UNEP

Curriculum Catalog
Holistic Waste Management

WSD University Consortium Asia & Pacific

ASIAN INSTITUTE OF TECHNOLOGY 1959

KYOTO UNIVERSITY FOUNDED 1897

TONGJI UNIVERSITY 1907

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OVERVIEW

The environmental system is broadly divided into three compartments: air, water and land, and the pollution problems are hence grouped into three categories: air pollution, water pollution, and solid waste. Therefore, the subsequent pollution control/waste management technology, policy, regulatory decisions and management strategies have been a single-medium approach, wherein the solid waste, wastewater and gaseous wastes and emission are dealt separately as 'silo', and are managed independently by various departments within an institution (for example – solid waste management department, sanitation and sewerage management department within a Municipality) without any interaction between these departments.

Typically, most of the existing academic curriculum and other capacity building programmes on waste management also have a compartmentalized approach of dealing with solid waste management, wastewater treatment, and gaseous emissions. However, in a practical professional setting, a policy maker, manager and a technician needs to make a decision based on the interconnectedness among various waste forms, through a holistic perspective and taking into account the socio-economic, technical, managerial and governance aspects of dealing with waste. Therefore, a need for professional academic curriculum on holistic approach to waste management was felt necessary to prepare a leadership that can address this new circular and holistic approach to waste management.

The program aims to meet this opportunity to spearhead the holistic waste management concept by incorporating all forms of wastes from a more holistic perspective by breaking these vertical 'silo' and handling the possible inter-linkages and the resultants multi-media wastes and emissions in solid, liquid, and gaseous forms. This is also in line with the integrated approaches of 2030 Agenda: Sustainable Development Goals.

This program prepares students to work in multidisciplinary teams involved in the design, development, and implementation of holistic management solutions by putting wastes in life cycle perspective for closing the resource loop, and contribute towards sustainable solutions taking into account the socio-economic, technical, managerial and governance aspects of dealing with waste.

This program will enhance peer learning, building leadership capacity, and capacitate professionally to communicate complex waste management and sustainability strategies across diverse levels, while widening your expertise in all forms of wastes and emissions and overall project management.

PROGRAM STRUCTURE

The program curriculum and delivery itself includes an integrated and holistic approach, with the course designed and delivered by a Consortium of six reputed international universities from Thailand, Japan, Australia, China, and India – consortium convened by the United Nations Environmental Programme International Environmental Technology Centre (UNEP IETC).

The program will run through one academic year worth 33 credits; 24 credit taught programme and 9 credit dissertation project at the end of the academic year. The programme will be delivered through a number of courses under four main modules consistently, under the overall the theme of "holistic waste management."

Module 1: Overview of Waste and Material Flow Management
Kyoto University-Japan, UNSW- Australia, and Griffith University- Australia
Courses:
Fundamentals of Waste Management 2(2-0)
State of Global and Regional Waste 2(2-0)
Materials Flow Management for Resource Conservation 2(2-0)

Module 2: Circular Economy and Holistic Waste Management
Asian Institute of Technology-Thailand
Courses:
Circular Economy and Resource Efficiency 2(2-0)
Sustainable Consumption and Production 2(2-0)
Principles of Reduce, Reuse and Recycling (3Rs) 2(2-0)

Module 3: Waste Treatment Technologies towards Holistic Approaches
Tongji University- China
Courses:
Environmental Science and Technology for Decision Makers 2(2-0)
Waste Treatment Technologies 3(3-0)
Selection and Transfer of Environmentally Sustainable Technologies 1(1-0)

Module 4: Waste Management Policy, Governance, and Financing
The Energy Research Institute- India
Courses:
Governance for Holistic Waste Service Delivery 2(2-0)
Economics of Waste and Innovative Financing 3(3-0)
Social Aspects of Waste Management 1(1-0)

Module 1	Overview of Waste and Material Flow Management

Module 1 Description

Title: Overview of Holistic Waste and Material Flow Management
Total Credit: 6
No. of courses: 3

Description
With current trends in population growth and industrialization, wastes and emission in solid, liquid, and gaseous forms are released to the environment faster than the earth can absorb them, and natural resources are consumed faster than they can be restored. This module presents a detailed overview of various waste forms, their sources of generation, characteristics, compositions, and their impacts on the environment and public health, as well as in the economy, hence in the overall sustainable development paradigm. Equally, issues related to land contamination, water and air pollution are major threats to life on earth. While there is no doubt that the life expectancy and quality of life has increased during the past decade, it has also resulted in the production of variety of pollutants, which are hazardous to the environment. A holistic approach is needed to overcome the challenges of waste (solid waste, wastewater, gas emissions etc.) to ensure the environmental and health impacts are minimized or avoided. The module therefore sets a scene for "holistic waste management" by showing the interlinkages among solid, liquid and gaseous wastes.

Wastes in general are considered as those materials which are no longer required by an individual, institution, or industry. But in current unsustainable production and consumption patterns, these by-products and end-products can be put into remanufacturing, in order to alleviate environmental degradation and bring together better resource productivity. Such resource recirculation framework first of all requires the study of fluxes of resources used and their flows through a region, through a single process or via a combination of various processes. Tools like Material Flow Analysis (MFA) is a helpful tool for characterization (from production to waste) of the flows and stocks, material, pathways, intermediates and final sinks that allow priority settings in waste management. This module also addresses the resource flow through material flow management.

This module sets the scene for other modules of the curriculum by dealing with 'Waste Overview and Materials Flow Management' via following three courses:

Course 1.1: Fundamentals of Waste Management (2 Credit)
- An Overview, Waste Characterization and Assessment,
- Introduction to Holistic Waste Management

Course 1.2: State of Global and Regional Waste (2 Credit)

Course 1.3: Material Flow Management for Resource Conservation (2 Credit)
- Material Flow Analysis (MFA) – 1 credit
- Life Cycle Analysis (LCA) – 1 credit

Module 1	Overview of Waste and Material Flow Management

After completing this module, students should be able to understand the Fundamentals of holistic waste management – solid waste, wastewater and gaseous emissions and their interconnectedness, Global & Regional situation of waste (Asia & Asia Pacific), Waste sampling and characterizing, and Concepts of material flow analysis and life cycle assessment.

Course 1.1 Fundamental of Waste Management 2 (2-0)

Course Objectives: Almost every human activity contributes to wastes either in solid, liquid of gaseous forms. This course will provide knowledge on waste types, their source, and factors contributing to waste generation, their impacts on human health and ecosystem functioning, and issues concerning waste management. This course will further discuss characteristics and composition of waste, which are the basis for appropriate waste management strategy, technology, and policy choices.

Learning Outcomes: After completing this course, students should be able to understand the following:

- Issues related to waste generation and types of different waste streams
- Sources and pathways of wastes
- Issues of waste management
- Waste composition and characterization
- Understand the holistic system approach to waste management, by breaking vertical Silos of individual waste form (solid, liquid, gas) and look for the possible interlinkages/resultants multi-media wastes and emissions issues
- Practice Holistic approach to waste management by outing wastes and emissions in the life cycle perspective for closing the resource loop, and contribute towards sustainable solutions to wastes and emissions.

Course Outline:

I. Fundamental understanding of solid waste, wastewater, gaseous pollutant sources, pathways & their impacts
   1. Environmental Problems – solid waste, wastewater and air pollution
   2. Fate and transport of a substance in the environment
   3. Assessment of environmental and public health, social and economic impacts of wastes

II. Waste composition and characterization
   1. Composition of wastes at various sources
   2. Physical, chemical, biological properties of waste
   3. Sampling techniques of solid waste, wastewater and air emissions – with practical waste sampling and basic laboratory sessions
   4. Waste characterization and modelling case study

III. Evolution of Waste management

1. Historical development in waste management
2. Integrated solid waste management (ISWM)- basics of waste handling, treatment, disposal and recovery of wastes, 3R
3. From Silo to Holistic Waste Management

IV. Defining Holistic Waste

1. Definition, terminologies
2. Practical examples of holistic waste management
3. Benefits of traditional Silo versus holistic approach to waste management

Reference Books

1. Tchobanoglous, G., Theisen, H., Vigil, S.A. (1993). Integrated Solid Waste Management- Engineering Principles and Management Issues. ISBN 0-07-112865-4, McGraw-Hill Kogakusha, Tokyo, Japan.
2. Andrew, F. (1999). Modeling the Environment- An Introduction to System Dynamics Modeling of Environmental Systems. Island Press, Washington D.C., United States.
3. Asano, T, et al., (2007). Water Reuse- issues, Technologies, and Applications. ISBN – 1:978-0-07-145927-3. Metcalf & Eddy/AECOM
4. UNEP (2009) Waste characterization and quantification with projections for future. Developing integrated solid waste management plan, Training Manual, Volume 1

Background Reading Materials

1. ASTM International. Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste. Designation: D 5231 – 92 (Reapproved 2003)
2. Environment Protection Agency (EPA). MSW Characterization Methodology.
3. Mid Atlantic Solid Waste Consultants. 2011 Iowa Statewide Waste Characterization Study
4. Ali Forouhar, Kiril D. Hristovski. Characterization of the municipal solid waste stream in Kabul, Afghanistan. Habitat International 36 (2012) 406e413
5. David C. Wilson. Development drivers for waste management. Waste Manage Res 2007: 25: 198–207
6. Paul Mac Berthouex and Linfield C. Brown. Pollution Prevention and Control – Human Health and Environmental Quality. ISBN- 978- 87- 403- 0526- 5
7. National Academy of Sciences, 1987. Multimedia Approaches to pollution Control: A Symposium Proceedings. Committee on Multimedia Approaches to Pollution Control. Constitution Avenue, NW, Washington, D.C. 2041
8. Hwong-wen Ma & Douglas J. Crawford-Brown (2001) The Use of a Multimedia Risk Analysis Approach in Designing Waste Management Strategies, Journal of the Air & Waste Management Association, 51:5, 742-749, DOI: 10.1080/10473289.2001.10464299

Journals and Magazines

1. Waste Management
2. Waste Management & Research
3. Journal of Resource Conservation and Recycling
4. Journal of Material Cycles and Waste Management

Video Clips

1. Are you eating plastic for dinner? www.ITSPLASTICWORLD.com
2. Recycling and education help revive Indonesia's Citarum river basin
3. Veolia Circular Economy

Course 1.2. State of Global and Regional Waste 2 (2-0)

Course Objective: The objective of this course is to prepare students for subsequent modules by providing the knowledge about the global and regional state of solid waste management, hazardous waste management, and wastewater treatment. Such knowledge is essential in developing holistic solutions to the global and regional waste problem. Waste generation and management in Asia and Pacific, African and Latin American regions and OECD countries will be covered in this course.

Learning Outcomes: The student on completion of this course will be able to:

- Global and regional issues and challenges related to solid waste and hazardous waste
- Global and regional issues and challenges related to wastewater
- Global and regional issues and challenges related to gaseous emissions/air pollution

Course Outline:

Section I. State of Global and Regional Solid and Hazardous Waste

Lecture 1: State of Global and Regional Waste Scenario (3 hr.)

- Review of concepts of waste
- Historical perspectives on global waste
- Current and emerging issues and challenges related to waste

Lecture 2: State of Solid Waste in Asian Region (3 hr)

- Regional trends
- State of solid waste generation, composition, collection, treatment and disposal in countries of the region
- Environmental and health impacts
- Case studies

Lecture 3: State of Solid Waste in Middle Eastern, African and Latin American regions and OECD countries (3 hr.)

- Regional trends
- State of solid waste generation, composition, collection, treatment and disposal in countries of the region
- Environmental and health impacts
- Case studies

Lecture 4: State of Hazardous Waste in Asia (3 hr.)

- Regional trends
- State of hazardous waste generation, composition, collection, treatment and disposal in countries of the region
- Environmental and health impacts
- Case studies

Lecture 5: State of Hazardous Waste in Middle Eastern, African and Latin American regions and OECD countries (3 hr.)

- Regional trends
- State of hazardous waste generation, composition, collection, treatment and disposal in countries of the region
- Environmental and health impacts
- Case studies

Lecture 6: State of Waste in Pacific Island Countries and Small Island Nations (3 hr.)

- Regional trends
- Waste in some countries

Section II. State of Global and Regional Wastewater and Air Pollution

Lecture 7: State of Global and Regional Wastewater 1 (6 hr.)

- State of world's water resources
- Status and challenges of water security in Asia Pacific region
- Wastewater generation and pollution impacts
- Wastewater treatment and reuse
- Country specific data

Lecture 8: State of Global and Regional Gaseous Emissions (6 hr.)

- Air pollution in some Asian cities
- Impacts of air pollution
- Case studies of air pollution
- Regional trends of gaseous emissions
- Air pollution and gaseous emissions from waste sector

Reference Books

1. UN HABITAT (2009) Solid Waste Management in World Cities
2. World Bank (2012) What a Waste: A global review of solid waste management. Urban Development Series Knowledge Papers No. 15
3. Tanaka, M., Agamuthu, P. Municipal Solid Waste Management in Asia and the Pacific Islands
4. Chin, J. (2011). Waste in Asia, March 2011. Responsible Research.
5. Asano, T., Burton, F., Leverenz, H., Tsuchihashi, R., Tchobanoglous, G. (2007). Water Reuse: Issues, Technologies, and Applications. Inc. & Eddy an AECOM Company. McGraw Hill Professional. ISBN – 1:978-0-07-145927-3.
6. UNEP (2015) Global Waste Management Outlook
7. Mackenzie Leo, D. (2010) Water and wastewater engineering: design principles and practice. McGraw Hill
8. Marquita K. Hill (2010) Understanding environmental pollution. Cambridge University Press
9. Schwela, D (2006) Urban air pollution in Asian cities: status, challenges and management. Earthscan Publishers.
10. Bhola R (2010) Air pollution: health and environmental impacts. CRC Press
11. UNEP 2016. GEO-6 Regional Assessment for Asia and the Pacific. United Nations Environment Programme, Nairobi, Kenya.
12. Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). (2010). Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. ISBN: 978-82-7701-075-5
13. ADB (2013). Asian Water Development Outlook 2013: Measuring water security in Asia and the Pacific. Mandaluyong City, Philippines: Asian Development Bank. ISBN: 978-92-9092-989-5 (PDF)
14. UNEP (2014). Year Book 2014 emerging issues update- Air Pollution: World's Worst Environmental Health Risk

Video Clips

- 2 minutes in Oceans with Jim Toomey : http://www.rona.unep.org/toomey
- The Water at Stake – BuriGanga, Bangladesh: https://vimeo.com/91490402
- Recycling and Education Help Revive Indonesia's Citarum River Basin: http://www.adb.org/news/videos/recycling-and-education-help-revive-indonesias-citarum-river-basin
- Air Pollution, Bozeman Science. Environmental Science 029: https://www.youtube.com/watch?v=_dTtvtlct9k
- Global Pandemic - Air Pollution | Romain Lacombe | TEDxAthens: https://www.youtube.com/watch?v=FKBVwX8dVhI

Course 1.3 Material Flow Management for Resource Conservation 2(2-0)

Course Objectives: To establish sustainable urban metabolism, concept, elements, control, optimization and management of urban metabolism will be explained in this course. The course will provide a review and detailed methodology of important environmental material accounting methods, such as Material Flow Analysis and Life Cycle Assessment; and show how they can be used to provide information to design more sustainable goods, processes and systems at a range of scales in our economy.

Learning Outcomes: After the course, students will be able to understand:

- Overview of Material Cycles system
- Skills of analyzing and conducting MFA studies
- Skills of analyzing and conducting LCA studies
- Show how the Material Flow Analysis (MFA) method is the foundation of all other material accounting methods, which add additional interpretative steps on top of the MFA
- Equip students to decide which material accounting technique will give the most useful information to answer the question.

Course Outline:

I. Waste Management and Material Cycles
1. Basic knowledge about waste management and material cycle society
2. Material cycle concept
3. Japan's experience of material cycles' society and 3R Forum for Asia and Pacific
4. Overview of material accounting
5. Material Input per Service Unit (MIPS)
6. Ecological Footprint

II. Urban Metabolisms and Sustainable Society
1. Basic knowledge about sustainability and society
2. Urban metabolism and management of waste, waste water and gaseous emission
3. Sustainability criteria and review

III. Material Flow Analysis
1. Overview of MFA
2. Applications of MFA in waste management
3. Tutorial on MFA tools/software (STAN)
4. MFA assignment

IV. Life Cycle Analysis
1. Overview of LCA
2. Applications of LCA in waste management
3. Tutorial on LCA tools (SimaPro software)
4. LCA Assignment

Reference Books

1. Burner, H., Rechberger, H. (2004). Practical handbook of Material Flow Analysis-Advanced Methods in Resource and Waste Management. Lewis Publishers
2. Mary Ann Curran (Editor) (2012). Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products. ISBN: 978-1-118-09972-8. Wiley
3. Wuppertal Institut for Climate (2002). Calculating MIPS – Resource productivity for Products and Services

Journals and Magazines

1. Waste Management, Elsevier
2. Waste Management and Research, Sage Journal
3. Resources, Conservation and Recycling, Elsevier

Module 2	Circular Economy and Holistic Waste Management

Module 2 Description

Title: Circular Economy and Holistic Waste Management
Total Credit: 6
No. of courses: 3

Description
Overconsumption, increasing prices of materials, subsequently, higher volume of waste generated are the typical characteristics of a linear economy's path that we are taking. However, we cannot keep going on with such business as usual linear economy system. The future of the economy has to be circular. Circular economy and resource efficiency focus on maximizing life cycle utility of resources- and- is designed to efficiently recirculate the raw material in a closed-loop, through minimization of resource use and maximization of waste recovery as secondary raw materials and alternative energy sources.

This module introduces introduce various 'circularity' concepts and principles, and practices that will place waste management as a key lever of circular economy This module runs through the through following three courses:

Course 2.1: Circular Economy and Resource Efficiency (2 Credit)

Course 2.2: Sustainable Consumption and Production (2 Credit)

Course 2.3: Principles of Reduce, Reuse and Recycling (2 Credit)

These courses will critically appraise and apply resource efficiency and circular economy tools (cleaner production and sustainable consumption, design for sustainability, resource efficiency, industrial symbiosis, circular cities, and 3Rs etc.) to facilitate holistic waste management in an urban context. As the holistic waste management also revolves around minimizing waste generation and handling of resultant multi-media wastes and emission arising from handling one form of waste, and its interconnectedness in solid, liquid, and gas phases, the concept of circular economy will be applied in dealing with all phases of wastes- solid, liquid and gaseous emission in a holistic manner.

Course 2.1. Circular Economy and Resource Efficiency 2 (2-0)

Course Objectives: Using fewer resources to achieve maximum output are critical to drive the economy in a close loop, especially in the resource constrained world. Circular economy facilitates waste reduction or even the elimination of the notion of wastes by turning them into resources. Such rethinking about extensive use and disposal of resources and, patterns of consumption and achieving resource efficiency in a close loop economy complements holistic waste management too. The course discusses the concept of circular economy at the production level for the full optimization of resource utilization advancing towards a circular economy, through improved efficiency of energy, water, and materials use, by-product exchanges among industrial networks. Eco Industrial Parks/clusters is the second layer of circular economy, where the circular economy mode "recovery-recycling-design-production" is followed, which realizes cyclic utilization of substance and optimization of resource allocation. Similarly, the circular economy at the consumption level is brought forward through circular cities, the cities are the front-runners of circular economy.

Learning Outcomes: This course enables students to look into an integrated way of handling liquid, solid, and gaseous emission from industries for waste/by-product exchange and resource recovery. Administered with extensive case studies, and real field visits and virtual tours, students will develop a holistic and pragmatic approach towards waste abetment in industries, and cities, and closing the resource loop through circular economy approach. At the completion of this course, students will be able to understand:

- The basic principles and ideas underlying the circular economy
- The opportunities and barriers of going "circular"
- Industrial symbiosis for closing the loop of an industrial production and waste management process
- Concepts, practices and innovation in gearing up cities for circular economy

Course Outline:

I. Theories on Resource Efficiency and Circular Economy

1. Resource Efficiency: What is it?
    - Natural Resources, Materials, and the Economy: trend of resource consumption, scarcity and projections on resource consumption
    - Resource Efficiency in Sustainable Development Goals
    - Resource Efficiency and Raw Materials: Material flows and resource productivity, and sustainable resource use
    - Transition to green and resource efficient economy
    - Resource efficiency and low carbon economy
    - Delivering Resource Efficiency: Policies, approaches, and governance

2. Circular Economy: An Introduction
    - Limits of Linear Economy/Consumption (from cradle to grave)
    - Benefits of Circular Economy (cradle to cradle) and opportunities

- Cases and different modalities of Circular Economy (in China, Japan, Europe)
- Circular Economy and material flow management
- Circular Economy Indicators
- Waste targets policy and legislation towards meeting the objectives of circular economy
- Creating Necessary reforms/frameworks for a circular economy
- Green business opportunities in circular economy
- The 'sharing/renting economy' and its implications for the circular economy

II. Eco-Industrial Clusters, Eco-cities, and the Environment

1. Industrialization, Resource Consumption and Waste Generation
   - Industrialization, Resource Consumption and Waste Generation
   - End-of-pipe treatment- Resources down the drain
   - Integrating EIC and Urbanization from resource and waste management perspective

2. Circular Economy in Practice- Industrial Symbiosis: Concepts of Industrial Symbiosis: Industrial Wastewater Reuse and Reclamation
   - Industrial Ecology in practice
     - Industrial Symbiosis – The case of Kalundborg symbiosis
     - Industrial Metabolism
     - Dematerialization
     - Green Chemistry

3. Industrial Parks
   - Upstream Vs. Downstream Approach to EIC
   - Eco-industrial Parks
   - Eco-industrial Networks
   - Resource Recovery Park
   - Zero-Emission Park
   - Waste Exchange Centers
   - Cases of traditional industrial parks
   - Eco-Towns- Integrating EIC and Urbanization from resource and waste management perspective

4. Gearing up Cities for the Circular Economy
   - Cities as Systems: Urban Metabolisms
   - Basic Principles of Circular Cities
   - City Level Decoupling
   - Cases of Circular Cities

Reference Books:

1. Nemerow, N.L (1995). Zero pollution from industry: Waste minimization through industrial complexes. John Wiley & Sons Ltd
2. M. Kutz, M. (2007). Environmentally Conscious Material and Chemical Processing. John Wiley & Sons Ltd
3. Venkatachalam, A., Thangavelu, S.M., Visvanathan, C. (2013). Eco-Industrial Cluster: A Prototype Training manual. ADBI. ISBN: 978-4-89974-039-1
4. Ellen MacArthur Foundation (2012). Towards the Circular Economy.
5. United Nations Environment Programme (2013). City Level Decoupling- Urban resource flows and the governance of infrastructure transitions. UNEP. ISBN: 978-92-807-3298-6
6. Asian Development Bank (2014). Urban Metabolism of Six Asian Cities. ISBN 978-92-9254-659-5 (Print), 978-92-9254-660-1 (e-ISBN). Mandaluyong City, Philippines: ADB

Journals and Magazines:

1. Journal of Industrial Ecology, Wiley Online Library
2. International Journal of Technology Management, Inderscience

Course 2.2. Sustainable Consumption and Production 2 (2-0)

Course Objective: The objective of this course is to present principles and applications of sustainable consumption and production concepts and tools to practice circular economy and resource efficiency. Living in the era of consumerism that encourages the purchase of goods and services in ever-greater amounts has led to unsustainable consumption and production patterns, hence leading to the resources scarcity. Therefore, only resource efficient, cleaner and safer production, and sustainable consumption can address a broader spectrum of "Sustainable Development" by responding to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations.

The course provides an overview of the changing pattern of production and consumption of goods and services, from closing the resource loop by practicing sustainable resource use and end-of life waste management in a more holistic ways- i.e., considerations from design stage to use/consumption, and the end-of life phase of the product and service, as well as making the entire chain of production, supply chain, and consumption in a more environmentally sustainable and socially and economically responsible ways to influence consumption behavior.

Learning Outcomes: The student on completion of this course will be able to:

- Understand fundamentals and concept of sustainable production and consumption

- Understand cleaner production as sustainable resource management, waste minimization and management approach
- Demonstrate importance of product improvement and redesign as part of sustainable manufacturing that reduces waste pollution, energy consumption and end of life waste management designing for recycling and reuse of parts
- Explore, explain and understand the role of Sustainable Supply Chain Management (SSCM) a Sustainable Public Procurement (SPP) in integrating resource efficient consumption and waste minimization

Course Outline:

Lectures on the latest topics on sustainable consumption and production methods, technologies, and systems cover: Introduction to the Cleaner Production - the systematic improvement of production processes to use fewer resources (water, energy, materials), Design for Sustainability Green Consumerism - Eco Labelling & Certification, Sustainable supply chain management, and Sustainable public procumbent. The course will also put emphasis on providing examples of practical applications for a range of production and consumption systems- manufacturing, food supply chains, energy generation, building sector, sustainable transport, etc.

I. Overview of Sustainable Consumption and Production (SCP)
   1. Fundamental concepts of SCP
   2. Definition of SCP
   3. SCP and Green Economy
   4. SCP and Sustainable Development Goals (SDGs)
   5. SCP Indicators

II. Sustainable Production Theory and Application
   1. Principles and Process of Cleaner Production (CP):
      Cleaner production (CP) as a tool for sustainable production of goods and services through a continuous application of an integrated preventive environmental strategy, hence handling, solid, liquid and gaseous forms of wastes and emissions produced during the production phase - introduce the concept of CP practice and technologies in the important sectors of the economy, methodologies and tools to apply CP to use energy efficiently, reduce pollution and minimize wastes.

   2. Design for Sustainability (DfS): Aspects of product design in reduction of scrap and waste, allowing a more efficient use of resources- optimal management of materials, consisting of the correct use of materials, reduction of toxic or polluting materials, and improvement of the product during its entire life cycle, in its use phase and end-of-life phase

III. Sustainable Consumption

1. Changing consumption patterns (of an individual, businesses and industry, and City and Country) – facts and statistics on resource constraints and waste and emissions related to consumption

2. Changing behavior- people's green choices - Influencing the consumption pattern - Green consumerism choices and Eco-Labeling and certifications of products and services, Greening Versus Greenwashing scams

IV. Tools for Practicing Sustainable Consumption

1. Sustainable Supply Chain Management (SSCM) - Supply chain Management includes all the processes involved in the production and distribution of a commodity to the point of consumption. SSCM facilitates sustainable production and consumption at the manufactures' level and also guide individual consumers to choose green products and services in a sustainable fashion. The SSCM not only supports the economic profitability, but also to environmental sustainability.
    - Key Concepts of SSCM
    - Lean and Green Supply Chain
    - Techniques to analyze environmental impacts of supply chain (ex. LCA)
    - Reverse Supply Chain

2. Sustainable Public Procurement (SPP) - Sustainable public procurement is one of the tools to promote SCP promoting better use of resources and end-of-life waste management. SPP policies with social dimensions also contribute to poverty alleviation and social justice, supporting sustainable development in general.

V. Design Workshop

Students will be engaged in a design workshop to practice cleaner production principles and principles of sustainable product design and innovation for the given consumer products.

1. Cleaner Production Practices
2. Design workshop

Reference Books:

1. Bishop, P.L. (2000): Pollution Prevention- Fundamentals and Practice. McGraw Hill International Edition
2. Hon, B. (2002). Design and Manufacture for Sustainable Development. ISBN 978160583964
3. UNEP (2012). Sustainable Consumption and Production: A Handbook for Policy Makers with cases from Asia and the Pacific.
4. UNEP (2013). Sustainable Public Procurement: A Global Review. ISBN: 978-92-807-3332-7

Journals and Magazines:

1. Journal of Cleaner Production, Elsevier
2. Sustainable Production and Consumption, Elsevier
3. Journal of Supply Chain Management, Emerald

Course 2.3. Principles of Reduce, Reuse and Recycling (3R) 2(2-0)

Course Objectives: This course deals with the comprehensive overview, planning and application of the principles reduce, reuse, and recycle as the basis for sustainable municipal solid waste, water and wastewater management in urban centers. This integrated 3R approach will instigate the "rethinking waste as resources" and facilitate holistic waste management. This course, however, only highlights the *pre-recycling requisites* (such as segregation, cleaning and sorting, collection, and waste handling) and *post-recycling requisites* (such as value addition of recycled products through the developing a recycling market. The actual recycling/treatment technologies are taught in other consecutive courses. This course also explores the interrelationship between successful waste reduction and reuse policies with a possible shift in recycling and treatment technologies.

Learning Outcomes: After the course, students will be able to understand:

- Definition of 3Rs, Opportunities and Barriers
- 3Rs in the solid waste sector- role of 3Rs towards circular economy realization through material recycling and energy recovery from wastes
- 3Rs in the water sector - efficient use of water resources and wastewater reclaim and reuse
- Pre-recycling/recovery processes (segregation, cleaning, size reduction etc.)
- Technological capacity and design modification with (the implementation) effective 3R policy performance
- Stakeholder mapping, institutional and multi-stakeholder coherence (their role in planning and implementation of holistic waste service delivery)

Course Outline:

I. 3R Definition
   1. What is 3R? Definitions, history and genesis, Benefits of 3R (socio-economic-and environmental benefits), calculation of waste recycling rate
   2. Waste Reduction/Minimization and reuse - techniques and policies and good practices of waste reduction cases
   3. Waste Recycling, Up-cycling
   4. Successful case of 3R at Institutional level; 3R Awards

II. Pre-processing of wastes for resource recovery
   1. Waste segregation at source: review of various practices of waste segregation in practice (ex. Dry and wet waste, two bins versus multiple bin system etc.)
   2. Waste collection and handling
   3. Manual and mechanic sorting of waste (optical sensors, magnetic strips etc.)
   4. Waste washing, cleaning and drying – and recycling related pollution issues
   5. Description of recycling processes of selected waste items- paper, plastic food waste, e-waste, tyre waste, and Absorbent Hygiene product wastes etc.

III. 3Rs in Water and Wastewater Sector

1. Reducing water footprint
2. Wastewater as a renewable resource
3. Reclamation and reuse of wastewater (potable and non-potable uses, and nutrient and energy recovery)
4. Circular water economy - Zero Liquid Discharge (ZLD) in industries

IV. 3R Policy and Technology Dynamics – Hits and Misfits

1. Review of successful waste reduction and reuse policies
2. Is recycling (at the end of life phase) the best solution?
3. Limits of recycling in the resource finite world
4. How will recycling focused policy downscale the waste reduction and reuse potential
5. Effects of recycling policies and regulations on waste segregation at source and vice-versa
6. Cases of successful waste reduction and affecting waste incineration facilities in Taipei
7. Waste Management Financing Failures – Waste management debt

V. Post-Recycling Requisite

1. The recycling market- status, barriers and opportunities
2. Role of government, private and individual consumers in promoting the market for recycled products

VI. Formulation of Holistic Waste Management Strategies (3R Blueprint) for a Municipality

Students will be provided with a typical environmental profile of an Asian city, which faces the challenges of ever-increasing influx of people creating demands for municipal services viz. water supply, drainage/sewerage, garbage collection, local air pollution control etc. The current waste flows, waste treatment and disposal practices, and other waste management factors will be presented in the case work. Based on the given case scenario, students will develop a holistic waste management plan for city's solid waste, wastewater, and gaseous wastes by applying theoretical concepts and principles learned during the coursework- such as 3R principles, sustainable consumption and production, resource efficiency, circular economy, eco industrial cluster development etc.

Reference Books:

1. Asano, T., Burton, F., Leverenz, H., Tsuchihashi, R., Tchobanoglous, G. (2007). Water Reuse: Issues, Technologies, and Applications. Inc. & Eddy an AECOM Company. McGraw Hill Professional. ISBN – 1:978-0-07-145927-3.
2. Minter, A. (2013). Junkyard Planet: Travels in the Billion-Dollar Trash Trade. ISBN – 978-1-60819-791-0
3. FOE/IGES (2013). Best Practices and Recommendations for Waste Reduction- Towards Sustainable Consumption.

4. 3R Knowledge Hub (2010). 3R in Asia- a Gap Analysis in Selected Asian countries. ISBN - 978-974-8257-41-9

Journals and Magazines:

1. Waste Management, Elsevier
2. Waste Management and Research, Sage Journal
3. Resources, Conservation and Recycling, Elsevier
4. International Journal of Environment and Waste Management, Inderscience

Module 3 Description

Title: Waste Treatment Technologies Toward Holistic Approach
Total Credit: 6
No. of courses: 3

Description
This module is a detailed account of solid waste, wastewater, and gaseous emissions handling, collection, treatment, recovery and recycling, and disposal technologies. This module will first look into isolated technologies for each waste types, and later build scenarios and examples for technology integration to handle resultant wastes and by-products in different than its original form. Along with the state of art technologies, this module will explore green and innovative technologies, and various tools for the selection of appropriate technologies, and technology transfer cases.

Courses included in this module are;

Course 3.1: Environmental Science and Technology for Decision Makers (2 Credit)

Course 3.2: Waste (Solid waste, wastewater, and gaseous emissions) Treatment Technologies (3 Credit)

Course 3.3: Selection and Transfer of Environmentally Sustainable Technologies (1 Credit)

These courses are expected to aide decision makers to understand interlinkages of all waste forms and help in choosing the appropriate treatment technologies in managing urban wastes in a holistic manner.

Course 3.1 Environmental Science and Technology for Decision Makers 2(2-0)

Course Objectives: The interdisciplinary and complex nature of urban environmental problems requires basic understanding of science and technological aspects affecting decision making of many professionals including planners and managers. Such knowledge will permit decision makers to consider and evaluate environmental impacts associated with any developments or projects in hand. This course is designed to provide the students with basic technical knowledge on environmental problems (with specific focus on solid waste, wastewater and gaseous emissions), characteristics and sources of pollutants, and possible technical solutions particularly those relating to urban environment.

Module 3	Waste Treatment Technologies Toward Holistic Approach

Learning Outcomes: The students should be able to:

1. Explain the character of environmental issues and the information relating environmental science and technology, and recall the key data needed for decision making.
2. Apply basic calculation method, indicator setting, and assessment framework for an individual environmental problem.
3. Determine the critical point of environmental problem, and apply knowledge concurrence with other disciplines.
4. Knowledge of the decision makers' roles for solving environmental issues.
5. Illustrate how to consider/solve environment problem using environmental science and technology.
6. Work with group members who are from various professional/academic background to end up with acceptable results.

Prerequisite: None.

Course Outline:

I. Key Themes of Environmental Sciences
   1. Environmental problems and causes
   2. Human population and environment
   3. Sustainability and systems thinking

II. Ecology and Environment
   1. Ecology and ecosystem
   2. Forests, wildlife, and biodiversity
   3. Biogeochemical cycles

III. Resources and Environment
   1. Land, soil, and minerals
   2. Water and water pollution
   3. Energy
   4. Air pollution and climate change
   5. Solid and hazardous waste

IV. Technology and Environment
   1. Technology and its environmental impacts
   2. Waste treatment technologies
   3. Environmentally sound technologies

V. Our Environmental Future

Reference Books:

1. D.B. Botkin and E.A. Keller. Environmental Science, Earth as a Living Planet, 8th Edition, John Wiley & Sons, Inc., M.A, 2011
2. G.T. Miller, Jr. and S.E. Spoolman. Environmental Science, 13th Edition, Brooks/Cole, Cengage Learning, Belmont, CA, 2010.
3. D.D. Chiras. Environmental Science, 7th Edition, Jones and Baralett Publishers, Sadbury, Mass., 2006
4. E.M. Stanely. Environmental Science and Technology, Lewis, Boca Raton, New York, 1997.
5. J. Antony. Design of Experiments for Engineers and Scientists, Butterworth Heinemann, NY, 2003
6. J. Birkeland. Design for Sustainability, Earthscan, VA, 2002
7. M.L. Davis and D.A. Cornwell. Introduction to Environmental Engineering, 4th Edition, McGraw-Hill, Boston, 2008
8. P.D. Berger and R.E. Maurer. Experimental Design with Applications in Management, Engineering, and the Sciences, Duxbury, CA, 2002
9. T.O'Riordan. Environmental Science for Environmental management, 2nd Edition, Prentice Hall, Harlow, UK, 2000
10. UNHSP. Enhancing Urban Safety and Security, A, 2007
11. WHO. Guideline for Drinking Water Quality, 3rd Edition, Geneva, 2004

Journals and Magazines:

1. Environmental Science and Technology, American Chemical Society
2. International Journal of Environmental Policy and Decision Making
3. International Journal of Waste Resources
4. Environmental Technology
5. Environmental Management

Course 3.2 Waste Treatment Technologies 3(3-0)

Course Objectives: This course gives a detailed account of solid waste, wastewater, and gaseous emissions treatment, recovery and recycling, and disposal technologies. All physical, chemical, and biological treatment processes with examples of specific waste stream will be presented. This module will first look into the state of art technologies isolated technologies for each waste types, and later build scenarios and examples for technology integration to handle resultant wastes and by-products in different than its original form.

Learning Outcomes: The student on completion of this course will be equipped with:

- Fundamentals of solid waste, wastewater, and gaseous emissions (treatment and resources recovery) management technologies
- Integration of technologies to treat wastes of all forms

Module 3	Waste Treatment Technologies Toward Holistic Approach

Course Outline:

I. Solid Waste Treatment Technologies

1. Biological Decomposition Processes of waste treatment
   - Aerobic and anaerobic processes
   - Composting – different types of composting
   - Anaerobic Digestion

2. Thermal Treatment of solid waste
   - Waste to Energy Processes – Incineration, Pyrolysis
   - Emission Control
   - Ash Management

3. Disposal of solid waste
   - Landfill- Siting, Design and Construction, Operation and Maintenance, Emission Control and Treatment
   - Landfill Gas Capture
   - Leachate Management
   - Landfill Mining
   - Landfill closure and rehabilitation

4. Emerging and Innovative Technologies and Case studies

II. Wastewater and Sludge Treatment Technologies

1. Primary and Physico-Chemical Treatment
   - Neutralization, Equalization
   - Settling, Coagulation, Flocculation, Flotation, Filtration.

2. Biological Treatment
   - Aerated Lagoons
   - Activated Sludge
   - Trickling Filters.

3. Tertiary Treatment; Sludge Treatment
   - Activated Carbon Process
   - Membrane technology
   - Nanotechnology
   - Biofilm and Biofloc Processes
   - Sludge digestion and drying
   - Land treatment of wastewater and sludge
     - Slow rate, rapid infiltration, and overland flow land-disposal systems
     - Soil treatment mechanisms
     - Groundwater recharge; design criteria for hydraulic and nitrogen application

- Energy recovery from wastewater
- Nutrient recovery/sludge recycling

III. Integrated Control Technologies for Stationary Sources and Mobile Sources of Air Pollution

1. PM Control Devices - Design Parameters and Collection Efficiency
   - Mechanical collectors: gravity settling chamber, cyclone
   - High efficiency collectors: Baghouse, Scrubber, Electrostatic precipitator, Hybrid
   - Selection of PM control devices

2. Gaseous Pollutant Control Mechanisms and Devices
   - Volatile Organic Compounds and general treatment principles
   - Absorption theory and devices
   - Adsorption theory and devices
   - Other systems: Incineration, Condensation, Membrane, Biofiltration
   - Considerations in gaseous pollutant control
   - Integrated approaches for SOx and NOx control

3. Mobile Source Control
   - Emission from mobiles sources
   - Integrated approach for mobile source control
   - Gasoline vapor from refueling stations
   - Control techniques for gasoline powered vehicles
   - Control techniques for diesel-powered vehicles

4. Emission reduction of climate forcing agents
   - Sources of major climate forcing agents (GHG, black carbon)
   - Integrated emission reduction measures
   - Carbon Capture and Storage (CCS)

5. Case Studies: Design Air Pollution Control Systems
   - Thermal power plants
   - Cement production plants
   - Municipal waste incinerators
   - Pulp and paper industry
   - Integrated GHG emission control for stationary and mobile sources
   - Integrated approaches for mobile sources control for a city.

Reference Books:

1. K. Wark, C.F. Warner, and T.W. Davis: Air Pollution: Its Origin and Control, Harper & Row, New York, 2003.
2. K. E. Noll: Fundamentals of Air Quality Systems - Design of Air Pollution Control Devices. AmericanAcademy of Environmental Engineers, USA. 1999. TD 889.N645 1999
3. H. E. Hesketh: Air Pollution Control, Technomic, Lancaster, 1991. TD883 H47
4. C. Polprasert: Organic Waste Recycling: Technology and Management, 3rd Edition, IWA Publishing, London, 2007
5. Tchobanoglous G. et al: Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 2005.
6. ISWA (Eds): Solid waste management for economically Developing Countries
7. James & James, 1996
8. Metcalf & Eddy: Wastewater Engineering, 4th Edition, McGraw Hill, New York, 2003
9. P. Zannetti: Air Pollution Modeling: theories, computational methods and available software, 1990. Computations Mechanics Publications. New York. TD883.1.Z36 1990
10. J.E. Bailey and D.F. Ollis: Biochemical Engineering Fundamentals, McGraw-Hill International, New York, 2nd edition, 1987.

Journals and Magazines:

1. International Journal of Waste Resources
2. International Journal of Water and Wastewater Treatment
3. Journal of Environmental Treatment Techniques (JETT)
4. Journal of the Air Pollution Control Association

Course 3.3 Selection & Transfer of Environmentally Sound Technologies (1-0)

Course Objectives: Environmental technologies provide solutions to pollution problems, however, not all environmental challenges have technological fixes. There are often other management and behavioral parts to avoid the pollution problems in the first place. Having said that, making the technological choices is an important part. To avoid obscured technologies, care must be given to select the most appropriate technologies that are acceptable and compatible with local social, economic, cultural, and environmental priorities.

This course will take students through various Environmentally Sound Technologies (ESTs) in (solid, liquid, gaseous) waste management that are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes. Along with the available ESTs, the course will also venture into technological innovations (which handles wastes and their by-products in a holistic manner), and the transfer of those proven

technologies within and across the countries, so as to accelerate technology leap-frogging. Technology transfer not only involves the passing of the necessary technological know-how but also building up of economic, technical, and managerial capabilities for the efficient use and further development of transferred technology. The main objective of this course is to prepare students with necessary knowledge and tools to plan to select the appropriate technology and implement technology transfer in waste management sector.

Learning Outcomes: The student on completion of this course would be able to:

- Deal with technologies available for wastewater treatment and management, solid waste, air pollution and industrial and hazardous waste treatment and management;
- Use tools for decision making in choosing the suitable ESTs
- Deal with technology transfer complexities, challenges and opportunities

Course Outline:

I. Understanding Technologies
   1. Concepts, evolution, and systems view
   2. Technology and environment

II. Environmentally Sound Technologies
   1. Definition and main features of ESTs
   2. Pollution control and waste treatment technologies
   3. Cleaner production and eco-industrial transition

III. Assessment and Selection of Technologies
   1. Framework for the selection of technologies
   2. Criteria and indicators
   3. Sustainability assessment methods
   4. Case studies

IV. Understanding Technology Transfer
   1. Framework, processes, and tools
   2. Challenges and barriers
   3. Regulations and policies
   4. Financing and economic aspects

V. Dealing with Technology Transfer
   1. Transfer of commercial technologies
   2. Transfer of environmentally sound technologies
   3. Cases studies
   4. Reforming the environmental technology transfer

Reference Books:

1. Sustainability Assessment of Technologies (SAT). UNEP International Environmental Technology Centre
2. Invention and Transfer of Environmental Technologies. OECD. ISBN: 9789264115613
3. UNEP (Editor); IETC (Editor) (1996): International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management.
4. Global Environment Facility (2008). Transfer of Environmentally Sound Technologies: The GEF Experience. GEF.
5. The International Handbook on Environmental Technology Management. ISBN: 978 1 84064 687 0
6. T. Graedel and J. Howard-Grenville Greening the Industrial Facility: Perspectives, Approaches, and Tools. Springer, New York, 2005.
7. A. Grübler. Technology and Global Change. Cambridge University Press, London, 1998.

Journals and Magazines:

1. Journal of Cleaner Production, Elsevier
2. Technological Forecasting and Social Change, Elsevier
3. The Journal of Technology Transfer, Springer
4. International Journal of Environmental Technology and Management, Inderscience

Module 4 Description

Title: Waste Management Policy, Governance, and Financing
Total Credit: 6
No. of courses: 3

Description
Waste management is not necessarily only a technical issue for local governments. In fact, many 'social, cultural, political, policy and regulatory, and economic contexts shape waste landscapes. Purely technocratic approaches are generally not successful, as they ignore issues of governance and urban management and development. Hence, waste management should be seen as a global, socio-political process involving complex patterns of multi-level governance.

This module examines the governance issues that are emerging in waste networks and focuses on waste management policies and regulations, innovative financing, social and institutional aspects and effective stakeholder engagement for solid waste, wastewater and gaseous emission management services in an urban centre.

This module will be delivered via following three courses:

Course 4.1: Governance for Holistic Waste Service Delivery (2 credit)

Course 4.2: Economics of Waste and Innovative Financing (3 credit)

Course 4.3: Social Aspects of Waste Management (1 credit)

In world practice, waste management has five obligatory aspects: social, economic, political, institutional and financial. These courses, thus provide an overview of these aspects as waste governance, which affects the use, development, and management of wastes. The focus will be on the interaction between urban politics and public management, emphasizing among others the interactive relationship between citizens, elected bodies, the administration, and organized groups or individual policy advocates (as representatives of organizations and business) at the city level.

Course 4.1. Governance for Holistic Waste Service Delivery 2(2-0)

Course Objective:

Waste management is one of the most visible of urban services, and the responsibility of local urban authorities (LUAs). These services consume a large proportion of the operational revenue of a city or municipality. The challenge of urban governance today is understanding and realizing a public management that goes beyond simple administration and integrate institutions, incentives and the interests of relevant individual and citizens. Reflecting this, there is a strong case for viewing the state of waste management as an overall indicator of urban development and the sustainability of the city. Effective waste management hence requires a strategic, participatory approach that addresses social, financial and environmental as well as technical issues. As such, an effective and sustainable waste management goes hand-in-hand with good local governance and

sound municipal management. Success of managing waste is not just the responsibility of governments, but a range of stakeholders involving industries and businesses, communities, households and informal waste sector for waste management and resource recovery.

This course deals with governance of managing all forms of wastes i.e., Waste (Garbage) governance, Wastewater Governance, and Air Quality Governance. Students will understand a shift in waste (solid, liquid, gaseous) management policy, politics, infrastructure, institution, and administrative systems that affect the use, development, and management of wastes in a holistic manner. Students will also be introduced to current themes that influence waste governance, including sustainable development, integrated water resource management, and equity for marginal and informal groups. Students will also be introduced to the discussions involving different spheres and scales of waste governance (public, private, and civil society sectors, and municipal to national, regional, and international tiers) of waste governance.

Learning Outcomes: The student on completion of this course will be well versed in:

- Understanding what urban governance is and its relationship with sustainable waste, wastewater and air quality management
- The evolution of waste management policies and regulations
- Explain the relationship and interaction among stakeholders governing urban environmental management attempts in different cases.
- Key steps in waste management planning and target setting
- Work in a group and in multi-disciplinary team for developing problem-based solutions or strategies.
- Propose an institutional and multi-stakeholder coherence for holistic waste management

Course Outline:

II. Understanding Urban Governance
1. Concept and definition of governance
2. Defining Environmental Governance
3. Overview of urban form and governance of cities
4. Urban governance and sustainable development
5. Sustainability via urban–rural resource circulation

III. Waste (Garbage), Wastewater, and Air Quality Governance: Definition
1. Definitions
2. Waste governance structure and tier: municipal level, national level and international level tier
3. Components of waste governance: politics of garbage, policy and legislation, institution and administrative system
4. Cities and Waste: Urban governance and waste management services
5. Planning concepts incorporating waste management

III. Politics of Waste Governance
1. Bad politics: Corruption in waste and wastewater treatment and reuse
2. Good politics: political commitment and agenda on waste management

IV. Waste Governance: Policy and Legislative Measures

1. Evolution in waste management policy shifts (new school of thoughts-circular economy)
2. Types of policy measures and instruments (legal mandatory, voluntary, economic approaches)
3. Public health and environmental legislations
4. Legislation on resource recovery and recycling
5. Framing policy for holistic waste management for a given region (case study)

V. Waste Governance: Institutional Framework and Administrative System

1. A typical institutional and administrative framework of a municipality for waste, wastewater and air quality management (*Silo* approach)
2. Non-State actors in Waste Management- Formal and informal stakeholders
3. Partnership approaches for waste, wastewater management service delivery
4. (In)coherence among the existing policy and institutional framework

VI. Rethinking Governance Structure for Holistic Waste Management

1. Social, economic, environmental and health target setting for effective integration and holistic waste service delivery
2. Results-based planning and evaluation for waste management programs and projects
3. Waste management project cycle management and applications
4. Integrated assessment and decision support system for waste service delivery
5. Project work on comparing governance (institutional) arrangements for conventional silo approach to waste management versus delivering solid, liquid and gaseous waste management in holistic manner

Reference Books:

1. Davies, A.R., 2008. The Geographies of Garbage Governance- Interventions, Interactions, and Outcomes. ISBN 978-0-7546-4433-0
2. Adepoju G. Onibokun, 1999. Managing the Monster: Urban Waste and Governance in Africa. International Development Research Centre (Canada).
3. Harold Crooks, 1993. Giants of Garbage: The Rise of the Global Waste Industry and the Politics of Pollution Control. ISBN 1-55028-399-5.
4. Larry S. Luton, 1996. The Politics of Garbage: A Community Perspective on Solid Waste Policy Making.
5. Gillian Whiteley. Junk: Art and the Politics of Trash.
6. Maria Jose Zapata, Michael Hall (eds), 2013. Organising Waste in the City- International Perspectives on Narratives and Practices. ISBN: 9781447306375
7. Cor van Montfort, Ank Michels, and Andrea Frankowski, 2014. Governance Models and Partnerships in the Urban Water Sector- A framework for analysis and evaluation. Tilburg University, Tilburg University, The Netherlands
8. Neil S Grigg, 2010. Governance and Management for Sustainable Water Systems. IWA Publications. ISBN13:9781843393467
9. Urban Governance in the Wastewater Sector of Mumbai. Geographisches Institut der Universität Zürich, 2009
10. Rolf Lidskog and Göran Sundqvist (Eds), 2001. Governing the Air- The Dynamics of Science, Policy, and Citizen Interaction. ISBN: 9780262016506

11. Steiss, A.W.: Strategic Management for Public and Non-profit Organizations; Dekker Inc., New York, 2003.
12. Bovaird, T. and Loeffler, E.: Public management and governance; Routledge, second edition, 2003.
13. Nitivattananon, V. and Wijaya, N.: Benchmarking on Environmental Infrastructure Management in Selected Cities of Southeast Asia, Southeast Asia Urban Environmental Management Applications (SEA-UEMA) Project, AIT, Thailand, 2010.

Journals and Magazines:

1. Cities
2. Habitat International
3. Journal of Environmental Management

Course 4.2. Economics of Waste and Innovative Financing 3(3-0)

Course Objectives: Waste is part of the economy – whether it is a by-product of economic activity or is a resource input to economic activity –through material or energy recovery. The first aspect of this course will therefore deal with the economic aspect as a clear policy driven through capturing potential green economy opportunities in the waste (solid, wastewater, gaseous emissions) sector. The course also deals with financially viable waste service delivery in developing countries. Whether it is liquid waste management or solid waste management, most of the times even O&M charges are not recovered in developing countries forget about recovery of capital expenditure. As a result, many a time it is not possible to modernize or expand waste service delivery in the longer run.

The objective of this course is therefore to identify the costs of inaction in or improper waste management as well as job opportunities as part of the green economy. The course also explores various avenues for innovative and profitable financing waste management services.

Learning Outcomes: After the course, students will be able to:

- Identify economy loss of inaction in solid waste, wastewater and air pollution management
- Compare different traditional and innovative schemes of financing waste service delivery
- Interconnect sustainable waste/resource management to vehicle green growth/ green economy

Course Outline:

III. Costs and Prices of Waste Management
1. Direct costs of waste collection, storage, transportation, processing and disposal
2. Indirect costs (cost of inaction – ecological impacts, health impacts, social costs
3. Cost recovery
4. Prices for (waste, water and wastewater) services
5. Economy of scale, public goods and externalities

IV. Economic Valuation Approaches to Waste Management

1. Environmental Externalities
2. Economic Valuation Methods
3. Cases of economic evaluation of solid waste, wastewater and gaseous emission management

V. Economics of Waste Management and Green Economy

1. Contribution and social, economic and environmental benefits of sustainable waste management to the green economy
2. Global waste market- billion-dollar economy
3. Waste management and green jobs
4. Informal Economy in Waste Sector

VI. Existing financing options for waste, wastewater management

1. Financing for municipal services (waste management)
2. Polluters Pay Principle (e.g. landfill tax, waste collection fees)
3. Extend producers' responsibility (Deposit system)
4. Public private partnership
5. Community financing for decentralized solutions

VII. Innovative Financing schemes for waste and wastewater infrastructure and service delivery

1. Intergovernmental transfers
2. Municipal Borrowing
3. Capital market financing (municipal/green bonds, credit rating and fiscal health)
4. Parastatals and financing of urban infrastructure
5. International financing of urban infrastructure
6. Environment credit risk
7. Carbon financing for waste sector
8. Result-based financing of waste management services

Reference Books:

1. UNEP, 2011. Towards a Green Economy. Pathways to Sustainable Development and Poverty Eradication. ISBN: 978-92-807-3143-9
2. World Bank, 2014. Results-based Financing for Municipal Solid Waste. Urban Development Series, July 2014, No. 20.
3. Dominic Hogg (ed.), Financing and Incentive Schemes for Municipal Waste Management. Case Studies. Eunomia Research & Consulting Ltd.
4. UN-HABITAT, 2009. Guide to Municipal Finance.
5. Anne Schienberg, 2001, Integrated Sustainable Waste Management - Financial and Economic Issues in Integrated Sustainable Waste Management.

Journals and Magazines:

1. Habitat International
2. Resources, Conservation, & Recycling

Course 4.3 Social Aspects of Waste Management 1(1-0)

Course Objectives: Waste and social aspects cannot be detached. It's a human habit to generate wastes, and it is them who has to actively participate for safe waste management and recovery systems. Waste management system that does not consider the social aspect does not have a high chance of success. In line with economic and financial aspects, this course covers stakeholders, public acceptance and participation, and recognizes the gender issues related to urban solid waste and wastewater management.

This course will explore social aspects at two levels, i) *social impact*- how is a society affected (positively and/or negatively) from waste, and ii) *social input* – what people can do in order to actively participate for achieving sustainable waste and wastewater management. The objective of this course is to explore opportunities for social sustainability and inclusivity for holistic waste management.

Learning Outcomes: After the course, students will be able to:

- Conduct social assessment of waste management programs and projects, and creating social value of waste management
- Map different stakeholders and their role in the planning and implementation of waste service delivery
- Recognize and analyze gender roles in sustainable waste and wastewater management

Course Outline:

I. Social Aspects – Assessment and Implications in Waste Management
   1. Social effects of poor sanitation and waste- relation between poverty, urban livelihood and waste management
   2. Social Assessment of waste and wastewater management program planning and design
   3. Public participation - social acceptance and/or rejection of waste management systems

II. Stakeholder Integration in Waste and Wastewater Management
   1. Formal waste management enterprises
   2. Informal sector and social enterprises in waste management
   3. Integration of informal waste sector

III. Gender and Waste Management
   1. The Nexus of Gender and Environment
   2. Why gender matters in waste, water, sanitation and pollution management?
   3. Gender and privatization of waste
   4. Gender and waste management: policy and practice
   5. Institutionalizing/mainstreaming gender in waste management projects and practices

Reference Books:

1. UNEP 2016. Global Gender and Environment Outlook. United Nations Environment Programme, Nairobi, Kenya. ISBN No: 978-92-807-3581-9
2. Caterbow, A., and Hausmann, J. 2014. Women and Chemicals-Scoping Study. Women in Europe for a Common Future (WECF)

3. Secretariats of the Basel, Rotterdam, Stockholm Conventions (BRS), April 2015. Gender Heroes: from grassroots to global action- A collection of stories featuring Gender Perspectives on the Management of hazardous chemicals and wastes
4. World Vision International 2015. Grassroots to Glovbal-Seven steps to citizen-driven accountability for sustainable development goals (policy report).
5. Anne Scheinberg, 2012. Informal Sector Integration and High Performance Recycling: Evidence from 20 Cities. Women in Informal Employment: Globalizing and Organizing (WIEGO) Working Paper (Urban Policies) No 23. ISBN 978-92-95095-15-1
6. P.Kashyap and C.Visvanathan (2014). Formalization of Informal Recycling in Low-Income Countries. Municipal Solid Waste Management in Asia and the Pacific Islands Challenges and Strategic Solutions (Chapter 4). Edited by A. Pariatamby and M.Tanaka, Published by Springer, ISBN: 978-981- 4451-72-7., pp: 41-60
7. Samson, M., 2003. Dumping on women: gender and privatization of waste management. Woodstock, South Africa: Municipal Services Project. Available at: http://www.ircwash.org/sites/default/files/Samson-2003-Dumping.pdf.
8. Kusakabe, K. and Jahan, J. (eds): Gender mainstreaming in urban environmental management projects: Lessons learned from Southeast Asia. Urban Environmental Management Applications (SEA-UEMA) Project, SEA-UEMA Project, AIT, Thailand, 2010.
9. Janis Bernstein, 2004. Social assessment and public participation in municipal solid waste management- toolkit.

Journals and Magazines:

1. Habitat International
2. Resources, Conservation & Recycling
3. International Journal on Regulation and Governance, TERI