- Gogos, C. G., & Tadmor, Z. (2013). Principles of polymer processing. John Wiley & Sons.
- Berins, M. (Ed.). (1991). Plastics engineering handbook of the society of the plastics industry. Springer Science & Business Media.

SUGGESTIVE READINGS

- Chan I. Chung, Hanser Verlag (2000) Extrusion of Polymers: Theory and Practice,
- R. J. Crawford, Rotational Molding of Plastics ABS, Research Studies Press Ltd.
- Crawford R.J., (1998) Plastic Engg, Butterworth-Heinemann.
- J.L. Throne (1987) Thermoforming Hanser Publishers.
- Rosato (1987) Blow Molding Handbook, Hanser Publishers.
- Harper, C. A., & Petrie, E. M. Plastic materials and processes: a concise encyclopedia. 2003.

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DISCIPLINE SPECIFIC CORE COURSE – 12

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
RECYCLING AND WASTE MANAGEMENT	**4**	**2**	**0**	**2**	**Class 12th with Physics, Chemistry, Mathematics**	**NIL**

Learning objectives

- To introduce the concept of life cycle analysis
- To learn about the solid waste management policies
- To learn about various sources of polymer waste generation and their management
- To understand various waste disposal and treatment methods

Learning outcomes

After studying this paper, students will be able to

- Explain the policies and legislations related to polymeric waste management and their impact on environment
- Apply the 4 R's approach (reduce, reuse, recycle, recover) for solid waste management

SYLLABUS OF DSC-12

THEORY COMPONENT-

UNIT 1: (10 Hours)

INTRODUCTION TO WASTE MANAGEMENT

Introduction to the concept of life cycle analysis, four pillars of LCA, plastic wastes and litter, social and environmental challenges of plastic waste recycling in India, Main features of Plastic waste management regulations in India, sorting techniques and classification (density - float sink and froth floatation methods, selective dissolution, optical, spectroscopic, sorting by melting temperature, triboelectric separator etc.).

UNIT 2: (6 Hours)

CLASSIFICATION OF WASTE MANAGEMENT

Thermoplastic waste management: 4 R's approach (reduce, reuse, recycle, recover), recycling classification - primary, secondary, tertiary, quaternary recycling with examples (mechanical, chemical and thermal processes)

UNIT 3: (4 Hours)

DISPOSAL AND WASTE TREATMENT TECHNIQUES

Controlled tipping, pulverization, composting, incinerators, pyrolysis, gasification, on-site disposal methods, compacting and baling

UNIT 4: (5 Hours)

THERMOPLASTIC RECYCLING

Recycling of polyolefins, PVC, PET, polystyrene, polyamides (nylon-6 and nylon-6, 6) etc.

UNIT 5: (5 Hours)

WASTE MANAGEMENT OF THERMOSET

Recycling of thermosets, reclaiming of rubber, tire retreading, uses of recycled rubber

PRACTICAL COMPONENT (60 Hours)

- Primary recycling of various waste collected from the environment.
- Secondary recycling of MSW by incorporating and blending the recyclable waste with virgin polymers.
- To study composting of natural/biopolymers.
- Separation of polymer mixture by sink flotation technique.
- Separation of polymer mixture by selective dissolution technique.
- To recover BHET from PET by chemical recycling process
- To recover adipic acid from nylon 66 by chemical recycling technique
- To study the effect of vulcanized rubber at varying ratio (in powder form) on mechanical properties of rubber vulcanizate
- To study the effect of vulcanized rubber at varying ratio (in powder form) on thermal properties of rubber vulcanizate
- To study the effect of vulcanized rubber at varying ratio (in powder form) on physical properties of vulcanized rubber

ESSENTIAL/RECOMMENDED READINGS

- Hawkins W. L., (1984) Polymer Degradation and Stabilization, SpringerLink.
- Reich L., Stivala S. S., (1971) Elements of Polymer Degradation, McGraw-Hill.
- Niti Aayog (2021), Undp Handbook on Sustainable Urban Plastic Waste Management
- Saha N. C., Garg M., Sadhu S. D., Ghosh A. K., (2022) Food Packaging-Materials, Techniques and Environmental Issues, Springer.
- Chandra R., Adab A., (2004) Rubber and Plastic Waste: Recycling, Reuse and Future Demand, CBS Publisher.
- NIIR Board of Consultant and Engineers, (2007) Medical, Municipal and Plastic Waste Management Handbook, National Institute of Industrial Research.
- Goodship V., (2007) Introduction to plastics recycling, Rapra.

SUGGESTIVE READINGS

- Maharana, T., Negi, Y. S., & Mohanty, B. (2007). Recycling of polystyrene. Polymer-Plastics Technology and Engineering, 46(7), 729-736.
- Caillol, S. (2014). Lifecycle assessment and green chemistry: a look at innovative tools for sustainable development. Environmental Impact of Polymers, 65-89.

- Klöpffer, W. (Ed.). (2014). Background and future prospects in life cycle assessment. Springer Science & Business Media.
- Dimitris, S., & Achilias, L. (2014). Recent advances in the chemical recycling of polymers (PP, PS, LDPE, HDPE, PVC, PC, Nylon, PMMA). Mater. Recycl. Trends Perspect, 3, 64.
- La Mantia, F. (2002). Handbook of plastics recycling. iSmithers Rapra Publishing.
- Braun, D. (2002). Recycling of PVC. Progress in polymer science, 27(10), 2171-2195.
- Scheirs J., (1998) Polymer Recycling, John Wiley & Sons.
- Blow S., (2000) Handbook of Rubber Technology, Hanser Gardner.
- Bandrup J.E., (1996) Recycling and Recovery of Plastics, Hanser Gardner.

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