

Itgalpur, Rajankunte, Yelahanka, Bengaluru – 560064

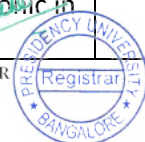
## Department of Mechanical Engineering

### 1.3.1

S. No	Name of the program	Course code	Name of the course	Gender/Human value/Professional Ethics/Environment & Sustainability
1	B.Tech	MEC3070	Electronics Waste Management	Environment & Sustainability

<b>Course Code:</b> MEC3070	<b>Course Title:</b> Electronics Waste Management <b>Type of Course:</b> Open Elective & Theory Only	<b>L- P- C</b>	3	0	3
<b>Version No.</b>	1.0				
<b>Course Pre-requisites</b>	NIL				
<b>Anti-requisites</b>	NIL				
<b>Course Description</b>	The present course on E-waste management will highlight the scenario of E-Waste management in India and its comparison with other countries. In Indian context, the role of various stakeholder in E-Waste management will be discussed followed by its effect on human health, environment and society will also be presented. Finally, the available option of extraction of Rare-Earth materials from the E-waste will also be discussed to throw some light on opportunities link with E-waste recycling.				
<b>Course Objectives</b>	The objective of the course is to familiarize the learners with the concepts of “ <b>Electronics Waste Management</b> ” and attain <b>ENTREPRENEURIAL SKILL</b> through <b>Participative learning techniques</b> .				
<b>Course Outcomes</b>	<b>On successful completion of this course the students shall be able to:</b>  <ol style="list-style-type: none"> <li>Understand the present scenario of E-waste generation in India.</li> <li>Understand the effect of E-Waste elements on <b>environment and public health</b>.</li> <li>classify the different existing recycling technique of E-Waste.</li> </ol>				
<b>Course Content:</b>					
<b>Module 1</b>	Introduction to E- Waste and its Management	Assignment	Data collection on consumption of Electronic products in last 10 years in India.	10 Sessions	
<b>Topics:</b> Present scenario of E-Waste, Definition to E-waste, Composition of E-Waste, Sources of E-Waste, E-Waste in India and global perspective (growth trend), Elements of Concern in E-Waste, Harmful Effects of E-Waste elements, Quantification of E-Waste, Case study of E- Waste (for a specific city), Economic assessment of E-Waste.					
<b>Module 2</b>	Environment and health concern	Assignment	Data collection on amount of different pollutants from top 10 consumer electronic in India.	10 Sessions	

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<p>Topics: Classification of E-Waste, Hazardous elements present in E-Waste, Toxicity concern of elements such as flame retardants, lead, mercury etc. on environment and public health. Exposure of E-Waste to mankind, Introduction to risk assessment, steps in risk assessment, Numerical problems on risk assessment.</p>				
<b>Module 3</b>	Recycling of E-Waste	Assignment & Case study	Data Collection on amount of material recovered from different E-Waste in 2019.	10 Sessions
<p>Topics: Introduction to recycling of E-Waste, steps in recycling, existing E-Waste recycling technique, case study of CRT recycling, Glass to glass recycling, glass to lead recycling, metal recovery, pyro metallurgical process, Hydrometallurgical process, Leaching technique and its mechanism, Bio metallurgical process.</p>				
<b>Module 4</b>	Environmentally sound E- Waste management	Assignment & Case study	Study different types of E-Waste Management starts-up	10 Sessions
<p>Topics: Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, Environmentally sound treatment technology for e- waste, Guidelines for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.</p>				
<p><b>Targeted Application &amp; Tools that can be used:</b> The growing concern of E-waste and the presence of precious metals attracts different E-Waste recycling plant in the country. The python (Pandas) will be used to analyze the data already existing to draw some insights of the trends in the E-Waste handling.</p>				
<p><b>Text books:</b> T1. Gev Eduljee, R M Harrison Electronic Waste Management: Edition 2</p>				
<p><b>References</b> R1. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website. R2. MSW Management Rules 2016, Govt. of India, available online at CPCB website. R3. Peyton L Sawyer, "Electronic Waste Management and Recycling Issues of Old Computers and Electronics", Nova Science Publication, 2010, E resource <a href="https://presiuniv.knimbus.com/openFullText.html?DP=https://www-emerald-com-presiuniv.knimbus.com/insight/content/doi/10.1108/00400910910960740/pdfplus/html">https://presiuniv.knimbus.com/openFullText.html?DP=https://www-emerald-com-presiuniv.knimbus.com/insight/content/doi/10.1108/00400910910960740/pdfplus/html</a></p>				
<p><b>Topics relevant to "ENTREPRENEURIAL SKILLS":</b> Classification of E-Waste, Hazardous elements present in E-Waste, Toxicity concern of elements such as flame retardants, lead, mercury for developing <b>ENTREPRENEURIAL SKILLS</b> through <b>Participative Learning techniques</b>. This is attained through assessment component as mentioned in the course handout.</p>				
<b>Catalogue prepared by</b>	Dr. Ashish Srivastava			
<b>Recommended by the Board of Studies on</b>	15 BOS, Dated 29/07/2022			
<b>Date of Approval by the Academic Council</b>	18 <sup>th</sup> Academic Council meet			

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# PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

## ACA-2[2019] COURSE HAND OUT

**SCHOOL:** School of Engineering

**DATE OF ISSUE:** 12-08-2021

**DEPARTMENT:** Mechanical Engineering

NAME OF THE PROGRAM	:	B.TECH
P.R.C. APPROVAL REF	:	PU/AC-18.6/MEC15/MEC/2019-23
SEMESTER/YEAR	:	4th
COURSE TITLE & CODE	:	Electronics Waste Management & MEC-3070
COURSE CREDIT STRUCTURE	:	3-0-0-3
CONTACT HOURS	:	40 Hrs
COURSE INSTRUCTOR	:	<b>Dr. Sudheer R</b>

### PROGRAM OUTCOMES:

#### Engineering Graduates will be able to:

**PO1.** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2.** Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3.** Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4.** Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5.** Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.



**PO6.** The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7.** Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8.** Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9.** Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10.** Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11.** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12.** Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**COURSE PREREQUISITES:** The course did not require any prerequisite and thus can be taken by any student from any discipline.

**COURSE DESCRIPTION:** E-Waste which includes loosely discarded, surplus, obsolete, broken electrical or electronic device is rapidly growing segment of municipal waste stream in the world. The present course on E-waste management will highlight the scenario of E-Waste management in India and its comparison with other countries. In Indian context, the role of various stakeholder in E-Waste management will be discussed followed by its effect on human health, environment and society will also be presented. Thereafter, risk pertaining to pollutants released from E-Waste recycling in soil, air and water will be discussed. Finally, the available option of extraction of Rare-Earth materials from the E-waste will also be discussed to throw some light on opportunities link with E-waste recycling.

**COURSE OBJECTIVE:** The objective of the course is to familiarize the learners with the concepts of “**Electronics Waste Management**” and attain **ENTREPRENEURIAL SKILL** through **Participative learning techniques**.



## COURSE OUTCOMES:

On successful completion of the course the students shall be able to:

1. Understand the present scenario of E-waste generation in India and the world and the opportunities associated with precious E-Waste elements.
2. Understand the effect of E-Waste elements on **environment and public health.**
3. Classify the different existing recycling technique of E-Waste.
4. Understand the tool such as Python (Pandas) to draw insight from E-waste data.

### MAPPING OF C.O. WITH P.O:[H-HIGH, M- MODERATE, L-LOW]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	M				L	M	L		M		L
CO2	H	H				M	M	M		M		L
CO3	H	M				L	M	L		M		L
CO4	H	H				M	H	L		M		L

## COURSE CONTENT (SYLLABUS):

### Module 1: Introduction to E-Waste and its Management

Present scenario of E-Waste, Definition to E-waste, Composition of E-Waste, Sources of E-Waste, E-Waste in India and global perspective (growth trend), Elements of Concern in E-Waste, Harmful Effects of E-Waste elements, Quantification of E-Waste, Case study of E- Waste (for a specific city), Economic assessment of E-Waste.

[10L Hours] [Knowledge level]

### Module 2: Environment and health concern

Classification of E-Waste, Hazardous elements present in E-Waste, Toxicity concern of elements such as flame retardants, lead, mercury etc. on environment and public health. Exposure of E-Waste to mankind, Introduction to risk assessment, steps in risk assessment, Numerical problems on risk assessment.

[10L Hours] [Comprehension level]

### Module 3: Recycling of E-Waste

Introduction to recycling of E-Waste, steps in recycling, existing E-Waste recycling technique, case study of CRT recycling, Glass to glass recycling, glass to lead recycling, metal recovery, pyro metallurgical process, Hydrometallurgical process, Leaching technique and its mechanism, Bio metallurgical process.

[10L Hours] [Comprehension level]

### Module 4: Environmentally sound E- Waste management

Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e- waste, Environmentally sound treatment technology for e- waste, Guidelines



for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.

**[10L Hours] [Comprehension level]**

**DELIVERY PROCEDURE (PEDAGOGY):**

Self-learning topics:	Industry and the recycling technique used therein to recycle E-Waste in Bengaluru city.
Topics for Participative Learning:	E-Waste industry and its future.
Topics for data analysis	Data analysis using Python (Pandas) to draw insight from E-waste data of any given city.

**Text book :**

1. Gev Eduljee, R M Harrison Electronic Waste Management: Edition 2

**Reference book(s):**

1. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website.
3. <https://presiuniv.knimbus.com/user#/searchresult?searchId=Electronic%20waste%20management&t=1664110477065>

**SCHEDULE OF INSTRUCTION:**

S.No	Module No.	Lecture No.	Topics	C.O Number	Delivery Mode	Date
1	1 <b>Introduction to E-Waste and its Management</b>	1	Introduction to E-Waste and its present scenario.	CO_1	PPT & video	
2		2	Definition to E-waste in respect to different countries, Composition of E-Waste.	CO_1	PPT	
3		3	Sources of E-Waste, E-Waste in India and global perspective (growth trend).	CO_1	PPT	
4		4	Elements of Concern in E-Waste and their	CO_1	PPT & Video	

  
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			proportion in different E-Waste.			
5		5	Harmful Effects of E-Waste elements.	CO_1	PPT	
6		6	Quantification of E-Waste.	CO_1	Notability app	
7		7	Case study of E-Waste (for a specific city)	CO_1	PPT	
8		8	Case study Continued	CO_1	PPT	
9		9	Economic assessment of E-Waste.	CO_1	PPT & Notability app	
10		10	Economic assessment of E-Waste continued	CO_1	PPT & Notability app	
11	<b>2</b> <b>Environment and health concern</b>	1	Classification of E-Waste	CO_2	PPT	
12		2	Hazardous elements present in E-Waste	CO_2	PPT	
13		3	Toxicity concern of elements such as flame retardants, lead, mercury etc. on environment and public health.	CO_2	PPT	
14		4	Toxicity concern of elements such as flame retardants, lead, mercury etc. on environment and public health continued..	CO_2	PPT	
15		5	Exposure of E-Waste to mankind	CO_2	PPT & Video	
16		6	Exposure of E-Waste to mankind	CO_2	PPT	
17		7	Introduction to risk assessment	CO_2	PPT	
18		8	Introduction to risk assessment continued..	CO_2	PPT	




19		9	steps in risk assessment	CO_2	PPT	
20		10	steps in risk assessment continued...	CO_2	PPT	
21		11	Numerical problems on risk assessment.	CO_2	PPT & Notability app	
22		12	Numerical problems on risk assessment.	CO_2	PPT & Notability app	
23		13	Numerical problems on risk assessment.	CO_2	PPT & Notability app	
24		14	Numerical problems on risk assessment.	CO_2	PPT & Notability app	
25	<b>3 Recycling of E-Waste</b>	1	Introduction to recycling of E-Waste	CO_3	PPT & Video	
26		2	Introduction to recycling of E-Waste continued....	CO_3	PPT & Video	
27		3	existing E-Waste recycling technique	CO_3	PPT	
28		4	case study of CRT recycling	CO_3	PPT	
29		5	Glass to glass recycling	CO_3	PPT	
30		6	pyro metallurgical process, Hydrometallurgical process	CO_3	PPT	
31		7	Bio metallurgical process.	CO_3	PPT	
32		8	Data analysis using Python (Pandas)	CO_4	Jupyter notebook	
33	<b>4. Environmentally sound E- Waste management</b>	1	Emerging recycling and recovery technologies	CO_4	PPT	
34		2	Guidelines for environmentally sound management of e- waste	CO_4	PPT	

35		3	Environmentally sound treatment technology for e-waste	CO_4	PPT	
36		4	Guidelines for establishment of integrated e-waste recycling and treatment facility	CO_4	PPT	
		5	Case studies and unique initiatives from around the world.	CO_4	PPT	

**Topics relevant to “ENTREPRENEURIAL SKILLS”:** Classification of E-Waste, Hazardous elements present in E-Waste, Toxicity concern of elements such as flame retardants, lead, mercury for developing **ENTREPRENEURIAL SKILLS** through **Participative Learning techniques**. This is attained through presentation as mentioned in the assessment component.

**ASSESSMENT SCHEDULE:**

Component	Contents	Course Outcome No.	Duration	Marks	% weight age	Venue , Date & Time
Mid-Term Exam	Module 1 & 2	CO1 & CO2	1 hour & 30 Minutes	50	25	As per the timetable from COE
Quiz/ Assignment	Topics will be announced one week prior to the submission/ participation data	CO1 & CO2	2 weeks	30	15	Will be announced one week prior to submission
Assignment 1	<a href="https://presiuniv.knimbuse.com/user#/se">https://presiuniv.knimbuse.com/user#/se</a>	CO1 & CO2	NA	10	5	Will be announced

  
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Review of digital/e resources from e Pres. Univ. link given in the References Section - (Mandatory to submit screenshot accessing digital resource. Otherwise it will not be evaluated)	archresult?searchId=Electronic%20waste%20management&t=1664110477065					one week prior to submission
Seminar/ Group Discussion (Participative Learning)	Topics will be announced one week prior to the submission/ participation data	CO3	30 Mins	10	5	Will be announced one week prior to submission
End term Exam	Complete syllabus	CO1, CO2, CO3 CO4	3 hours	100	50	As per the timetable from CoE

**COURSE CLEARANCE CRITERIA:**

Method of Assessment for Courses with Credit Structure (L – T – 0) or (L – 0 – 0)			
Components of Continuous Assessments		Weightage (% of Total Marks)	Duration of Assessment
1	Mid Term	25%	1.5 hour
2	This Component of continuous assessment shall consist of at least TWO (02) of the following: (1) Assignment(s) (2) Quiz	25%	NA

	(3) Technical Seminar / Report (4) Attendance / Class participation (5) Assessment on self-learning topic(s), or (6) Any other type of assessment as prescribed in the concerned Course Handout.		
<b>3</b>	End Term Final Examinations	50%	3 hour
<b>Total</b>		10%	

The student has to secure a minimum of 40% in the continuous assessment for the eligibility for end term examination. The student needs to secure a minimum of 30% in the end term examination to clear the course.

**ATTENDANCE: Students are required to have minimum of 75% of attendance to be eligible to attend exam.**

**CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:**

Students are encouraged to come for any discussions on this course at my chamber between 3:00 PM - 4:00 PM on Friday

**SAMPLE THOUGHT PROVOKING QUESTIONS:**

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1.	Expalin with the help of Bar chart the growing trends of E-Waste in India.	4	CO_1	Knowledge
2.	List the major chemical element (precious) present in the leatest model of i-Phone.	4	CO_2	Knowledge
3.	Based on the last 5 year E-Waste data, find the average life of 10 different brand of smartphone used in India.	5	CO_3	comprehension
4.	List the effect of chemical elemnts on public health.	4	CO_3	comprehension
5.	What is the use of following function under Python-Pandas library 1. shape 2. info 3. describe	5	CO_4	comprehension

**Target set for course Outcome attainment:**

Sl.no	CO No.	Course Outcomes	Target set for attainment in percentage
01	CO1	Understand the present scenario of E-waste generation in India and the world and the opportunities associated with precious E-Waste elements.	45
02	CO2	Understand the effect of E-Waste elements on environment and public health.	50
03	CO3	Classify the different existing recycling technique of E-Waste.	50
04	CO4	Understand the tool such as Python (Pandas) to draw insight from E-waste data.	50

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

**Course Completion Remarks &Self-Assessment.**

S.No	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
1	Program Integration			
2	Module : 01			
3	Module : 02			
4	Assignment-1			
5	Module : 03			

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6	Module : 04			
7	Assignment-2			
8	Quiz			

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

S.No	CO. No	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment & Measures to enhance the attainment
1	CO-1		65		
2	CO-2		60		
3	CO-3		65		
4	CO-4		60		

Name and signature of the Faculty member:

D.A.C. observation and approval:

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