

Pimpri Chinchwad Education Trust's
PIMPRI CHINCHWAD COLLEGE OF ENGINEERING
SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune



**Curriculum Structure and Syllabus
of
Minors In
Sustainable Waste Management for Smart Cities
(Regulations 2023)**



Effective from Academic Year 2026-27

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value-Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with ability to think and act independently in demanding situations

EOMS Policy

“We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

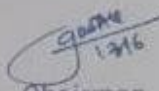
We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute’s social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS).”

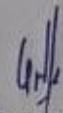
Course Approval Summary

Board of Studies - Department of Civil Engineering

Sl.No.	Name of the Course	Course Code	Semester	Page Number	Signature and stamp of BOS
1	Municipal Solid Waste Management in Smart City	BCI25MN01	V	10	 Chairman BoS, Civil Engineering PCET's, Pimpri Chinchwad College of Engineering, Sector No. 26, Pradhikaran, Nigdi, Pune-44
2	Solid Waste Engineering Lab – I	BCI25MN02	V	12	
3	Hazardous and e- Waste Management	BCI26MN03	VI	14	
4	Solid Waste Engineering Lab – II	BCI26MN04	VI	15	
5	Industrial Waste Management	BCI27MN05 (A)/ BCI28MN09 (B)	VII/ VIII	17	
6	Seminar	BCI27MN06 (A)/ BCI28MN10 (B)	VII/ VIII	19	
7	Mini Project	BCI28MN07 (A)/ BCI27MN08 (B)	VIII/ VII	21	

"Knowledge Brings Freedom"

Approved by Academic Council:


Chairman
 Academic Council
 PCET's, Pimpri Chinchwad College of Engineering
 Sector No. 26, Pradhikaran, Nigdi, Pune-44

Chairman, Academic Council
 Pimpri Chinchwad College of Engineering

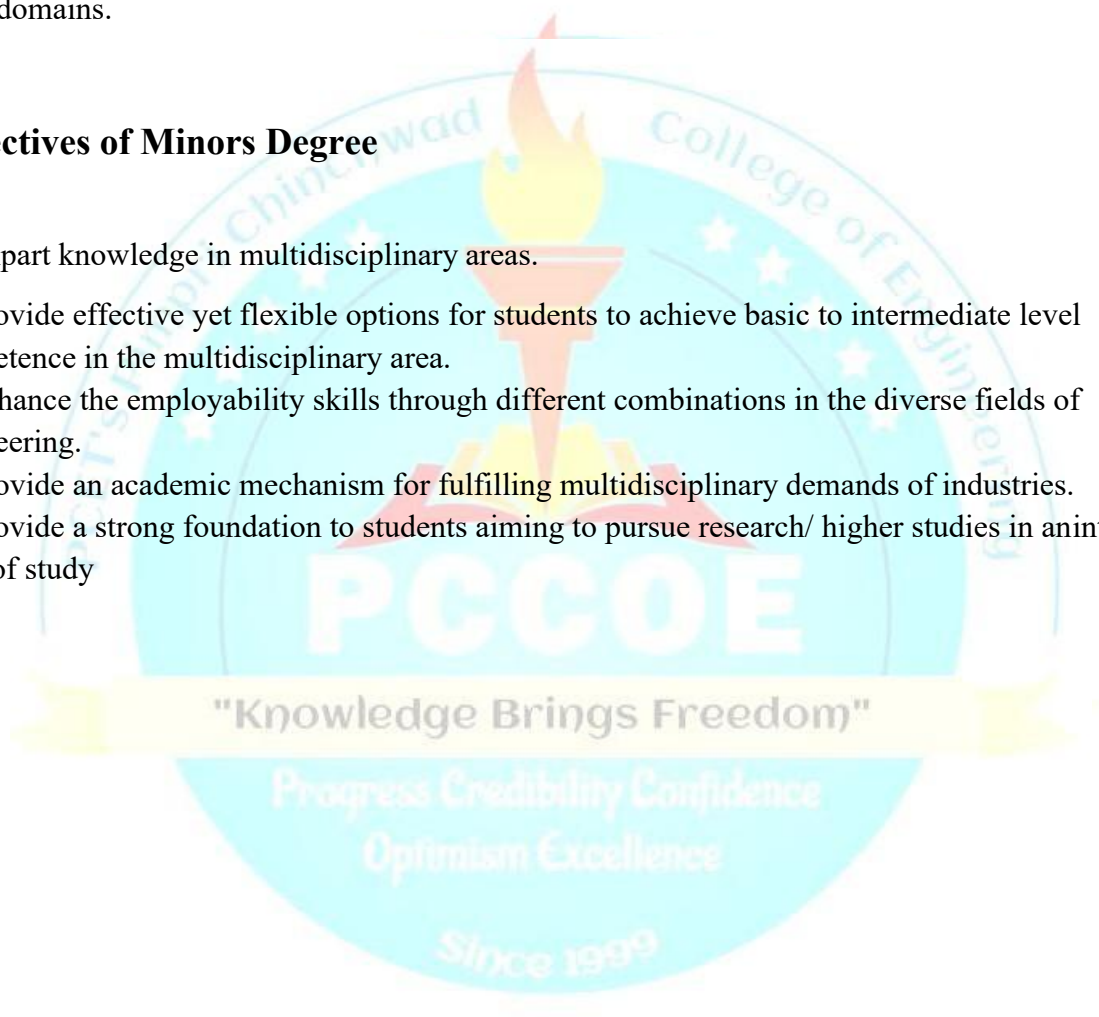
Preface

Looking at Global Scenario to enhance the employability skills and impart deep knowledge in emerging/ multidisciplinary areas, an additional avenue is provided to passionate learners through the Minors and Honours Degree Scheme in academic structure.

For **Minors degree** program, student has to earn additional 18 credits in multidisciplinary areas of other domains.

Objectives of Minors Degree

- To impart knowledge in multidisciplinary areas.
- To provide effective yet flexible options for students to achieve basic to intermediate level competence in the multidisciplinary area.
- To enhance the employability skills through different combinations in the diverse fields of engineering.
- To provide an academic mechanism for fulfilling multidisciplinary demands of industries.
- To provide a strong foundation to students aiming to pursue research/ higher studies in an interdisciplinary field of study



Preface of Minors in Sustainable Waste Management for Smart Cities

Worldwide the cities are planned and developed or converted into smart cities. Smart city will focus on solving majority of the problems of urbanization by use of information and communication technologies (ICT). One of the challenges these cities will have to handle is of scientific treatment and disposal of the waste generated by its dwellers i. e municipal solid waste (MSW)

The minor course designed by the Civil Engineering Department will help students in developing the understanding of the problems related to MSW, scientific data collection and estimation of the quantities that will be generated. The course will also make student capable of designing the composting system. The course will further impart the knowledge of waste to energy systems, other various treatment and disposal technologies for MSW. The course will develop the holistic understand of the landfills, its construction and operations.

Objectives:

1. To develop understanding of problems of solid waste, its characteristics and estimation of quantity of solid wastes.
2. To impart the knowledge of solid mathematics, science, and engineering for effective solid waste collection systems, for waste collection route optimization and its economics.
3. To build concept of design of composting systems, maintain and operate composting process for effective organic waste recycling.
4. To develop understanding of waste to energy system and design of bio-methanation and incineration system.
5. To develop understand construction and operations of landfill facilities and management of legacy solid waste.

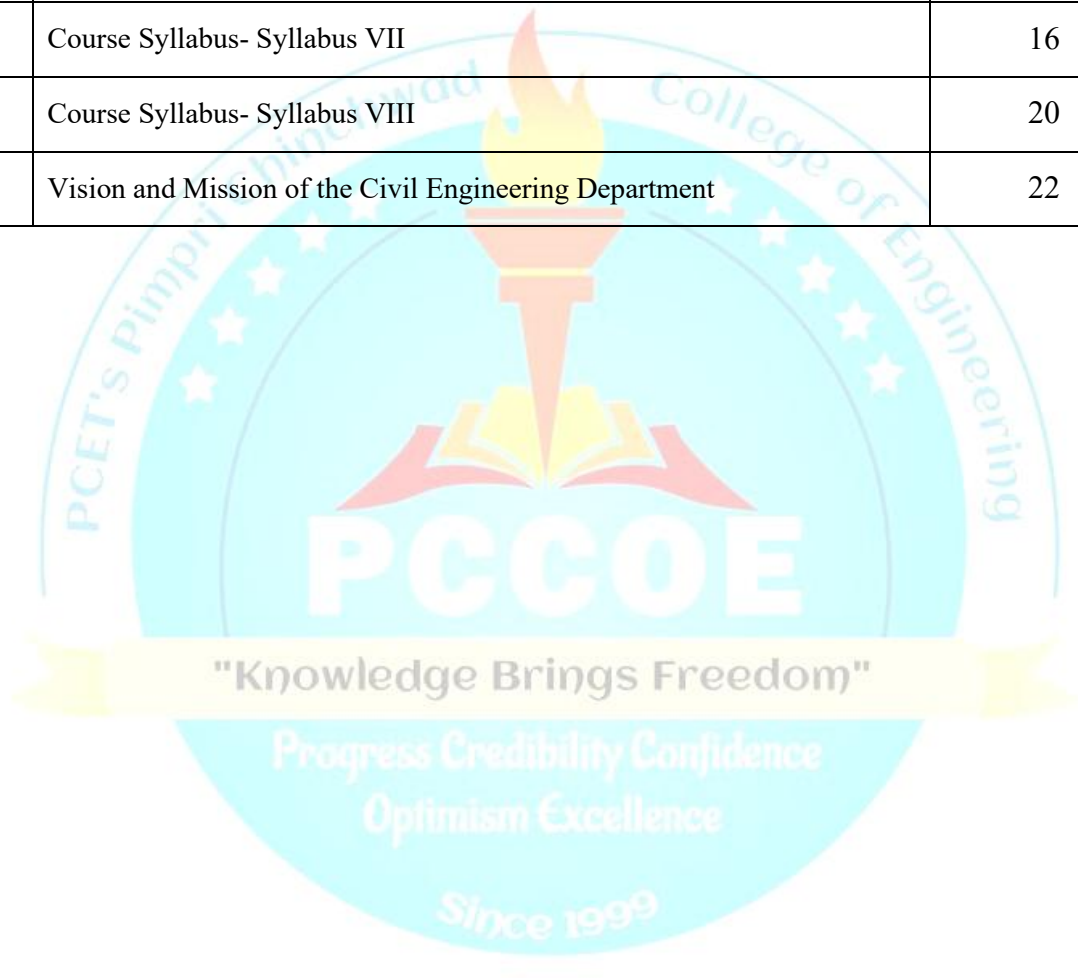
Outcomes:

After learning the course, the students should be able to:

1. Develop outline solid waste management systems with respect to its generation rate (quantity), sampling, characteristics and regulatory/legal requirements.
2. Explain and suggest relevant method of storage, collection and transportation of solid waste for the given site condition with justification.
3. Develop understanding of technological applications for processing and material recovery from solid waste with its economics and design composting system for organic waste.
4. Describe the fundamental and technological aspects of waste to energy systems from solid waste and to design anaerobic digester and incineration system.
5. Outline the operation, and maintenance of sanitary landfill and management of legacy waste.
6. Explain the functional element for management of special waste and suggest the relevant method of reuse and recycling for the given type of waste in the given situation.

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LIST OF ABBREVIATIONS IN CURRICULUM STRUCTURE

Sl. No	Abbreviation	Expansion
1	L	Lecture
2	P	Practical
3	T	Tutorial
4	H	Hours
5	CR	Credits
6	FA	Formative Assessment
7	SA	Summative Assessment
8	TW	Term Work
9	OR	Oral
10	PR	Practical
11	PROJ	Project



CURRICULUM STRUCTURE**For Minors in Sustainable Waste Management for Smart Cities**

Scheme A														
Semester	Course Codes	Course Name	Teaching Scheme				CR	Evaluation Scheme and Marks						
			L	P	T	H		FA1	FA2	SA	TW	PR	OR	Total
V	BCI25MN01	Municipal Solid Waste Management in Smart City	3	-	-	3	3	20	20	60	-	-	-	100
V	BCI25MN02	Solid Waste Engineering Lab – I	-	2	-	2	1	-	-	-	-	-	25	25
VI	BCI26MN03	Hazardous and e- Waste Management	3	-	-	3	3	20	20	60	-	-	-	100
VI	BCI26MN04	Solid Waste Engineering Lab – II	-	2	-	2	1	-	-	-	25	-	-	25
VII	BCI27MN05	Industrial Waste Management	3	-	-	3	3	20	20	60	-	-	-	100
VII	BCI27MN06	Seminar	-	4	-	4	2	-	-	-	30	-	20	50
VIII	BCI28MN07	Mini Project	-	10	-	10	5	-	-	-	75	-	50	125
			9	18	-	27	18	60	60	180	130	-	95	525

Scheme B														
Semester	Course Codes	Course Name	Teaching Scheme				CR	Evaluation Scheme and Marks						
			L	P	T	H		FA1	FA2	SA	TW	PR	OR	Total
V	BCI25MN01	Municipal Solid Waste Management in Smart City	3	-	-	3	3	20	20	60	-	-	-	100
V	BCI25MN02	Solid Waste Engineering Lab – I	-	2	-	2	1	-	-	-	-	-	25	25
VI	BCI26MN03	Hazardous and e- Waste Management	3	-	-	3	3	20	20	60	-	-	-	100
VI	BCI26MN04	Solid Waste Engineering Lab – II	-	2	-	2	1	-	-	-	25	-	-	25
VII	BCI27MN08	Mini Project	-	10	-	10	5	-	-	-	75	-	50	125
VIII	BCI28MN09	Industrial Waste Management	3	-	-	3	3	20	20	60	-	-	-	100
VIII	BCI28MN10	Seminar	-	4	-	4	2	-	-	-	30	-	20	50
		Total	9	18	-	27	18	60	60	180	130	-	95	525

L- Lecture, T- Tutorial, P- Practical, H-Hours, CR- Credit, FA – Formative Assessment, SA –Summative Assessment, TW – Term Work, PR- Practical Exam, OR – Oral Exam

Course syllabus

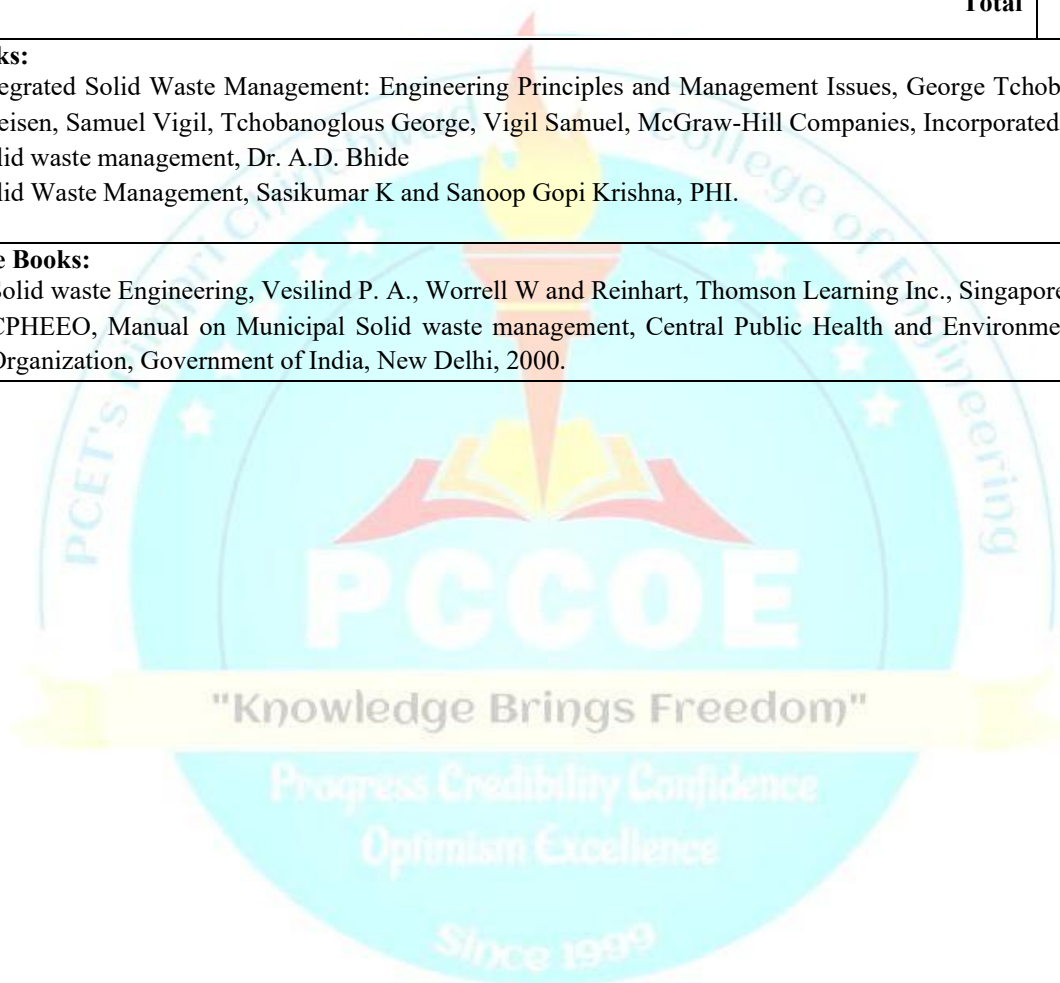
Semester-V

Minors in

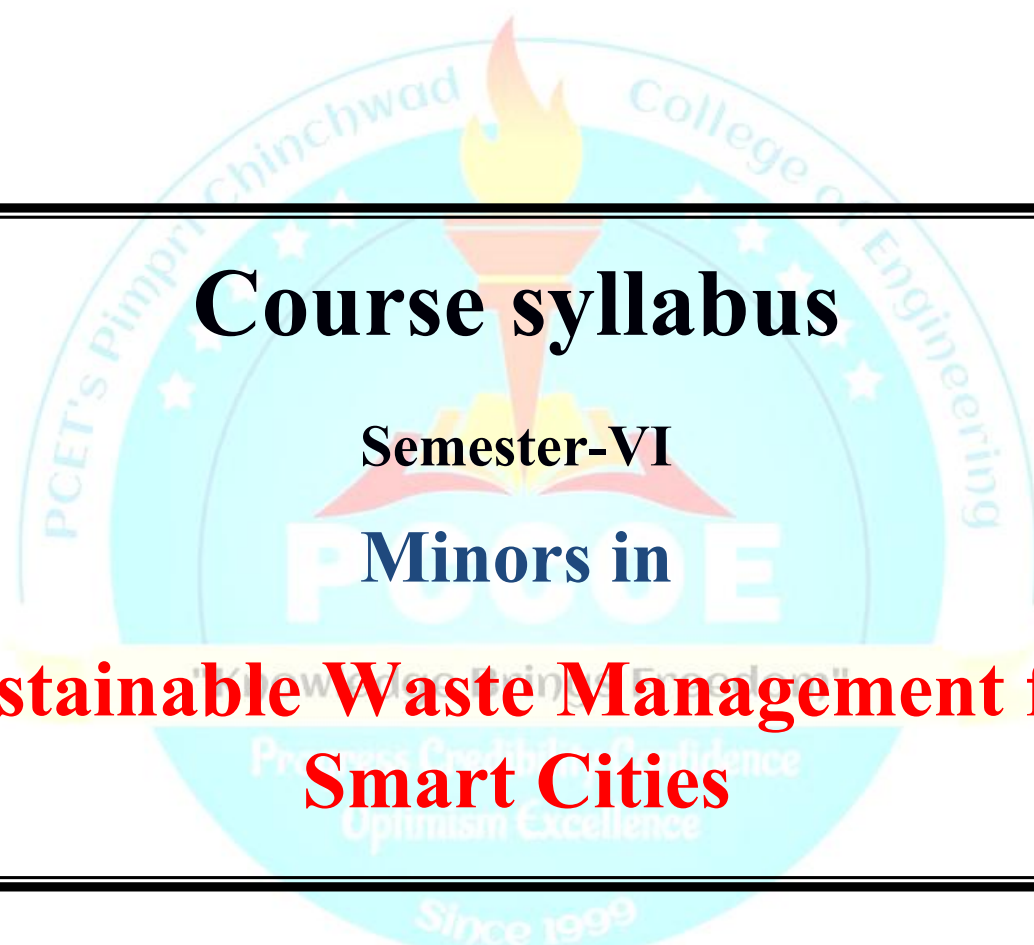
**Sustainable Waste Management for
Smart Cities**

Program:	Minors in Sustainable Waste Management for Smart Cities			Semester:	V		
Course:	Municipal Solid Waste Management in Smart City			Code:	BCI25MN01		
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	H	FA1	FA2	SA	Total
3	-	3	3	20	20	60	100
Pre-requisite: Environmental studies							
Objectives: </							

5.	Disposal of Solid Waste Landfill: Introduction, components of land filling, types of land filling, site selection, acceptable waste, construction techniques, maintenance and precautions, leachate and landfill gas: estimation, management, treatment and disposal/reuse, control of contamination of ground water, operation monitoring, closure and end-use, concept of bioreactor landfill: principle, types, applications. Legacy waste management or biomining: concept, methods, applications, economics and time duration.	7
6.	Government Initiatives- Solid Waste Management Swachh Survekshan and its impact on the SWM scenario in India, National Urban Livelihood Missions (NULM) and its role in SWM, social entrepreneurship, Swachhta & Rural Engagement cell (SESREC): government of India initiatives, success stories of SWM in India.	8
	Total	45
Text Books: 1. Integrated Solid Waste Management: Engineering Principles and Management Issues, George Tchobanoglous, Hilary Theisen, Samuel Vigil, Tchobanoglous George, Vigil Samuel, McGraw-Hill Companies, Incorporated. 2. Solid waste management, Dr. A.D. Bhide 3. Solid Waste Management, Sasikumar K and Sanoop Gopi Krishna, PHI.		
Reference Books: 1. Solid waste Engineering, Vesilind P. A., Worrell W and Reinhart, Thomson Learning Inc., Singapore. 2. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.		



Program:	Minors in Sustainable Waste Management for Smart Cities				Semester:	V	
Course:	Solid Waste Engineering Lab – I				Code:	BCI25MN02	
Teaching Scheme				Evaluation Scheme			
Practical	Tutorial	Credit	H	TW	OR	PR	Total
2	-	1	2	25	-	-	25
Objectives: 1. To impart knowledge to determine characteristics of solid waste 2. To develop understanding of identification of problems in solid waste and suggest solution to it.							
Outcomes: After learning the course, the students should be able to: 1. Determine the physical and chemical characteristics of solid waste. 2. Estimate future solid waste generation rate and quantity. 3. Identify problems of solid waste and propose different solutions to it.							
Detailed Syllabus: 1. Report of site visit to municipal solid waste management: Housing society/village/town/city. 2. Practical identification of impacts and problems of improper management of municipal solid waste. 3. Practical sampling methods and characterization study of municipal solid waste: present and future trend, estimation of quantity of refuse. 4. Determine moisture content and volatile solids for organic faction of municipal solid waste by using oven and muffle furnace. 5. Determine carbon/ nitrogen/ phosphorous content of manure produced from composting process or organic faction of municipal solid waste. 6. Determine calorific value of municipal solid waste by using bomb calorimeter. 7. Practical/theoretical determination of municipal solid waste generation rate and estimation of quantity of MSW for present and future scenario 8. Preparation of a report based on field visit or case study to study use of smart technologies in solid waste management sector (sensors for segregation of waste using of VTS /GPS/ RFID system and reverse vending machine installed at bus station, railway station.)							
Reference Books: 1. Integrated Solid Waste Management: Engineering Principles and Management Issues, George Tchobanoglous, Hilary Theisen, Samuel Vigil, Tchobanoglous George, Vigil Samuel, McGraw-Hill Companies, Incorporated. 2. Solid waste management, Dr. A.D. Bhide 3. Solid Waste Management, Sasikumar K and Sanoop Gopi Krishna, PHI. 4. Solid waste Engineering, Vesilind P. A., Worrell W and Reinhart, Thomson Learning Inc., Singapore. 5. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000							



Course syllabus

Semester-VI

Minors in

**Sustainable Waste Management for
Smart Cities**

Program:	Minors in Sustainable Waste Management for SmartCities				Semester:	VI	
Course:	Hazardous and e- Waste Management				Code:	BCI26MN03	
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	H	FA1	FA2	SA	Total
3	-	3	3	20	20	60	100
Pre-requisite: 1. Environmental studies 2. Municipal solid waste management in smart Cities.							
Objectives: 1. To provide the knowledge on basics of hazardous waste and its management. 2. To impart the knowledge of chemical, physico-chemical and biological treatment of hazardous waste. 3. To develop the understanding of the landfill design. 4. To impart knowledge on fundamentals and management of E-Waste with respect to recovery of resources 5. To develop the understanding of control measures for reduction of E-waste at source.							
Outcomes: After Completing this course, student will be able to: 1. To define the hazardous waste and explain its management. 2. To explain various chemical , physico-chemical and biological treatments for hazardous waste 3. To design the landfill for the hazardous waste. 4. To explain the fundamentals and management of E-Waste with respect to resource recovery and control measures for reduction of E-waste at source							
Detailed Syllabus:							
Unit	Description						Duration (H)
1.	Hazardous Waste Management – Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects. Objectives and key points of Hazardous Waste Management Rules, 2016.						8
2.	Physico-chemical Treatment of Solid and Hazardous Waste Chemical treatment processes for HW (combustion, stabilization and solidification of hazardous wastes); physico-chemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation.						7
3.	Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.						7
4.	Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration						8
5.	E-waste: Fundamentals and management Introduction, toxicity due to hazardous substances in e-waste and their impacts, guidelines for environmentally sound management of e-waste, domestic e-waste disposal, e-waste management, technologies for recovery of resource from electronic waste occupational and environmental health perspectives of recycling e-waste in India. Objectives and key points of E-Waste Management Rules – 2016.						7
6.	E-waste: Control measures Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.						8
	Total						45
Text Books: 1. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994. 2. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.							
Reference Books: 1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005. 2. Johri R., “E-waste: implications, regulations, and management in India and current global best practices”, TERI Press, New Delhi							

Program:	Minors in Sustainable Waste Management for Smart Cities			Semester:	VI		
Course:	Solid Waste Engineering Lab – II			Code:	BCI26MN04		
Teaching Scheme				Evaluation Scheme			
Practical	Tutorial	Credit	H	TW	OR	PR	Total
2	-	1	2	25	-	-	25
Objectives: 1. To develop understanding of identification of problems in hazardous waste & e-waste and suggest solution to it. 2. To develop ability to note critical observations and interpret them for waste management activities.							
Outcomes: After Completing this course, student will be able to: 1. Identify problems of hazardous waste and propose different solutions to it 2. Identify problems of e-waste and propose different solutions to it. 3. Prepare a site visit report including critical observations and interpretation regarding the visited site.							
Detailed Syllabus:							
1. Study of developing value added products form waste. 2. Identify any hazardous waste problem and suggest appropriate solution. 3. Prepare a report for management of e-waste based field visit. 4. Prepare a report for management of hazardous waste based on field visit. 5. Report on MSW management by NGO/ ULBs for zero waste management concepts. 6. Prepare a report based on filed visit or case study for pay as you pollute or extended producer responsibility (EPR) behavioral analysis in solid waste management.							
Reference Books: 1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005. 2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994. 3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997. 4. Johri R., “E-waste: implications, regulations, and management in India and current global best practices”, TERI Press, New Delhi							

"Knowledge Brings Freedom"

Progress Credibility Confidence

Optimism Excellence

Since 1999

Course syllabus

Semester-VII

Minors in

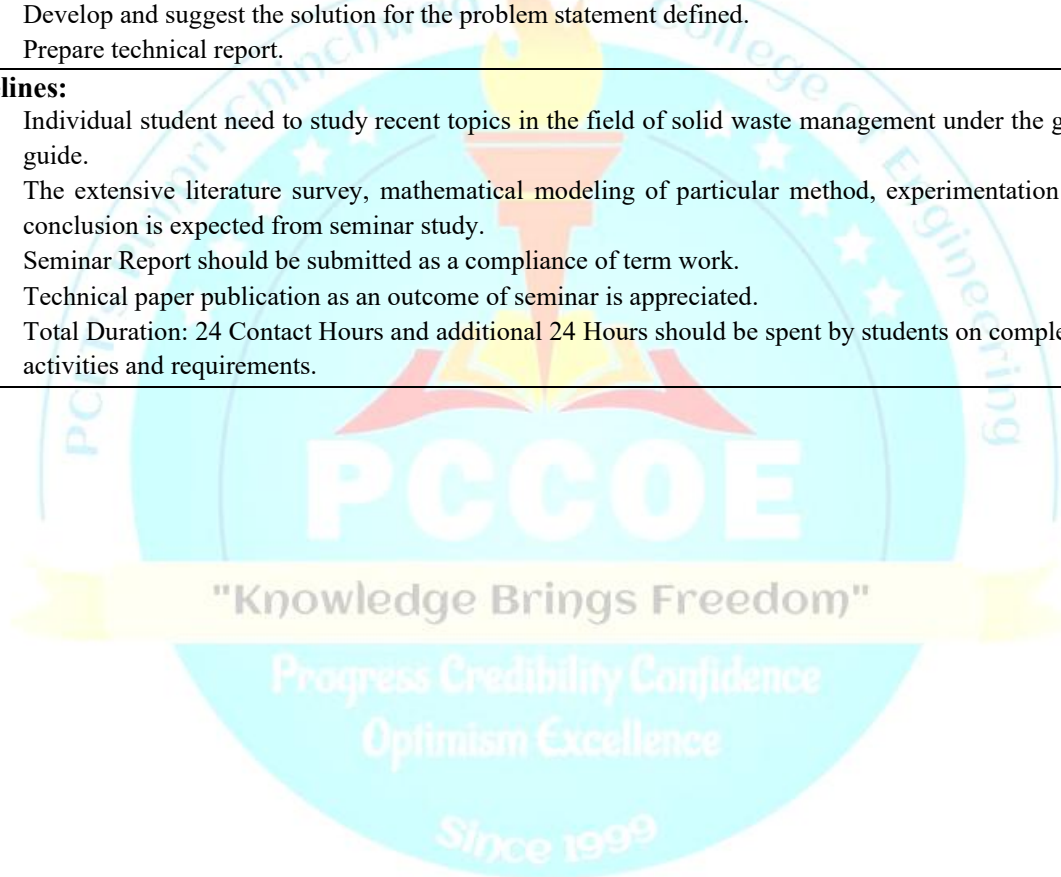
**Sustainable Waste Management for
Smart Cities**

Program:	Minors in Sustainable Waste Management for Smart Cities			Semester:	VII		
Course:	Industrial Waste Management			Code:	BCI27MN05 (A)/ BCI28MN09 (B)		
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	H	FA1	FA2	SA	Total
3	-	3	3	20	20	60	100
Pre-requisite: 1. Environmental Studies 2. Municipal Solid Waste Management for smart cities 3. Hazardous and E-Waste Management							
Course Objectives: 1. To develop understanding of classification and segregation of industrial waste. 2. To impart the knowledge of construction and demolition waste management. 3. To build the concept of physical, chemical and biological treatment methods for residue form industries. 4. To impart the knowledge of waste management audit and its significance 5. To build the concept of plastic waste management.							
Outcomes: After learning the course, the students should be able to: 1. Explain fundamental concepts of industrial waste and construction and demolition waste management 2. Understand physical, chemical and biological treatment methods for residue form industries 3. Describe necessity and standards of waste management audit. 4. Explain the plastic waste management practices.							
Detailed Syllabus:							
Unit	Description						Duration (H)
1.	Introduction: Impact of Industrial Waste on the society and environment. Environmental standards applicable to industrial units. Segregation and classification of waste from the industries. Treatment and disposal methods.						8
2.	Construction and Demolition Waste (C&D waste): Introduction, characteristic, Storage of C&D waste, collection and transportation, 3R concept, Disposal.						7
3.	Residual waste management from industries and treatment plants: Physical, chemical and biological characteristics of residues from industries and treatment plants; Treatment methods- physical, chemical and biological treatment methods; Disposal methods						7
4.	Treatment Process of Industrial Effluent Equalization, neutralization, removal of suspended and dissolved organic solids, chemical oxidation, adsorption, removal of dissolved inorganics, combined treatment of industrial and municipal wastes, residue management, dewatering, disposal						8
5.	Waste management audit: Necessity for internal audit, standards for audits, audit planning, materiality and sampling, internal control overview of compliance, Evaluate the Economics of Pollution Prevention, Environmental Audit, understanding of rules and regulations, documentation procedures, recordkeeping requirements.						7
6.	Plastic waste: Plastic Waste – Sources, Production, Global and Indian Context; Plastic Waste Management Practices – Plastic management- recycling, energy production, landfilling, other application.						8
	Total						45
Text Books: 1. Frank Woodard, (2001). Industrial Waste Treatment Handbook. Elsevier, USA 2. T. T. Shen, “Industrial Pollution Prevention”, Springer							
Reference Books: 1. Tchobanoglous G., Theisen H., and Vigil S.A. (2014). Integrated Solid Waste Management, Engineering Principles and Management Issues, 2nd Ed., McGraw-Hill, USA							

2. John Pichtel (2014). Waste Management Practices: Municipal, Hazardous and Industrial, 2nd Ed., CRC Press, USA
3. Vesilind, P.A., and Worrell W. A. (2016) Solid Waste Engineering, 2nd Ed., Cengage India 4. Peavy, H.S, Rowe, D.R., and Tchobanoglous, G., (2017).
4. Environmental Engineering, Indian ED, McGraw Hill Inc., India
5. Tchobanoglous G., Frank Kreith., (2002). Hand Book of Solid Waste Management, 2nd Ed., McGraw Hill, USA.
6. CPHEEO (2016). Manual on Municipal Solid Waste Management, Ministry of Urban Development, India.
7. R.L. Stephenson and J.B.Blackburn, Jr., "Industrial Wastewater Systems Hand book", Lewis Publisher, New York



Program:	Minors in Sustainable Waste Management for Smart Cities				Semester:	VII	
Course:	Seminar				Code:	BCI27MN06 (A)/ BCI28MN10 (B)	
Teaching Scheme				Evaluation Scheme			
Practical	Tutorial	Credit	H	TW	OR	PR	Total
4	-	2	4	50	-	-	50
Detailed Syllabus:							
Objectives: 1. To work on a specific technical topic in solid waste management, in order to acquire the skills for technical communication. 2. To acquire technical writing abilities for seminars and conferences.							
Outcomes: After learning the course the students should be able to: 1. Identify and define a problem statement in the area of sustainable solid waste management 2. Evaluate literature in the area of research and establish scope of work. 3. Develop and suggest the solution for the problem statement defined. 4. Prepare technical report.							
Guidelines: 1. Individual student need to study recent topics in the field of solid waste management under the guidance of allocated guide. 2. The extensive literature survey, mathematical modeling of particular method, experimentation and valuable conclusion is expected from seminar study. 3. Seminar Report should be submitted as a compliance of term work. 4. Technical paper publication as an outcome of seminar is appreciated. 5. Total Duration: 24 Contact Hours and additional 24 Hours should be spent by students on completion of related activities and requirements.							



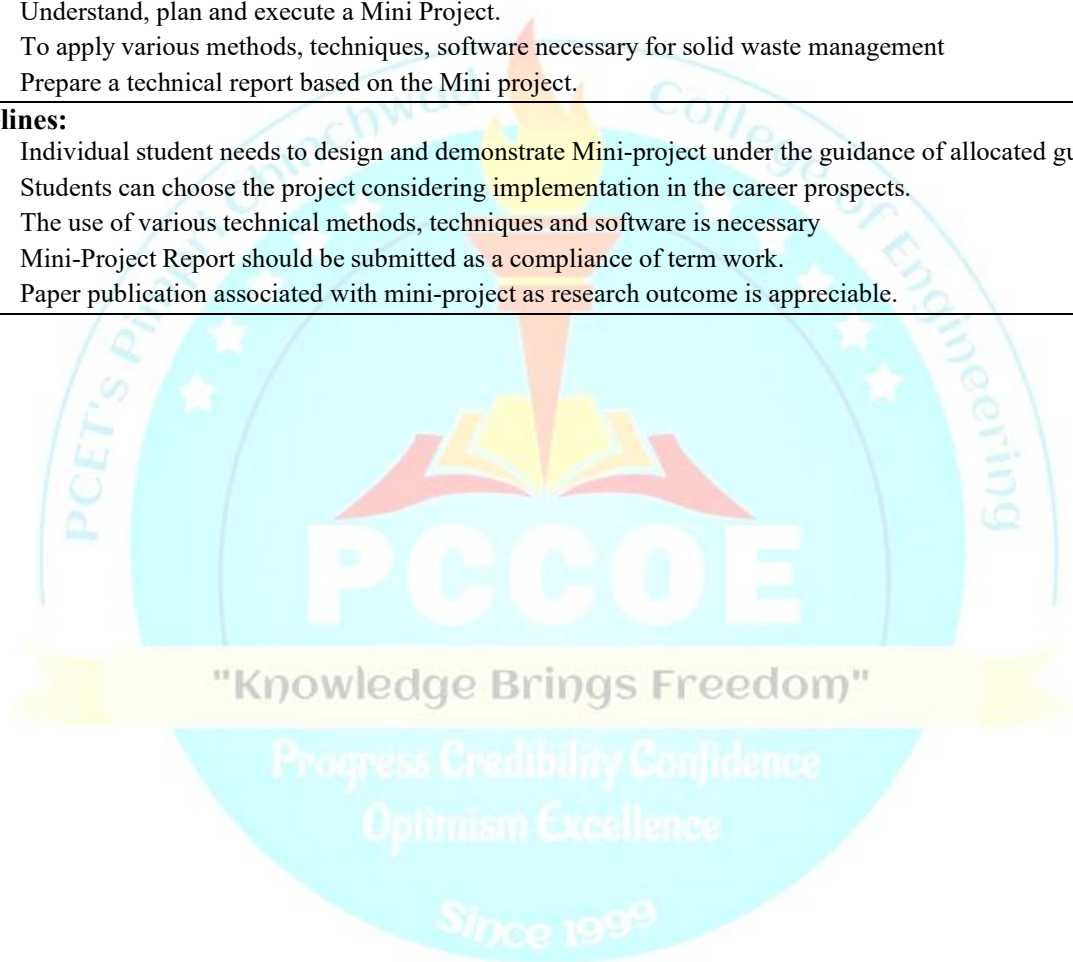
Course syllabus

Semester-VIII

Minors in

**Sustainable Waste Management for
Smart Cities**

Program:	Minors in Sustainable Waste Management for Smart Cities			Semester:	VIII	
Course:	Mini Project			Code:	BCI28MN07 (A)/ BCI27MN08 (B)	
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Credit	H	TW	OR	Total
10	-	5	10	75	50	125
Detailed Syllabus:						
Objectives: 1. To plan for various activities of the project and channelize the work. 2. To analyze, design and implement real time application using available platforms.						
Outcomes: After learning the course the students should be able to: 1. Understand, plan and execute a Mini Project. 2. To apply various methods, techniques, software necessary for solid waste management 3. Prepare a technical report based on the Mini project.						
Guidelines: 1. Individual student needs to design and demonstrate Mini-project under the guidance of allocated guide. 2. Students can choose the project considering implementation in the career prospects. 3. The use of various technical methods, techniques and software is necessary 4. Mini-Project Report should be submitted as a compliance of term work. 5. Paper publication associated with mini-project as research outcome is appreciable.						



Vision of the Civil Engineering Department

To establish as a premier civil engineering department in Maharashtra in the coming five years by providing quality education, fostering innovation with ethical values to serve the society.

Mission of the Civil Engineering Department

1. Fostering value-based education to achieve academic excellence with the right attitude and professional ethics.
2. Inculcating a culture of research and innovation, with an aim of serving society in a sustainable manner.
3. Developing skilled civil engineers with an ability to provide solutions to meet national and global challenges in accordance with the needs of the society.

Program Specific Outcomes (PSO) of Civil Engineering Department

1. Graduates in civil Engineering will demonstrate proficiency in practical applications for quality construction work in the domain of Structural Engineering, Water Resources-Environmental Engineering, Geotechnical-Transport and Construction Management.
2. A graduate in Civil Engineering, equipped with the necessary skills and technical knowledge, can become an entrepreneur in the field, capable of identifying business opportunities, developing business plans, managing resources, designing and executing sustainable construction projects for infrastructural development.