

<b>Course title:</b> Solid and Hazardous Waste Management				
<b>Course code:</b> NRE 189		<b>No. of credits:</b> 3	<b>L-T-P:</b> 36-6-0	<b>Learning hours:</b> 42
<b>Pre-requisite course code and title (if any):</b> NRE 131 Environmental Chemistry and Microbiology, NRE 137 Environmental Monitoring laboratory				
<b>Department:</b> Energy and Environment				
<b>Course coordinator:</b> lakshmi.raghupathy23@gmail.com			<b>Course instructor:</b> Dr Lakshmi Raghupathy	
<b>Contact details:</b>				
<b>Course type:</b> Core			<b>Course offered in:</b> Semester 2	
<b>Course Description</b> The course would cover-general introduction including definition of solid wastes–municipal waste, biomedical waste, hazardous waste, e-waste; legal issues and requirements for solid waste management; sampling and characterization of solid waste; analysis of hazardous waste constituents including QA/QC issues; health and environmental issues related to solid waste management; steps in solid waste management-waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques (composting, vermi-composting, incineration, non-incineration thermal techniques, refuse derived fuels, land-filling); economics of the onsite vs. offsite waste management options (individual vs. common treatment/disposal practices, integrated waste management; and waste minimization and concepts of industrial symbiosis and industrial ecology.				
<b>Course objectives</b>				
1. Understanding of problems of municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc.				
2. Knowledge of legal, institutional and financial aspects of management of solid wastes.				
3. Become aware of Environment and health impacts solid waste mismanagement				
4. Understand engineering, financial and technical options for waste management				
<b>Course content</b>				
<b>Module</b>	<b>Topic</b>	<b>L</b>	<b>T</b>	<b>P</b>
1.	General introduction including definitions of solid waste including municipal, hospital and industrial solid waste; legal issues and requirements for solid waste management and health and environmental issues related to solid waste management.	3		
2.	Sampling and characterization of solid waste	3		
3.	Analysis of hazardous constituents in solid waste including QA/QC issues	3	2	
4.	Health and environmental issues related to solid waste management	2		
5.	Waste reduction at source – municipal and industrial wastes	2		
6.	Material and resource recovery/recycling from solid wastes	2		
7.	Methods of waste collection, collection techniques, waste container compatibility, waste storage requirements, transportation of solid wastes	2		
8.	Treatment and disposal techniques for solid wastes–composting, vermin-composting, autoclaving, microwaving, incineration, non-incineration thermal techniques, use of refuse derived fuels, land-filling	7	2	
9.	Economics of on-site vs. off-site waste treatment and disposal (individual vs. common disposal)	4	2	
10.	Waste minimization and concept of industrial ecology and industrial symbiosis	4		
11.	Integrated waste management practices	4		
	<b>Total</b>	<b>36</b>	<b>6</b>	
<b>Evaluation criteria</b>				
▪ Tests 1 & 2: 40% (20% each)				

<ul style="list-style-type: none"> <li>▪ Assignments: 10%</li> <li>▪ Test 3: 50%</li> </ul>
<p><b>Learning outcomes</b></p> <ul style="list-style-type: none"> <li>• After completion of the course students should be able to-do sampling and characterization of solid waste; analysis of hazardous waste constituents including QA/QC issues; understand health and environmental issues related to solid waste management; apply steps in solid waste management-waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques; economics of the onsite vs. offsite waste management options</li> </ul>
<p><b>Pedagogical approach</b> Blend of classroom teaching, case studies and field exposure</p>
<p><b>Materials</b></p> <p>Required text</p> <ol style="list-style-type: none"> <li>1. Batstone R., Smith J.E. (Jr.) and Wilson D. (1989) <i>The Safe Disposal of Hazardous Wastes-the Special Needs and Problems of Developing Countries</i>, The World Bank Technical Paper No. 93, Vol. I, II and III, Washington, DC, The World Bank.</li> <li>2. Central Public Health and Environmental Engineering Organization (CPHEEO) (2000) <i>Manual on Municipal Solid Waste Management</i>, New Delhi, Controller of Publications.</li> <li>3. Freeman H.M. (1988) <i>Standard Handbook of Hazardous Waste Treatment and Disposal</i>, New York, McGraw-Hill.</li> </ol> <p>Suggested readings</p> <ol style="list-style-type: none"> <li>1. Prüss A., Giroult E. and Rushbrook P. (1999) <i>Safe Management of Wastes from Health-care Activities</i>, Geneva, World Health Organization.</li> <li>2. SW-846 (1980) <i>Test Methods for Evaluating Solid Waste, Physical/Chemical Methods</i>, Washington, DC, USEPA, Available at <a href="http://www.epa.gov/epawaste/hazard/testmethods/sw846/index.htm">http://www.epa.gov/epawaste/hazard/testmethods/sw846/index.htm</a>.</li> <li>3. Tchobanoglous G., Theisen H. and Vigil S. (1993) <i>Integrated Solid Waste Management: Engineering Principles and Management Issues</i>, New York, McGraw-Hill.</li> <li>4. Vesilind P.A., Worrell W.A. and Reinhart D.R. (2001) <i>Solid Waste Engineering</i>, Australia, CL-Engineering.</li> </ol> <p>Journals</p> <ol style="list-style-type: none"> <li>1. International Journal of Environment and Waste Management</li> <li>2. Waste Management</li> <li>3. Journal of Environmental Management</li> </ol>
<p><b>Advanced Reading Material</b></p>
<p><b>Additional information (if any)</b></p>
<p><b>Student responsibilities</b> The students are expected to submit assignments in time and come prepared with readings when provided.</p>

**Course reviewers:**