematics, science and engineering which serve as the foundation for the Programme.
2. Graduate will demonstrate the ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
3. Graduate will become familiar with modern engineering tools and analyze the problems within the domains of Green Manufacturing as the members of multidisciplinary teams.
4. Graduate will acquire the capability to identify, formulate and solve engineering problems related to production engineering.
5. Graduate will demonstrate an understanding of professional and ethical responsibility with reference to their career in the field of production engineering.
6. Graduate will be able to communicate effectively both in verbal and non-verbal forms.
7. Graduate will be trained towards developing and understanding the impact of environmental oriented components on global, economic, and societal context.
8. Graduate will be capable of understanding the value for life-long learning.
9. Graduate will demonstrate knowledge of contemporary issues pertaining to the health and well-being of desirable living forms inhabiting the environment.
10. Graduate will demonstrate the ability to use the techniques, skills and modern engineering tools necessary for engineering practice in the field of Production Engineering.
11. Graduate will be able to design and develop innovative/ manufacturable / marketable / environmental friendly products useful to the nation and the society.
12. Graduate will be able to manage any organization well and will be able to emerge as a successful entrepreneur.

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PROGRAMME SPECIFIC OUTCOMES (PSOs)

By completion of this post graduate programme in Manufacturing Engineering with specialization in green manufacturing, the graduates will have following Program specific outcomes;

1. Foundation of sustainable development: Knowledge on application of appropriate manufacturing systems and their impact on environment towards sustainability.
2. Knowledge on Green Manufacturing practices: Familiarization of clean manufacturing systems and practices.
3. Knowledge on Product life cycle assessment, impact analysis on environment and development of green manufacturing processes.

MAPPING OF PEOS WITH POS

Programme educational objectives	Programme outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
I	√	√	√					√		√		
II				√	√		√	√			√	√
III			√		√	√	√	√	√			

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
FIRST YEAR	SEM I	Green Manufacturing Design and Practices		√	√				√				√	
		Energy Management			√				√		√	√	√	
		Green Chemistry Laboratory		√	√	√	√		√		√	√		
	SEM II	Environment Sustainability and Impact Assessment		√		√			√		√		√	
		Statistical Techniques for Manufacturing	√		√	√						√	√	
		Green Practices Laboratory		√		√			√		√		√	
SECOND YEAR	SEM III	Quantitative Techniques for Manufacturing	√		√	√						√	√	
		Research Methodology and IPR	√		√	√	√		√		√	√	√	
		Case Studies in Green Manufacturing Practice			√								√	
	SEM IV	Green Manufacturing Management		√	√				√			√	√	√
		Sustainable Manufacturing		√	√				√	√	√	√		
		Modelling and Factory Simulation Laboratory		√	√	√							√	
		Mini Project with Seminar	√		√	√			√			√	√	
THIRD YEAR	SEM V	Dissertation – I	√	√	√	√	√	√	√	√	√	√	√	√
	SEM VI	Dissertation – II	√	√	√	√	√	√	√	√	√	√	√	√

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UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
M.E. MANUFACTURING ENGINEERING
(WITH SPECIALIZATION IN GREEN MANUFACTURING ENGINEERING) (PART TIME)
I TO VI SEMESTERS CURRICULUM AND SYLLABUS
SEMESTER I

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	GR5101	Green Manufacturing Design and Practices	PCC	3	0	0	3	3
2.	GR5102	Energy Management	PCC	3	0	0	3	3
3.		Program Elective I	PEC	3	0	0	3	3
PRACTICAL								
4.	GR5111	Green Chemistry Laboratory	PCC	0	0	4	4	2
			Total	**9**	**0**	**4**	**13**	**11**

SEMESTER II

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	GR5201	Environment Sustainability and Impact Assessment	PCC	3	0	0	3	3
2.	GR5202	Statistical Techniques for Manufacturing	PCC	3	0	0	3	3
3.		Program Elective - II	PEC	3	0	0	3	3
4.		Program Elective - III	PEC	3	0	0	3	3
PRACTICAL								
5.	GR5211	Green Practices Laboratory	PCC	0	0	4	4	2
			TOTAL	**12**	**0**	**4**	**16**	**14**

SEMESTER III

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
2.	GR5301	Quantitative Techniques for Manufacturing	PCC	3	1	0	4	4
3.		Program Elective - IV	PEC	3	0	0	3	3
4.		Audit Course I*	AC	2	0	0	2	0
PRACTICAL								
5.	GR5311	Case Studies in Green Manufacturing Practice	PCC	0	0	4	4	2
			TOTAL	**10**	**1**	**4**	**15**	**11**

* Audit Course is optional.

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SEMESTER IV

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	GR5401	Green Manufacturing Management	PCC	3	1	0	4	4
2.	CI5072	Sustainable Manufacturing	PCC	3	0	0	3	3
3.		Program Elective V	PEC	3	0	0	3	3
4.		Audit Course II*	AC	2	0	0	2	0
PRACTICAL								
5.	GR5411	Mini Project with Seminar	EEC	0	0	4	4	2
6.	GR5412	Modelling and Factory Simulation Laboratory	PCC	0	0	4	4	2
			TOTAL	**11**	**1**	**8**	**20**	**14**

* Audit Course is optional.

SEMESTER V

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.		Program Elective - VI	PEC	3	0	0	3	3
2.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
3.	GR5511	Dissertation - I	EEC	0	0	12	12	6
			TOTAL	**6**	**0**	**12**	**18**	**12**

SEMESTER VI

Sl. No.	Course Code	Course Title	Category	PERIODS PER WEEK			Total Contact Periods	Credits
				L	T	P		
PRACTICAL								
1.	GR5611	Dissertation - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 74

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PROGRAM CORE COURSE (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	GR5101	Green Manufacturing Design and Practices	PCC	3	3	0	0	3
2.	GR5102	Energy Management	PCC	3	3	0	0	3
3.	GR5201	Environment Sustainability and Impact Assessment	PCC	3	3	0	0	3
4.	GR5202	Statistical Techniques for Manufacturing	PCC	3	3	0	0	3
5.	GR5301	Quantitative Techniques for Manufacturing	PCC	3	3	1	0	4
6.	GR5401	Green Manufacturing Management	PCC	3	3	1	0	4
7.	CI5072	Sustainable Manufacturing	PCC	3	3	0	0	3
Laboratory Courses								
1.	GR5111	Green Chemistry Laboratory	PCC	4	0	0	4	2
2.	GR5211	Green Practices Laboratory	PCC	4	0	0	4	2
3.	GR5311	Case Studies in Green Manufacturing Practice	PCC	4	0	0	4	2
4.	GR5412	Modelling and Factory Simulation laboratory	PCC	4	0	0	4	2

PROGRAM ELECTIVE COURSES (PEC)

SEMESTER I, ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GR5001	Design for Environment	PEC	3	0	0	3	3
2.	GR5002	Green Chemistry	PEC	3	0	0	3	3
3.	GR5003	Sustainability Practice	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GR5004	Safety Engineering	PEC	3	0	0	3	3
2.	GR5005	Legal Aspects of Environmental Engineering	PEC	3	0	0	3	3
3.	GR5006	Green Building Design and Management	PEC	3	0	0	3	3

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SEMESTER II, ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GR5007	Energy Saving Machinery and Components	PEC	3	0	0	3	3
2.	GR5008	Green Electronics Manufacturing	PEC	3	0	0	3	3
3.	GR5009	Green Energy System	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GR5010	Hazardous Management	PEC	3	0	0	3	3
2.	GR5011	Recycling of Materials	PEC	3	0	0	3	3
3.	GR5012	Industrial Solid Waste Management	PEC	3	0	0	3	3

SEMESTER IV, ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GR5013	Green Supply Chain Management	PEC	3	0	0	3	3
2.	GR5014	Waste Stream Mapping	PEC	3	0	0	3	3
3.	GR5015	Lean Manufacturing System and Applications	PEC	3	0	0	3	3

SEMESTER V, ELECTIVE VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GR5016	Optimization Techniques for Manufacturing	PEC	3	0	0	3	3
2.	MN5071	Financial Management	PEC	3	0	0	3	3
3.	GR5017	Quality Management in Manufacturing	PEC	3	0	0	3	3

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RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	2

OPEN ELECTIVE COURSES [OEC]

(Out of 6 Courses one Course must be selected)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytic	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No.	Course Code.	Course Title	Category	Periods per week			Credits
				L	T	P	
1	GR5411	Mini Project with seminar	EEC	0	0	4	2
2	GR5511	Dissertation - I	EEC	0	0	12	6
3	GR5611	Dissertation - II	EEC	0	0	24	12

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GR5101	GREEN MANUFACTURING DESIGN AND PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the concept of environmental design and industrial ecology.
- To impart knowledge about air pollution and its effects on the environment.
- To enlighten the students with knowledge about noise and its effects on the environment.
- To enlighten the students with knowledge about water pollution and its effects on the environment.
- To introduce the concept of green co-rating and its need

UNIT I DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT 9

Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

UNIT II AIR POLLUTION SAMPLING AND MEASUREMENT 9

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 III NOISE POLLUTION AND CONTROL 9

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

UNIT IV WATER DEMAND AND WATER QUALITY 9

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 V GREEN CO-RATING 9

Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green Co-Rating

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : know the environmental design and selection of eco-friendly materials.
CO2 : analyze manufacturing processes towards minimization or prevention of air pollution.
CO3 : analyze manufacturing processes towards minimization or prevention of noise pollution.
CO4 : analyze manufacturing processes towards minimization or prevention of water pollution.
CO5 : evaluate green co-rating and its benefits.

REFERENCES

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓					✓				✓	
CO2		✓	✓									
CO3		✓	✓									
CO4		✓	✓									
CO5							✓					

GR5102 ENERGY MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- To familiarize the concepts of energy and environment to the students so that there will be general awareness about renewable energy sources.
- To familiarize the students about conservation of the energy and use it for industries.
- To stress upon the role of various energy technologies so that the students will be able to choose an appropriate technology.
- To stress about energy measurement and its management to energy sector.
- To brief about the finance and economics aspects of energy so that optimal utilisation can be achieved.

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 TECHNOLOGIES 9

Fuels and consumption – Boilers - 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.

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UNIT V ECONOMCIS AND FINANCE **9**

Costing techniques – Cost optimization – Optimal target investment schedule – Financial appraisal and profitability – Project management.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : get familiarity with the concepts of energy and environment, and select suitable renewable energy sources.
CO2 : gain the knowledge acquired to implement and achieve conservation of energy.
CO3 : choose an appropriate energy technology with the knowledge acquired.
CO4 : choose appropriate energy measurement method.
CO5 : achieve optimal utilisation by reducing cost.

REFERENCES

1. Murphy W.R. and Mc kay G. Energy Management, Butterworths, London, 2009.
2. Callaghn P W O, Design and Management for Energy Conservation, Pergamon Press, 2004
3. David Merick and Richard Marshal, Energy, present and future options, Vol, I and II", John Wiley and Sons, 2009.
4. Chakrabarthi A, Energy engineering and management, PHI, 2011.
5. Sharma K V and Venkataseshiah P, Energy management and conservation, IK international, Delhi, 2011.
6. Ray D. A. Industrial energy conservation, pergamon press, 2004.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓		✓	✓		
CO2							✓		✓		✓	
CO3										✓	✓	
CO4			✓							✓		
CO5										✓	✓	

GR5111 GREEN CHEMISTRY LABORATORY **L T P C**
0 0 4 2

OBJECTIVES

- To create awareness about degree of water pollution as per green chemistry norms
- To make the students to understand pH Value of water as per industrial requirements
- To familiarize TDS, hardness and alkalinity of water according to the industrial and domestic needs

LIST OF EXPERIMENTS

1. To determine the Chemical Oxygen Demand of the given water sample
2. To determine biological oxygen demand of the given water sample
3. To estimate dissolved Oxygen (DO) in the waste water sample.
4. To estimate Total Dissolved Solids (DO) in the drinking water sample
5. Determination of PH Value for municipal and industrial waters.
6. Determination of hardness (temporary, permanent and total) of domestic and industrial waters.
7. Estimation of alkalinity of water sample.
8. Properties of acid base

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9. Determination of PH Value of normal and polluted soils.
10. To determine Acidity of water titrometric method.
11. Preparation of Eco friendly pesticides
12. Estimation of waterborne bacteria, cysts and viruses inpurified drinking water (RO/UV/UF).

TOTAL : 60 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : analyse degree of water pollution as per green chemistry
CO2 : evaluate PH Values of water for industrial requirements
CO3 : carry out experiments to confirm TDS, hardness and alkalinity of water according to industrial and domestic needs

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓				✓		✓			
CO2				✓			✓			✓		
CO3		✓	✓		✓							

GR5201 ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- To make the students to understand the concepts of Environmental Sustainability & Impact Assessment
- To familiarize the students in environmental decision making procedure.
- Make the students to identify, predict and evaluate the economic, environmental and social impact of development activities
- To provide information on the environmental consequences for decision making
- To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

UNIT I ENVIRONMENTAL IMPACT ASSESMENT 9

Environmental impact assessment objectives – rationale and historical development of EIA - Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive.

UNIT II ENVIRONMENTAL DECISION MAKING 9

Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and management of environmental impacts- 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 LIFE CYCLE ASSESSMENT 9

Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting

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UNIT V SUSTAINABLE URBAN ECONOMIC DEVELOPMENT 9

Spatial economics – Knowledge economy and urban regions.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : know the concepts of Environment Sustainability and trained to make decision related to Environment.

CO2 : make decision that has an effect on our environment

CO3 : know the basics of environmental policy, planning and various legislation

CO4 : get valuable information for exploring decisions in each life stage of materials, buildings, services and infrastructure.

CO5 : create jobs and offer better livelihoods; increase economic growth; improve social inclusion; promote the decoupling of living standards and economic growth from environmental resource use; protect local and regional ecosystems; reduce both urban and rural poverty

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
4. Canter, R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
5. Shukla, S.K. And Srivastava, P.R., "Concepts In Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.
6. John G. Rau And David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓					✓		✓			
CO2		✓					✓		✓			
CO3			✓								✓	
CO4			✓								✓	
CO5		✓	✓	✓			✓					

GR5202 STATISTICAL TECHNIQUES FOR MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES

- To train the students so that the students will be able to design experimental designs and use these concepts for research design.
- To introduce the concept of probability so that they can be used for industrial applications.
- To stress upon the importance of the sampling theory and its usefulness in industrial quality control.
- To make students familiarize with the concepts of estimation theory and its applications.
- To help students the usefulness of test of significance and its applications in industry and research.

UNIT I PROBABILITY THEORY 9

Sample space - Sample point – Random variable – Discrete and continuous random variable –Probability mass and density functions – Expected value, Variance and standard deviations of random variables – Joint density and mass functions – Covariance and Correlation between random variables –Moment about mean and origin – Moment generating and characteristic functions- Binomial, Poisson and normal distribution and their applications- Green Manufacturing applications.

UNIT II SAMPLING THEORY 9

Population and sample – Sampling with and without replacement – Random sample – Finite and infinite populations – Large and small samples – Sampling distributions of means, proportions, difference of means and proportions – Student 't' distribution – chi square distribution – Fisher's distribution and their applications – Degrees of freedom – Case studies in Green Manufacturing.

UNIT III ESTIMATION THEORY 9

Unbiased and efficient estimates – Point and Interval estimation – Confident Interval estimates – Confidence level and Coefficient – confidence limits for mean, proportions, difference of means, proportions- confidence limits using student 't' distribution, chi square and F distribution- applications.

UNIT IV TESTING OF HYPOTHESIS 9

Null and alternate hypothesis- Procedure for testing hypothesis and significance - One and two tailed tests- Level of Significance of large samples for means, proportions, difference of means ,difference of proportions – Tests based on student t distribution, chi square distribution and F distribution – Applications – Research studies in Green Manufacturing.

UNIT V ANALYSIS OF VARIANCE 9

Design of experiments – Total variation, Variation between treatment and within treatment – one factor experiments – Mathematical model for one factor experiments – Two factor experiments, - Mathematical model for two factor experiments – Applications.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : design experiments for research and industry.
CO2 : apply the concept of probability so that they can be used for industrial applications.
CO3 : use sampling theory and its usefulness in industrial quality control.
CO4 : apply the concepts of estimation theory to industrial problems.
CO5 : apply the test of significance and its applications to industry and research.

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5. Morries H. Degroot, Mark J. Schervish, Probability and Statistics, Pearson education, 2018
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									
CO2	✓		✓	✓						✓		
CO3	✓			✓						✓		
CO4				✓						✓		
CO5				✓						✓	✓	

GR5211 GREEN PRACTICES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES

- To study about various green practices to be followed in different industries / environments

1. Spindle and feed drive units power measurement in center lathe / CNC turning or milling machine
   (Consider a typical component and record the power using power sensor under different operation conditions and evaluate the energy consumption and efficiency of the process)
2. Machining under different cooling and lubrication strategy
3. Coolant life management
4. Energy requirement prediction model
5. Estimation of carbon foot print from different machining processes
6. Determination of SO_2, NO_X, and oxidants concentration in ambient air.
7. Determination of CO and CO_2 and unburned hydrocarbons concentration in IC Engine Exhaust.
8. Manufacturing of Green Soap
9. Experiment on Industrial noise measurement
10. Free and forced vibration measurement on simple cantilever beams / Machine members
11. Experimental Measurement of Illumination with various types of bulbs

TOTAL : 60 PERIODS

OUTCOMES

At the end of this course, the students will:

CO1 : have knowledge in implementing green practices in all the fields such as industries, apartments and environments.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓		✓			✓		✓		✓	

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RM5151 **RESEARCH METHODOLOGY AND IPR** **L T P C**
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

Attested

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GR5301	QUANTITATIVE TECHNIQUES FOR MANUFACTURING	L	T	P	C
		3	1	0	4

OBJECTIVES
- To introduce the linear programming techniques such as graphical method and simplex method.
- To develop optimal solutions to transportation and assignment problems.
- To familiarize the concepts of game theory and its industrial applications.
- To stress on the importance of queuing theory and its applications in waiting line problems.
- To develop replacement models and to decide on optimal replacement policy.

UNIT I LINEAR PROGRAMMING 12

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

UNIT II TRANSPORTATION AND ASSIGNMENT METHODS 12

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

UNIT III THEORY OF GAMES 12

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

UNIT IV QUEUING THEORY AND SIMULATION 12

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

UNIT V REPLACEMENT PROBLEMS 12

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

TOTAL : 60 PERIODS

OUTCOMES

At the end of this course, the students will be able to:
- CO1 : use simplex method to solve industrial problems.
- CO2 : develop optimum transportation schedule and assignment for industrial problems.
- CO3 : design a suitable strategy for a given industrial problem using the concepts of game theory.
- CO4 : design a suitable queuing model for a given application.
- CO5 : design optimal replacement policies for replacement of equipments.

REFERENCES

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3. Ravindran A, Philips D T and Solberg JJ, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 2007
4. Sharma J.K., Operations Research – Theory and Applications , 5 th edition, Macmillan India Ltd., 2013
5. Hamdy A.Taha, Operations Research – An Introduction, Pearson, 10 th edition, 2017
6. Srinivasan G., Operations Research, Prentice hall of India, 2010.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓						✓	✓	
CO2	✓		✓	✓						✓		
CO3			✓	✓						✓		
CO4										✓	✓	
CO5		✓								✓	✓	

GR5311 CASE STUDIES IN GREEN MANUFACTURING PRACTICE

L	T	P	C
0	0	4	2

OBJECTIVES

- To introduce the various live case studies from industries on Green Manufacturing to the students
- Presentation of various case studies from industries / buildings on Green Manufacturing, Green co-rating.

DESCRIPTION

Students will be required to identify case studies from industries related to Green Manufacturing practices and the case study will be presented by students with solutions.

TOTAL : 60 PERIODS

OUTCOME

At the end of this course, the students will be able to:

CO1 : analyze the problems and offer solutions related to Green Manufacturing.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			✓								✓	

GR5401	GREEN MANUFACTURING MANAGEMENT	L	T	P	C
		3	1	0	4

OBJECTIVES

- To familiarize with the various forecasting models.
- To impress upon the importance of sequencing problem in industries.
- To design and develop inventory control models for a given industry.
- To familiarize with project management techniques such as CPM and PERT.
- To train on the plant engineering techniques such as plant location, plant layout, materials handling and work study.

UNIT I FORECASTING 12

Forecasts-Types-Purpose- opinion and judgmental method-Time series methods – moving average - weighted moving average – method of least squares – Exponential smoothing method- Regression and correlation methods – simple and multiple regression – Linear and Nonlinear regression – Green Manufacturing applications.

UNIT II SCHEDULING AND SEQUENCING 12

Scheduling – Single Criterion rules –Sequencing –n job 2 machine problem – Johnson's algorithm – 3 machine problem – M machine problem – Graphical method for 2 jobs M machine problems –Heuristic methods – Case studies in Green Manufacturing

UNIT III INVENTORY 12

Inventory – purpose of inventory – Basic EOQ Model –Quantity discount model – Reorder level – Fixed order quantity inventory system – Periodic review system – ABC analysis – Materials requirement planning – EOQ models under constraints – Purchasing management – Stores management – Just In Time inventory system – Vendor evaluation - Inventory pricing –Supply chain Management – Aggregate planning- Green Inventory Management.

UNIT IV PROJECT MANAGEMENT 12

Project network analysis – Activities – Events- critical path method – Method based on time estimates – Programme Evaluation Review Technique –Optimistic, pessimistic time, most likely time - Probability of completion of projects – Time crashing of Projects –Optimum duration and cost

UNIT V PLANT ENGINEERING AND WORK STUDY 12

Plant location – Factors affecting plant location – Break even analysis- Factors weighted rating method – Plant layout- Types- Selection – Plant layout Techniques – Travel chart method – Line balancing method– Work study – method study – Principles of Motion economy – steps in methods study - Charts – Micromotion study-memo motion study – multiple activity charts- therbligs – work measurement – stop watch time study – Production studies – PMTS – Work sampling – Materials handling – Principle – Selection- Green plant layout designs and material handling system.

TOTAL : 60 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : Select an appropriate forecasting method for a given industry.
CO2 : obtain optimal solutions for sequencing problem in industry.
CO3 : design a suitable inventory system for any particular industry.
CO4 : use the project management techniques to minimize the project time.
CO5 : design plant layout and materials handling systems and can make use of the concepts of work study for work design.

REFERENCES

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, McGraw Hill 14th edition, 2017.
2. Norma Gaither and Gregory Frazier, Operations Management, Cengage Learning 2016.
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6. Kesavan R, Elanchezhiyan C, Sundar Selwyn T, Engineering Management – Eswar Press, 2005

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓				✓				✓	
CO2										✓	✓	
CO3											✓	✓
CO4										✓	✓	
CO5												✓

CI5072 SUSTAINABLE MANUFACTURING L T P C
3 0 0 3

OBJECTIVES

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I ECONOMIC SUSTAINABILITY 9

Industrial Revolution-Economic sustainability: globalization and international issues-Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability -Assessments of economic sustainability

UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9

Social sustainability – Introduction-Work management -Human rights - Societal commitment -Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources - Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT III SUSTAINABILITY PRACTICES 9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model

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UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9	0.9				0.9	0.9	0.6	0.9	0.9
CO2	0.9	0.6				0.9	0.9	0.6	0.6	0.9
CO3	0.9	0.9		0.9		0.6	0.6	0.6	0.6	0.6
CO4	0.9	0.9		0.6		0.6	0.6	0.9	0.6	0.6
CO5	0.9	0.9	0.6			0.9	0.9	0.9	0.9	0.9

REFERENCES:

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2. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
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5. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

GR5411 **MINI PROJECT WITH SEMINAR** **L T P C**
0 0 4 2

OBJECTIVE

- To enable the students to select a suitable topic to analyse and solve problems of industries/ research/ academic organizations related to green manufacturing.

DESCRIPTION

- The students will have to identify smaller problems from industries/research/academic organizations pertaining to green manufacturing, analyze and offer solutions to the problems identified based on the knowledge acquired.
- Seminar has to be given periodically for evaluation
- A project report is to be submitted at the end for evaluation.

EVALUATION

- The progress of mini project will be evaluated through reviews and finally presentation with report will be evaluated jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 PERIODS

OUTCOME

At the end of this course, the students will be able to:

CO1 : apply the knowledge gained from theoretical and practical courses in solving the problems by creative, well planned and organized manner related to green manufacturing.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

GR5412 **MODELLING AND FACTORY SIMULATION LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES

- To introduce the concepts and applications of CAD modelling and factory related operations
- Students will gain an understanding of the 3D modelling software
- Students will study and practice the sequencing, process planning and line balancing.
- Students will have hands-on experience on virtual reality.

MODELLING LABORATORY

1. 3D Modelling and Assembly of Engine components like Engine Crank Shaft, Connecting Rod, Cotter Joint, Plummer Block and Coupling using 3D modeling software

FACTORY SIMULATION LABORATORY

1. Offline - Programming of movement sequence of Robot Configuration using simulation software.
2. Offline - manufacturing process planning for specific operation sequence graphically using simulation software.
3. Estimation of manufacturing operation time and perform line balancing.
4. Virtual reality viewers using 3D CAD models for industry 4.0.
5. Internet of things application for pilot project.

Attested

TOTAL : 60 PERIODS

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OUTCOMES

At the end of this course, the students will be able to:

CO1 : design and construct a layout for robot simulation

CO2 : calculate manufacturing process planning, line balancing using 3D CAD model.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓									
CO2			✓	✓							✓	

GR5511 **DISSERTATION - I** **L T P C**

0 0 12 6

OBJECTIVE

- To enable the students to select a suitable topic to analyse and solve problems of industries/ research/ academic organizations related to green manufacturing.

DESCRIPTION

- The students will have to identify problems from industries/research/academic organizations pertaining to green manufacturing, analyze and offer solutions to the problems identified based on the knowledge acquired.
- The students can also Identify larger problems for which a part of the work should be completed in dissertation – I and further work should be performed in dissertation – II
- A report for Dissertation - I is to be submitted at the end for evaluation.

EVALUATION

- The progress of dissertation-I will be evaluated through reviews and finally dissertation will be evaluated jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 90 PERIODS

OUTCOME

At the end of this course, the students will be able to:

CO1 : apply the knowledge gained from theoretical and practical courses in solving the problems by creative, well planned and organized manner related to green manufacturing.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Attested

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GR5611	DISSERTATION II	L	T	P	C
		0	0	24	12

OBJECTIVE

- To enable the students to select a suitable topic to analyse and solve problems of industries/ research/ academic organizations related to green manufacturing.

DESCRIPTION

- The students will have to identify a larger problem from industries/research/academic organizations pertaining to green manufacturing, analyze and offer solutions to the problems identified based on the knowledge acquired.
- The students who have completed a part of the work as dissertation – I should complete the remaining part in dissertation – II.
- A report for Dissertation - II is to be submitted at the end for evaluation.

EVALUATION

- The progress of dissertation-II will be evaluated through reviews and finally dissertation will be evaluated jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 180 PERIODS

OUTCOME

At the end of this course, the students will be able to:

CO1 : apply the knowledge gained from theoretical and practical courses in solving the problems by creative, well planned, organized manner related to green manufacturing.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

GR5001	DESIGN FOR ENVIRONMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

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

UNIT I THE GREEN MOVEMENT **9**

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 9

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 9

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 9

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 9

Electronic Equipment industries – Xerox corporation: reducing the footprint, Hewlett Packard: A green giant – Sony Electronics: Innovation in design 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: ensuring a better quality.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : have knowledge of decision making with respect to the green movement
CO2 : apply the art and science of design environment
CO3 : apply the design rules and guidelines in preserving the environment
CO4 : impart the knowledge to analyse methods for design decisions
CO5 : apply the real world practice for design environment

REFERENCES

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2. Dorothy Mackenzie, L. King, Green Design: Design for the Environment, 1997.
3. Joseph Fiksel, Design for Environment: Creating Eco-efficient products and processes, McGraw Hill, 1996.
4. Nand K. Jha, Green design and manufacturing for sustainability CRC Press,2016.
5. Samir B. Billatos and Nadia A. Basaly, Green technology and design for environment, Taylor and Francis, 1997.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			✓								✓	
CO2		✓	✓	✓					✓			
CO3		✓	✓						✓			
CO4		✓	✓						✓			
CO5		✓	✓						✓			

Attested

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GR5002	GREEN CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To make the students to design green chemical products and processes to reduce the generation of hazardous substances.
- To introduce the importance of green chemistry's route in the pollution prevention
- To provide the students about stable and green chemical synthesis
- To familiarize the student to green chemistry reactions in order to provide safer environment
- To create awareness to choose safer materials for a safer world

UNIT I INTRODUCTION TO GREEN CHEMISTRY 9

Introduction – Definition - Need for green chemistry- - eco-efficiency– environmental protection law-challenges- green methods – green products- recycling of waste- – Twelve principles of green chemistry – Synthetic chemistry – Yield and atom economy – green soap manufacturing and methane combustion – waste prevention –awards for green chemistry – international organizations promoting green chemistry.

UNIT II INTERACTION OF ENVIRONMENTAL SPHERES 9

Introduction to environments – five environmental spheres (atmosphere – anthrosphere – biosphere – hydrosphere – geosphere) – and their interactions – carbon cycle – nitrogen cycle - challenges - environmental pollution and its prevention – green chemistry's route 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 theory for green chemical theory synthesis – the brief periodic table information for stable chemicals, manufacturing for 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 rule 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 formulae – mole and percentage composition.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : design green chemical products and process to reduce hazardous substance
CO2 : familiarize green chemistry's route in the pollution prevention.
CO3 : gain knowledge about green chemical synthesis towards suitable development.
CO4 : realize with green chemical reactions for safer environments
CO5 : select the safer materials for a safer world.

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1. Manahan, Stanley E., Green Chemistry and The Ten Commandments of Sustainability, Chemchar Research, Inc, Columbia, Missouri, USA, 2006.
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓						✓			
CO2		✓	✓				✓		✓			
CO3											✓	✓
CO4		✓					✓		✓			
CO5		✓					✓		✓			

GR5003 SUSTAINABILITY PRACTICE

L	T	P	C
3	0	0	3

OBJECTIVES

- To gain knowledge on the sustainability and present global issues
- To have knowledge on the economy and main stream sustainable development
- To introduce the various concepts of environment, degradation and sustainability
- To have knowledge on balancing the ecology
- To know the various risk faced by the society

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 conversation - 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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : Know the need for sustainability
CO2 : develop the skills to create various sustainable development practices
CO3 : know the issues related to the environment degradation
CO4 : ecological sustainability and its current issues
CO5 : Know the current risk faced by the society.

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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓								✓	
CO3			✓				✓		✓			
CO4			✓				✓		✓			
CO5							✓		✓		✓	

GR5004 SAFETY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

- To design or prevention through design is in the core for maintaining engineering systems safe.
- To evaluate occupational safety and health hazards in the workplace.
- To determine appropriate hazard controls following the hierarchy of controls.
- To determine appropriate hazard controls following the hierarchy of controls.
- To prevent incidents using the hierarchy of controls, effective safety and health management systems and task oriented training

UNIT I SAFETY IN METAL WORKING AND WOOD WORKING MACHINES 9

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

UNIT II PRINCIPLES OF MACHINE GUARDING 9

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grindingshaping-sawing-shearing-presses-forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

UNIT III SAFETY IN WELDING AND GAS CUTTING 9

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

UNIT IV SAFETY IN COLD FORMING AND HOT WORKING OF METALS 9

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

UNIT V SAFETY IN FINISHING, INSPECTION AND TESTING 9

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry – industrial waste disposal.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : evaluate workplace to determine the existence of occupational safety and health hazards
CO2 : identify relevant regulatory and national consensus standards along with best practices that are applicable.
CO3 : analyze the effects of workplace exposures
CO4 : select appropriate control methodologies based on the hierarchy of control
CO5 : analyze injury and illness data for trends.

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1. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓					✓		✓			
CO2			✓							✓	✓	
CO3			✓				✓		✓	✓		
CO4			✓		✓							
CO5			✓				✓		✓			

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GR5005 LEGAL ASPECTS OF ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

- To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India.
- To gain knowledge on function of regulatory agencies for water related issues
- To gain knowledge on function of regulatory agencies for air related issues
- To gain knowledge on environmental protection acts
- To know the provision for forest and court related issues

UNIT I INTRODUCTION **9**

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration – Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)

UNIT II WATER (P&CP) ACT, 1974 **9**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III AIR (P&CP) ACT, 1981 **9**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV ENVIRONMENT (PROTECTION) ACT 1986 **9**

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

UNIT V OTHER RELATED ACTS **9**

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC - Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases. international acts

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : get the awareness of laws related to environmental and legal aspects
CO2 : get legal practices related to water.
CO3 : expose in the pollution related to air and control prevention techniques
CO4 : apply the legal practices related to environmental management
CO5 : expose for various acts related to public and legal procedures.

REFERENCES

1. Central Pollution Control Board, Pollution Control acts, Rules and Notifications issued there under Pollution Control Series – PCL/2/1992, Delhi, 1997.
2. Shyam Divan and Armin Roseneranz Environmental law and policy in India, Oxford University Press, New Delhi, 2001.

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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓				✓		✓			
CO2									✓	✓		
CO3							✓		✓	✓	✓	
CO4							✓		✓		✓	
CO5		✓			✓		✓		✓			

GR5006 GREEN BUILDING DESIGN AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

- To expose students to various green building concepts.
- To impart knowledge about utilisation and management of water in buildings.
- To enlighten students with knowledge about various energy requirements in buildings and management principles.
- To impart knowledge about thermal design in buildings and its influences.
- To expose students to concept of solid waste management and green composites.

UNIT I GREEN CONCEPTS IN BUILDINGS 9

Green Building concepts and definition – Heat Transfer – Measuring Conduction Convection and Radiation – Thermal Storage – Measuring latent and sensible heat – Psychrometry Chart – Types of Shading Devices –Design responses to energy conservation strategies. - Building materials, embodied energy, maintenance and environmental implications.

UNIT II WATER MANAGEMENT IN BULDINGS 9

Water utilisation in buildings – Environmental implications of buildings on water, energy, waste disposal and carbon emissions – Management of sullage and 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 - Zoning – General Principles of Passive Solar Heating – Direct Gain Thermal Storage of Wall and Roof - Roof Radiation Trap - Solarium - Isolated Gain Key Design Elements – Sunspace –Case Studies – General Principles of Passive Cooling – Principles – Case Studies – Courtyards – Roof Ponds – Methods of utilisation solar and wind energy - Predicting Ventilation in buildings – Room Organization Strategies for Cross and Stack Ventilation – Radiation – Evaporation and dehumidification – Wind Catchers – Induced Ventilation - Earth Sheltering - Wind Tower - Earth Air Tunnels

UNIT IV THERMAL MANAGEMENT OF BUILDINGS 9

Thermal comfort in Buildings – Heat Insulation – Heat transfer characteristic of Building materials and building techniques – Thermal Design of buildings – Influence of Design Parameters – Mechanical Controls – Implications of geographical locations and seasonal variations – Orientation of buildings – Incidence of solar heat on buildings – 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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : apply suitable schemes towards design of green building.
CO2 : apply suitable schemes towards management and treatment of waste water in buildings.
CO3 : Know the different techniques of energy management.
CO4 : apply suitable techniques towards management and control of thermal energy (heat) in buildings.
CO5 : apply suitable schemes towards recycling of solid wastes and green composites.

REFERENCES

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.
4. Handbook on Functional Requirements of Buildings Part 1 to 4 SP: 41 - 1995.
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓						✓			
CO3			✓	✓							✓	
CO4			✓	✓							✓	
CO5			✓						✓		✓	

GR5007 ENERGY SAVING MACHINERY AND COMPONENTS L T P C
3 0 0 3

OBJECTIVES

- To introduce the various energy saving machineries and components to the students for the purpose of conserving energy.
- To understand the basics and principles of transforms, Pumps and motors.
- To impart the knowledge about the methods of energy conservation.
- To introduce the energy efficiency devices and concepts of ENCON.
- To impart the knowledge about CO_2 mitigation.

UNIT I BASICS OF ELECTRICAL ENERGY USAGE 9

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

UNIT II TRANSFORMERS and MOTORS 9

Transformer – Basics and Types – AVR and OLTC Concepts – Selection of Transformers – Performance Prediction - Energy Efficient Transformers - Motors : Specification and Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding and Over sizing - Energy Efficient Motors – ENCON Scope. Transmission Line Parameters – Transmission Line Losses- Kelvin's Law Performance Calculation And Analysis

UNIT III FANS, PUMPS AND COMPRESSORS 9

Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods adopted for effecting ENCON – Economics of ENCON adoption in all the 3 utilities

UNIT IV ILLUMINATION AND ENERGY EFFICIENT DEVICES 9

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

UNIT V CO_2 MITIGATION AND CASE STUDIES 9

Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO_2 Mitigation - Energy Conservation - Cost Factor. Case Studies on Industrial Energy Audit

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : understand the various energy saving machinery and components.
CO2 : understand the various methods of conservation of energy.
CO3 : evaluate the performance and energy conservation of fans, pumps and compressors.
CO4 : understand the various energy efficiency devices.
CO5 : understand CO_2 mitigation and cost factor.

REFERENCES

1. Hamies, Energy Auditing and Conservation ; Methods Measurements, management and Case Study, Hemisphere, Washington, 1980
2. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001
4. Peters, Kraushaar and Ristenen, Sustainable Energy, beta – test – draft, Energy and Problems of a Technical Society, 1993
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (www.energymanagertraining.com)
6. Nagrath IJ and Kothari DP, Power system engineering, TMH, 2007

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				✓			✓		✓			
CO2							✓		✓			
CO3			✓	✓								
CO4			✓	✓							✓	
CO5									✓	✓	✓	

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GR5008 GREEN ELECTRONICS MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES

- To familiar the various standards and legislation of modern electronic manufacturing.
- To know the conventional electronic processing and lead free electronic manufacturing techniques.
- To recognize the steps involved in assembly process and understand the need of recycle the electronics
- To implement reliability and product life cycle estimation tools in green electronic manufacturing.
- To demonstrate the green electronic manufacturing procedure in applications.

UNIT I INTRODUCTION TO GREEN ELECTRONICS 9

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. 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 9

Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - 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

UNIT III GREEN ELECTRONICS ASSEMBLY AND RECYCLING 9

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

UNIT IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN 9

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry

UNIT V CASE STUDIES 9

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : get concise awareness of standards and legislation of modern electronic manufacturing for green environment.
CO2 : explain the conventional electronic processing and lead free electronic manufacturing techniques.
CO3 : realize the assembly process and the need of recycle of electronics
CO4 : use reliability and product life cycle estimation tools for electronic manufacturing.
CO5 : validate the green electronic manufacturing procedures in applications.

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REFERENCES

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.
3. Sanka Ganesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
4. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			✓								✓	
CO2			✓	✓								
CO3			✓	✓							✓	
CO4			✓	✓						✓		
CO5				✓						✓	✓	

GR5009 GREEN ENERGY SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES

- To familiarize the various energy sources and their uncertainties.
- To stress upon various forecasting techniques for energy demand.
- To introduce the concepts of green cycles.
- To familiarize the students with various green processes associated with chemical, petro chemical refineries and fertilizer industries.
- To train on analysis of energy resources such as wind, water and tidal.

UNIT I ENERGY SOURCES 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 ENERGY FORECASTING 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 GREEN CYCLES 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 GREEN PROCESSES 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 ANALYSIS OF ENERGY RESOURCES 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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : select a suitable energy source for a subject industry.
CO2 : select suitable forecasting techniques to estimate the demand of energy.
CO3 : select suitable bio-geo-chemical cycles for environmental design.
CO4 : utilize the green processes in industries such as chemical refineries and petrochemicals.
CO5 : do input-output analysis so that cost savings can be made.

REFERENCES

1. Krentz, J. H., Energy Conservation and Utilisation , longman higher education, 1983.
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.
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓				✓		✓		✓	
CO2		✓	✓				✓		✓		✓	
CO3		✓					✓		✓		✓	
CO4		✓	✓							✓		
CO5										✓	✓	

GR5010 HAZARDOUS MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

- To understand the sources of solid and hazardous wastes.
- To evaluate the health risks posed by abandoned waste sites and waste disposal operations.
- To have knowledge on radiation and its effect of nuclear energy.
- To understand methods of solid waste disposal.
- To evaluate the legislation designed to control the production, clean up and disposal of solid and hazardous waste disposal operations.

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, 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 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 9

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

UNIT IV E-WASTES AND BIOLOGICAL TREATMENT OF HAZARDOUS WASTE 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. Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation

UNIT V SCIENTIFIC LAND FILL 9

Concept and definition – Site selection and approval – Acceptable wastes for landfill – Design and construction – Liners, clay, geo-membrane, HDPE, geo-net, geo-textile – Treatment and disposal of leachate – combined and separate treatment, site remediation – Remedial techniques.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : evaluate and examine the technical and economical points related to general hazardous waste management.
CO2 : classify the hazardous wastes according to their properties.
CO3 : design the appropriate treatment systems and disposal systems for hazardous wastes.
.CO4 : collect required data for a Hazardous Waste Management Plan and Set up hazardous waste recycling systems.
CO5 : apply the and use of hazardous wastes.

REFERENCES

1. Bhide A.D., Sundaresan B.B., 'Solid Waste Management – Collection Processing 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.
3. Safety Manual, Edel Engineering consultancy Pvt.Ltd., Chennai, 2000.
4. Biomedical waste (Management and Handling) Rules, 2016
5. Micheal D. Lagega, Philip L. Buckingham, Jeffrey E. Evans, Hazardous waste management, waveland press, 2010.
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CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓						✓		
CO2		✓	✓				✓		✓			
CO3		✓	✓				✓		✓			
CO4		✓	✓							✓	✓	
CO5							✓		✓	✓		

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GR5011	RECYCLING OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the concept of recycling, recycling techniques and recycling of various kinds of materials
- To expose the students for various recycling techniques.
- To create awareness to recycle the paper, household and metal waste
- To have knowledge on metal waste and its related recycling process.
- To introduce the concept of recycling the plastic, glass and rubber 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 metals and steel cans, ferrous metals, non-ferrous metals

UNIT V RECYCLING OF PLASTICS AND GLASS **9**

Recycling of thermoplastics-mechanical and chemical process, application of recycling materials, recycling of thermosets and polymer composites- application of recycled materials, recycling of used tyres and other rubber products-conversion of tyres to carbon black and oil.

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : understand the concept of waste and recycling
CO2 : understand various processing equipment used in recycling methods.
CO3 : to recycle the paper and household waste
CO4 : understand the recycle of ferrous and non ferrous metal waste
CO5 : understand the recycle concept of plastics and rubber.

REFERENCES

1. Allen W.S.and Baker P.N., Handbook of plastic Recycling, Alkem Quality Edition, Alkem Publishing, 2009.
2. John Scheirs, Polymer Recycling, Wiley Series in Polymer Science, 1997.
3. Mckinney R., Technology of paper Recycling, Blackie Academic and professional, 1997.
4. Herbert F. Lund, Recycling Handbook, McGraw-Hill 2nd Edition, 2001
5. Donald L. Stewart, James C. Daley, Robert L. Stephens, recycling of metals and engineered materials, Wiley, 2013.
6. Sally Morgan, Waste, Recycling and Reuse, Evans Brothers Limited, 2009.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓		✓		✓	
CO2										✓	✓	
CO3							✓		✓	✓	✓	
CO4							✓		✓	✓	✓	
CO5							✓		✓	✓	✓	

Attested

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Centre for Academic Courses
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GR5012	INDUSTRIAL SOLID WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system, our context.
- To describe appropriate methods to minimize the impact to public and occupational health from solid waste related activities
- To analyze Industrial waste generation patterns, as well as management and disposal techniques
- To analyze and communicate to the students for the importance of one of the components of an integrated solid waste handling system – including source reduction, recycling and reuse, composting, or land filling and combustion
- To analyze at least one environmental health topic for its impact on health and propose solutions based on what is known about the challenges/barriers.

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.

UNIT III STORAGE AND COLLECTION 9

Storage - Collection for low-rise dethatched 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 – Screens – 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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : develop the concepts of storage, collection and safe disposal of solid wastes
CO2 : explain the hierarchical structure in solid waste management and a requirement for an integrated solution.
CO3 : examine the technical points that are required to set up a solid waste management system.
CO4 : apply the legal legislation related to solid waste management.
CO5 : make an economical analysis of the solid waste management system.

REFERENCES

1. Chandrappa, Ramesha – Solid work Management, Springer, 2012.
2. George Tchbanoglous, Frank Kreith – Hand book of Solid Waste Management – McGraw Hill, 2002.
3. Javaid A. and Essadiqi E., Final Report on Scrap Management, Sorting and Classification of Steel, 2003
4. Embracing the zero waste challenge sustainability Report, 2012
5. Tirthakar Banejee, Plastics Waste Management in India: an integrated solid waste management approach, World Scientific Publishing Co., Singapore, 2014

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			✓	✓						✓		
CO2			✓				✓		✓		✓	
CO3			✓	✓						✓		
CO4							✓		✓	✓		
CO5										✓	✓	✓

GR5013 GREEN SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

- To introduce the concepts of Green supply chain Management (GSCM) to the students.
- To introduce the broad range of Supply chain activities
- To stress on importance of managing GSCM
- To design GSCM
- To develop logistics for GSCM

UNIT I NEED FOR GREEN SUPPLY CHAIN MANAGEMENT 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 – Inter model terminals – Cargo securing

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : design on logistics For supply chain management
CO2 : monitor Green Supply Chain Management.
CO3 : manage Green Supply Chain Management.
CO4 : design supply network.
CO5 : design suitable logistics.

REFERENCES

1. Balkan Cetinkaya and Richard Cuthbertson 'Sustainable Supply Chain Management' 2nd Edition, Springer, 2011.
2. Hsiao-fan wang and Surendra M. Gupta, Green Supply Management: Product Life Cycle Approach, McGraw Hill, 2011.

3. Alexander Trautrims, Chee Yew Wong, and David B. Grant, sustainable logistic and supply chain management: Principles and Practices for Sustainable Operations and Management, Kogan, 2017.
4. Micheal Hugos, Essentials of Supply Chain Management, Wiley, 2018.
5. Shoshanah Kohen, Joseph Roussel, Strategic supply chain management, wiley, 2018
6. Sunil Chopra and Peter Meindl, Supply Chain Management, Pearson Publishers, 2016.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓									
CO2											✓	✓
CO3				✓	✓							
CO4			✓	✓								
CO5		✓		✓			✓			✓		

GR5014 WASTE STREAM MAPPING

L	T	P	C
3	0	0	3

OBJECTIVES

- To introduce various concepts of Material recycling.
- To familiarize the mechanism of biological processing for resources recovery..
- To stress upon the importance of biochemical conversion of waste energy.
- To discuss about thermo chemical conversion of waste energy.
- To discuss case studies on waste recycling.

UNIT I MECHANICAL PROCESSING FOR MATERIAL RECYCLING 9

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 9

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- Large scale 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 9

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, $DeNO_x$ 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 9

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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : develop methods for resource recovery towards sustainability.
CO2 : identify a suitable mechanism of biological processing for resource recovery.
CO3 : develop suitable designs for biochemical conversion of waste to energy.
CO4 : develop suitable designs for thermo chemical conversion of waste to energy.
CO5 : find a solution for various waste recycling issues.

REFERENCES

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

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓					✓		✓			
CO2			✓				✓		✓			
CO3			✓				✓		✓		✓	
CO4		✓	✓				✓		✓			
CO5		✓	✓	✓								

GR5015 LEAN MANUFACTURING SYSTEM AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES

- To introduce the lean manufacturing and identify the waste.
- To study the various tools for lean manufacturing (LM).
- To apply the above tools to implement LM system in an organization.
- To provide knowledge on perfect value creation process that has zero waste.
- To apply the lean manufacturing tools and techniques through case studies.

UNIT I INTRODUCTION TO LEAN MANUFACTURING **9**

Introduction to Lean- Definition, Purpose, features of Lean, top seven wastes, Need for Lean, Elements of Lean Manufacturing.

UNIT II LEAN MANUFACTURING TOOLS AND METHODOLOGIES **9**

Lean manufacturing Tools - 5S principles –Total Productive Maintenance – Pillars of TPM - Total quality management –Principles and implementation.

UNIT III JUST IN TIME MANUFACTURING, VSM **9**

Introduction - Elements of JIT - Uniform production rate - Kanban system - Small lot size - Quick, inexpensive set-up - Continuous improvement. Value stream mapping - Procedure and principles.

UNIT IV LEAN SIX SIGMA APPROACH **9**

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Sigma implementation Features of lean six sigma, The laws of lean six sigma, Benefits of lean six sigma, Introduction to DMAIC tools.

UNIT V CASE STUDIES **9**

Various case studies of implementation of lean manufacturing at industries

TOTAL : 45 PERIODS

OUTCOMES

At the end of this course, the students will be able to:

CO1 : Identify the waste in various manufacturing process.
CO2 : understanding principles of cellular manufacturing, JIT and TPM
CO3 : Reduce the manufacturing time by applying concepts of TQM, 5S and VSM.
CO4 : get knowledge on six sigma approach
CO5 : get knowledge on applying the lean manufacturing tools and techniques

REFERENCES

1. Ronald G. Askin and Jeffrey B. Goldberg Design and Analysis of Lean Production Systems, John Wiley & Sons, 2003
2. Rother M. and Shook J, 'Learning to See: Value Stream Mapping to Add Value and Eliminate Muda' , Lean Enterprise Institute, Brookline, MA,1999.
3. Mikell P. Groover , 'Automation, Production Systems and CIM, 2002.
4. Lonnie Wilson, How to implement lean manufacturing, MG Graw Hill, 2015.
5. Pascal Dennis, Lean Production Simplified- CRC press, 2007.
6. Micheal l George, David Rowlands, Mark Price, John Mazy, Lean Six Sigma, MC-Graw Hill, 2005.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				✓			✓					
CO2		✓		✓						✓		
CO3										✓	✓	
CO4	✓			✓						✓	✓	
CO5		✓	✓	✓						✓		

GR5016 OPTIMIZATION TECHNIQUES FOR MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the basics of optimization and its engineering application
- To gain knowledge on linear and non- linear programming and its technique
- To apply basic concepts of mathematics to formulate an optimization problem.
- To provide experience on network techniques.
- To create aware of recent optimization tools like genetic algorithm.

UNIT I INTRODUCTION **9**

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

UNIT II CLASSIC OPTIMIZATION TECHNIQUES **9**

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

UNIT IV INTEGER AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES **9**

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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : apply the significance of optimization technique.
CO2 : Cast engineering minima/maxima problems into optimization framework.
CO3 : Apply efficient computational procedures to solve optimization problems related to non-linear programming.
CO4 : Use integer and dynamic programming to solve industrial problems.
CO5 : Use optimization techniques using algorithms.

REFERENCES

1. Panneerselvam R., “Operations Research”, Prentice Hall of India Private Limited, New Delhi – 2006
2. Sharma J.K., Operations Research – Theory and Applications – Macmillan India Ltd., 2013
3. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 2017
4. Guptha P.K. and Man-Mohan, Problems in Operations Research – Sultan chand& Sons, 2014
5. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 2007
6. Srinivasan G. Operations Research, Prentice Hall of India, 2010.

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				✓								✓
CO2	✓		✓									✓
CO3	✓					✓						✓
CO4	✓			✓								✓
CO5			✓	✓							✓	

MN5071 **FINANCIAL MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the concepts of financial accounting.
- To introduce the various functions of financial management to handle higher level financial decisions.
- To gain the knowledge about concepts of financial and various budgeting and cost accounting.
- To develop the knowledge in the field of capital budgeting and cost accounting.
- To gain the knowledge about financial management techniques to make a profit.

UNIT I FINANCIAL ACCOUNTING 9

Accounting concepts – Business transaction – Assets- Viabilities – Roumers equity-Assets – types – Financial statements – Income statement – Balance sheets – sources of finance – Internal sources – External sources – Equity capital – Dept capital .

UNIT II FINANCIAL MANAGEMENT 9

Functions of finance department – Purpose of finance – capital – Types – Working Capital – Sources of working capital – Working capital management – Grow working capital – Net working capital – Operating cycle – Working capital financing policy – cash management – Management of accounts relievable – Inventory pricing – Dividend policy – capital structure .

UNIT III CAPITAL BUDGETING 9

Evaluation of alternate investment criteria – Methods of capital budgeting – Pay Back Method – Accounting rate of return method – Present value method – Benefit cost ratio- Net Benefit cost ratio – Internal rate of return – Cost of capital – Determination of interest rate .

UNIT IV COST ACCOUNTING 9

Cost accounting and cost estimation – Difference – Aims and objectives of cost estimation and cost accounting – Elements of cost – Components of cost – Estimation of material cost - labor cost – Overheads – Types - Factory overheads - Administrative overheads – selling overheads - Distribution overheads – Fixed overheads and Fluctuating overheads.

UNIT V DEPRECIATION AND PROFIT PLANNING 9

Depreciation – causes of depreciation - Methods of depreciation – Straight line method Declining balance method – sum of the years digit method – sinking fund method- Annuity method – Repair provision method – Profit planning – Fixed cost – Variable cost – Selling price – Breakeven analysis – Breakeven volume – Angle of Incidence – Margin of safety - Multiproduct Breakeven analysis – Effect of changes in Selling price , Fixed cost , Variable cost on Breakeven volume , Margin of safety , angle Incidence.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Train in various functions of finance such as working capital management, current assets managements to make investment decisions.

CO2 : Handle the highest level financial decisions.

CO3 : Work in a capital financing policy and handle the cash management.

CO4 : Perform the various method in capital budgeting, understand and analyse different costs involved in financial managements.

CO5 : Make investment decisions when they take up senior managerial position.

REFERENCES:

1. Prasanna Chandra, Financial Management, Tata McGraw Hill(India), 9th edition 2018.
2. Narang G.B.S, Production and Costing, Khanna Publishers, 2005.
3. Kesavan R, Elanchezian C and Vijaramnath B, Engineering Economics and Cost Analysis, Anuradha Publications, 3rd Edition – 2012
4. Khan MY, Jain P K, Basic Financial Management, McGraw Hill,7th Edition, 2014.
5. James C, Van Home, Fundamentals of Financial Management, Prentice hall, 1989.
6. Rodney D Stewart, Cost Estimation, Wiley, 1991.

Course Outcomes	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓			✓	✓
CO2	✓	✓	✓	✓		✓		✓			✓	✓
CO3	✓	✓	✓	✓		✓		✓		✓	✓	
CO4	✓	✓	✓	✓		✓		✓			✓	
CO5	✓	✓	✓	✓		✓		✓			✓	

Attested

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GR5017	QUALITY MANAGEMENT IN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To expose the students to the various quality control techniques and also to understand the importance and concept of reliability and maintainability in industries.
- To study the approaches and techniques to assess and improve process and/or product quality and reliability.
- To Introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring
- To Introduce the recent principles and techniques of Statistical Quality Control and their applications.
- To illustrate the students the basic concepts and techniques of modern reliability engineering tools.

UNIT I INTRODUCTION 9

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

UNIT II QM PRINCIPLES 9

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 AND 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 AND 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

OUTCOMES

At the end of this course, the students will be able to:

CO1 : understand the various quality principles, tools and control techniques and to construct the various quality control charts

CO2 : develop design concepts for reliable system by implementing quality systems in industries.

CO3 : attain the basic techniques of quality improvement, fundamental knowledge of statistics and probability and Use control charts to analyze for improving the process quality.

CO4 : describe different sampling plans and student will be able to solve problems by various design methods.

CO5 : acquire basic knowledge of reliability and the concepts of reliability and maintainability.

REFERENCES

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

CO/PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓						✓		
CO2		✓	✓	✓						✓	✓	
CO3	✓		✓	✓								
CO4			✓	✓						✓		
CO5	✓		✓									

OPEN ELECTIVE COURSES (OEC)

OE5091	BUSINESS DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

OE5092 INDUSTRIAL SAFETY L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 OPERATIONS RESEARCH L T P C
3 0 0 3

COURSE OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II **9**

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method - CPM/PERT

UNIT V NETWORK ANALYSIS – III **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING *CONCEPTS* **9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT **9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

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UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

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UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method –Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

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REFERENCES:
1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

COURSE OBJECTIVES:
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:
CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

COURSE OBJECTIVES :

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE **L T P C**
2 0 0 0

COURSE OBJECTIVES:

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

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UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 VALUE EDUCATION L T P C

2 0 0 0

COURSE OBJECTIVES:

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095 CONSTITUTION OF INDIA L T P C
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

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UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

COURSE OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

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UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

COURSE OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

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TOTAL: 30 PERIODS

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Anna University, Chennai-600 025

COURSE OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama
   (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

COURSE OBJECTIVES:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

Attested

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