Learning Outcomes-Based Curriculum Framework (LOCF)

Scheme and Syllabus of

B. Voc. (Industrial Waste Management)

(Three-Year Bachelor's Degree Programme)

w.e.f. 2022-23

DEPARTMENT of VOCATIONAL Studies and Skill Development

School of Life-long Learning

Central University of Haryana
Mahendergarh, Haryana

BACKGROUND

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in the 32nd meeting of the Academic Council of the University held on April 23, 2021. The roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasizing upon— integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness;

Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard Classification of Occupations; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with industry and businesses; closer collaborations between industry and higher education institutions for technical, vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course.

In case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council, Industry and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of B.Voc Industrial Waste Management program has been devised with concerted efforts of the faculty, Heads of the Departments, Industry experts and members of skill council for Green Jobs (SCGJ). Curriculum is aligned with National Skill Qualification Framework (NSQF) and has adopted job roles corresponding to NSQF level-4 to NSQF level-7 from the skill council for Green Jobs. Job roles includes *Wastewater Treatment Plant Technician*

(NSQF Level-4), *Water Quality Testing Technician* (NSQF Level-5), *Manager-Waste Management* (NSQF Level-6) & *Plant Incharge-Wastewater treatment Plant* (NSQF Level-7).

The draft prepared by each department was discussed in series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

PROGRAMME OUTCOMES

After successful completion of the programme:

PO1. Scientific knowledge: Apply the knowledge of science and industrial technology to the solution of scientific problems in the industry.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex scientific problems reaching substantiated conclusions using first principles of biological sciences, and chemical sciences.

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

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

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

PO6. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the scientific practice.

PO7. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO8. Communication: Communicate effectively on complex activities with the scientific community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO09. Project management: Demonstrate knowledge understanding of the scientific and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO10. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES

3. Program Specific Outcomes (PSOs):

On completing B Voc. in Industrial Waste Management Programme, the students shall be able to realize following outcomes:

PSO-1 Demonstrate critical understanding of waste management practices.

PSO-2 Understand the impact of Industrial pollution in environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO-3 Demonstrate the knowledge of sustainable waste management technologies and formulate a plan for waste recycling and reuse.

PSO-4 Develop skills necessary for accurate sampling and analysis of environmental samples.

PSO-5 Demonstrate and understand the environmental principles and apply these to his own work.

PSO-6 Know and understand the occupational health and safety (OHS) standards and associated risks in industry.

PSO-7 Communicate effectively, being able to comprehend and write effective reports, make effective presentations, and give and receive clear instructions.

PSO-8 Understand the need of life long learning and will be able to work in teams

LEARNING OUTCOME INDEX:

Mapping of Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

PSOs→	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
POs↓ PO1	√	√	X	√	√	X	√	√
PO2	√	√	X	√	√	X	X	√
PO3	√	√	√	√	√	X	√	√
PO4	√	√	√	√	√	X	X	√
PO5	√	√	√	X	√	√	√	√
PO6	X	√	√	X	√	√	√	√
PO7	X	√	X	√	X	√	√	√
PO8	√	√	√	√	√	√	√	√
PO9	X	√	√	√	√	X	X	√
PO10	√	√	√	√	√	√	√	√

Mapping of general education component courses with PSOs

PSOs→	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
Core Course Number↓								
CC-1	√	X	X	X	√	X	X	√
CC-2	√	√	√	√	√	X	X	√
CC-3	X	X	X	√	X	X	√	√
CC-4	√	√	√	√	√	√	√	√
CC-5	√	√	√	√	√	X	X	√
CC-6	√	√	√	√	√	√	√	√
CC-7	√	√	√	X	√	√	X	√
CC-8	√	√	√	√	√	√	√	√
CC-9	√	X	√	√	√	√	√	√
CC-10	√	X	X	X	√	√	√	√
CC-11	√	√	√	√	√	X	X	√
CC-12	√	√	√	√	√	√	√	√
CC-13	√	√	√	√	√	√	X	√
CC-14	√	√	√	√	√	√	X	√
CC-15	√	√	√	√	√	√	√	√
CC-16	√	√	√	√	√	√	√	√
CC-17	√	√	√	√	√	√	√	√
CC-18	√	√	√	√	√	X	√	√
CC-19	√	√	√	√	√	X	X	√
CC-20	√	√	√	√	√	√	√	√
CC-21	√	√	√	X	√	X	√	√
CC-22	√	√	√	X	√	√	√	√
CC-23	√	√	√	√	√	√	X	√
CC-24	√	√	√	√	√	√	√	√

Mapping of skill education component courses with PSOs

PSOs→	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
Core Course Number↓								
SC-1	√	√	√	√	√	√	X	√
SC-2	√	√	√	√	√	X	√	√
SC-3	√	√	√	√	√	√	√	√
SC-4	√	√	√	√	√	√	√	√

TEACHING LEARNING OUTCOME METHODOLOGIES

Learning based curriculum designed for various courses under B. Voc. (Industrial Waste Management) Programme aim for dissemination of up-to-date knowledge, development of student's capability to use ideas and information, and their ability to test those ideas and evidence. The courses also aim for facilitating the personal development and capacity of students to plan and manage their own learning. Instead of using traditional teaching methods, new teaching methods and pedagogical tools are required to ensure the achievement of desired learning outcomes for each of the courses. In view of the programme outcomes, following teaching methodologies will be used:

- Class room lectures;
- Use of up-to-date textbooks, other learning resources;
- Use of internet to support and explore the knowledge;
- Use of case studies;
- Practical exercises for each course to augment the learning;
- Work experience through internship and fieldwork;
- Projects;
- Demonstrations;
- Group working;
- Simulations (e.g. computer based);

 Problem solving;

 Discussion and debate;

 Role play;

 Quizzes;

 Seminar presentations;

 Class presentations;

 Tutorials;

 Examination papers

ASSESSMENT OUTCOME MEASUREMENT METHODS

Methods of measuring student learning are often characterized as summative or formative assessments:

Summative assessments: It includes case study analysis, assessment and evaluation of internship reports, project report evaluation, tests, quizzes, and other graded course activities that are used to measure the performance of learner. These assessments are cumulative and often reveal what students have learned at the end of a unit or the end of a course. Within a course, summative assessment includes the system for calculating individual student grades.

Formative assessment: It includes any means by which students receive input and guiding feedback on their relative performance to help them improve. It can be provided face-to-face in office hours, in written comments on assignments.

An array of direct and indirect methods should be used based upon the above-mentioned methodologies and assessment tools to assess the level of learning outcome(s) under each course with more weightage on ‘Formative Assessment’ to ensure that the learner improves during the teaching learning process. Direct measures require a learner to present or demonstrate their learning or produce work so that observers can assess how well students’

work or responses fit institution-or program-level expectations of outcomes. It includes examinations, field experience, internship, lab reports, case studies, etc. as mentioned under Teaching Learning Outcome Methodologies and Summative Assessment. Through the indirect measures, the observer would be able to infer student abilities, knowledge, and values based on an analysis of reported perceptions about student mastery of outcomes using the indirect measures.

BLENDED LEARNING

B.Voc. Industrial Waste Management is focussed to provide quality skill education. Success of skill education requires direct interaction of students with the industrial experts and hands-on-industrial training. Learning at B.Voc. Industrial Waste Management program in CUH involves regular expert lectures of the industrial experts. With the online classes being the option in NEP-2020, department will be conducting online expert classes from the industry for the skill enhancement of the students.

SCHEME AND SYLLABUS

Bachelor of Vocation (B.Voc.) in

Industrial Waste Management

DEPARTMENT of VOCATIONAL Studies and Skill Development
School of Life-long Learning

Central University of Haryana
Mahendergarh, Haryana

CENTRAL UNIVERSITY OF HARYANA

Department of Vocational Studies and Skill Development

B. Voc. (INDUSTRIAL WASTE MANAGEMENT)

(Semester-wise Course Structure)

(w.e.f. July 2021)

Type of Course	Module Code	Name of Course	Credits (T+P)	Marks
YEAR – 1, SEMESTER – I				
GENERAL EDUCATION COMPONENT				
CC-1	SLLL IWM 1101C 4004	Introductory Biology	**4** (4+0)	100
CC-2	IWM-102	Concepts in Chemistry	**4** (4+0)	100
CC-3	IWM-103	English Communication	**2** (2+0)	50
CC-4	IWM-104	Practical	**2** (0+2)	50
		TOTAL	**12**	300
SKILL COMPONENT				
SC-1	**NSQF level 4 Job role "Wastewater Treatment Plant Technician"**		**18**	
YEAR – 1, SEMESTER – II				
GENERAL EDUCATION COMPONENT				
CC-5	IWM-201	Instrumentation Techniques-I	**4** (4+0)	100
CC-6	IWM-202	Environmental Science	**4** (4+0)	100
CC-7	IWM-203	Environmental Pollution	**2** (2+0)	50
CC-8	IWM-204	Practical	**2** (0+2)	50
			12	300
SKILL COMPONENT				
SC-2	**NSQF level 5 Job role "Water Quality Testing Technician"**		**18**	**----------**
YEAR – 2, SEMESTER – III				
GENERAL EDUCATION COMPONENT				

CC-9	IWM-301	Environmental Chemistry	**4** (4+0)	100
CC-10	IWM-302	Fundamentals of Mathematics and Statistics	**2** (2+0)	50
CC-11	IWM-303	Microbiology	**4** (4+0)	100
CC-12	IWM-304	Practical	**2** (0+2)	50
		TOTAL	**12**	300
SKILL COMPONENT				
SC-3	**NSQF level 6 Job role "Manager-Waste Management"**		**18**	**----------**
YEAR – 2, SEMESTER – IV				
GENERAL EDUCATION COMPONENT				
CC-13	IWM-401	Bioprocessing and Utilization of Agricultural Wastes	**2** (2+0)	50
CC-14	IWM-402	Solid Waste Management	**4** (4+0)	100
CC-15	IWM-403	Pollution Control and Management	**4** (4+0)	100
CC-16	IWM-404	Practical	**2** (0+2)	50
		TOTAL	**12**	300
SKILL COMPONENT				
SC-3	**NSQF level 6 Job role "Manager-Waste Management"**		**18**	**----------**
YEAR – 3, SEMESTER – V				
GENERAL EDUCATION COMPONENT				
CC-17	IWM-501	Industrial Health and Safety	**2** (2+0)	50
CC-18	IWM-502	Wastewater Management	**4** (4+0)	100
CC-19	IWM-503	Instrumentation Techniques-II	**4** (4+0)	100
CC-20	IWM-504	Practical	**2** (0+2)	50
		TOTAL	**12**	300
SKILL COMPONENT				
SC-4	**NSQF level 7 Job role "Plant In-charge (Wastewater Treatment Plant)"**		**18**	**----------**
YEAR – 3, SEMESTER – VI				
GENERAL EDUCATION COMPONENT				
CC-21	IWM-601	Air and Soil Pollution Management	**2** (2+0)	50

CC-22	IWM-602	Environmental Policies and Laws	**4** (4+0)	100
CC-23	IWM-603	Hazardous, Radioactive and E-waste Management	**4** (4+0)	100
CC-24	IWM-604	Practical	**2** (0+2)	50
		TOTAL	**12**	300
SKILL COMPONENT				
SC-4	**NSQF level 7 Job role "Plant In-charge (Wastewater Treatment Plant)"**		**18**	**----------**

SEMESTER-I

Program Name: B. Voc.-Industrial Waste Management

Course Code: IWM 101	**Course Name:** Introductory Biology	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (4Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic Biology	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO101.1	Chemical basis of origin of life and experiments for supporting that idea, Theories of evolution and human evolution and importance of Biology.
CO101.2	Huge diversity of life animal forms existing on the earth ranging from the simplest, smallest protozoan to the highly complex and largest aquatic or land vertebrates, interaction between organisms and classification, life history of parasites.
CO101.3	Structure and purposes of basic components of prokaryotic and eukaryotic cell, biological significance of major classes of molecules found in living organisms.
CO101.4	Understand the structure of ATP, Various ways in which enzymes increase the rate of biological reactions, This course also deals with various process of plants like photosynthesis, respiration etc.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**Cos**
1	**Introduction to life** The living world: Life and living systems, Themes in the study of biology; Importance of biology in everyday life, The early earth, characteristics of life, origin of life (3 hypothesis), Evolution: Theory of evolution, evidences, Fossils and human evolution.	**15**	**CO101.1**
2	**Classification of life** Biological classification: Prokaryotes, Eukaryotes, Archaeabacteria, Viruses- animal viruses and microbial virus (bacteriophage), viroids and lichens; Five kingdoms- Monera, Protista, Fungi, plantae and animalia Structure and life history of parasites as illustrated by amoeba, Entamoeba, Plasmodium; General structure and life history of insects like mosquito, mite and silk worm	**20**	**CO101.2**
3	**Cell and biomolecules** A living cell; Cell - the unit of life. Origin of cell, Cell cycle and cell division, stages of mitosis and meiosis, and their significance. Structure and function of biomolecules: Water, Carbohydrates, Lipids, Proteins, Nucleic acids, Enzymes and cofactors, Factors affecting enzyme activity, (pH, temperature).	**15**	**CO101.3**
4	**Energy metabolism** Grouping of organisms based on energy need and mineral nutrition; Biochemical pathway-Oxidation, reduction reactions, NAD*, Free energy, ATP, Fermentation, Respiration, Osmotic potential in plants.	**10**	**CO101.4**

	(Aerobic/Anaerobic), Glycolysis, Enzyme activity; Photosynthesis		

Text Books:

1. Dhami P.S. Chopra G. Srivastava H.N."A textbook of Biology" , 2012
2. Verma P.S. Aggarwal V.K. "Cytology, Biomolecules and molecular Biology"
3. Bhatia K.N. Tyagi M.P. "Trueman's elementary Biology", A trueman publication.
3. Pandey S.N. Mishra S.P. Trivedi P.S.A text book of botany, Vikas publishing house.

Reference Books:

1. Chand S. Verma P.S. Pandey B.P. Chand S. Publishing.
2. Daniel Garber Steven, Wiley John and sons Inc.A self teaching guide Biology.
3. Sangve K.B. Wagh G.A. Kulkarni D.S.Kasar C.R. Laharia R.R .Cell and development Biology.
4. Bhutani S.P. Ane books pvt ltd, Chemistry of Biomolecules.
5. Partidas Carlos, The origin of life: A new evolutionary theory

Course Code: IWM 102	**Course Name:** Concepts in Chemistry	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**Ist year** **IstSemester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	General Chemistry	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					
CO102.1	Explain the concept of periodic properties such as electron affinity, electronegativity and ionization energy.				
CO102.2	Explain the terms ligand, denticity of ligands, chelate, coordination number and use Valence Bond Theory to predict the structure and magnetic properties of metal complexes.				
CO102.3	Understand the three laws of thermodynamics, concept of enthalpy, entropy and learn the kinetic aspects of chemical reactions and reaction equilibria.				
CO102.4	Understand Electrophiles, nucleophiles, free radicals and intermediates along the reaction pathways.				
CO102.5	Learn and identify many organic reaction mechanisms including Nucleophilic substitution, Electrophilic addition and Free radical substitution and understand formation, properties of alcohols, ketones and alkyl halides.				
CO102.6	Evaluate the titrations of acid-base mixtures and generate the titration curves for strong acids and bases.				

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**Cos**
1	Periodic Properties: position of elements in the periodic table, Atomic and ionic radii, ionization electron affinity and. electronegativity definition, trends in periodic table and applications in predicting chemical behavior. Introduction and IUPAC nomenclature of coordination compounds isomerism in coordination compounds, stereochemistry of complexes with 4 and 6 coordination numbers, Werner's coordination orbital theory, Valence bond theory,	**15**	**CO102.1 CO102.2**

	(inner and outer orbital complexes), electroneutrality principle and back bonding, chelate effect		
2	Thermodynamics: First law, second law and third law of thermodynamics, concept of enthalpy, entropy, Hess's law; Gibbs free energy, Chemical potential: van't hoff reaction isotherm, van't Hoff Equation; chemical Kinetics: zero, first and second order reactions, complex reactions Catalysis: Types of catalysis, theory and applications of homogeneous and heterogeneous catalysis, biocatalysis, phase transfer catalysis, transition metal and organocatalysis; Chemical equilibrium-Reversible reactions, law of mass action, equilibrium constant, factors influence equilibrium states, relation between Kp and Kc, Ionic Equilibrium-Acids, bases, pH scale	**17**	**CO102.3**
3	Introduction common names and IUPAC names of organic compounds, inductive effect, mesomeric effect and electromeric effect, formation, structure and stability of reactive carbon species - carbonium ion, carbanion, free radical and carbenes, electrophiles and nucleophiles organic reactions and their mechanisms, addition, substitution and elimination reactions, Chemistry of alcohols, amines aldehydes, ketones, halides, structure, preparation and properties	**15**	**CO102.4 CO102.5**
4	Analytical chemistry: Significant figures, Accuracy & precision, methods of expressing concentration- normality, molarity, molality, w/w, v/v, ppm and interconversions, primary and secondary standards, Titrimetric analysis acid base, non-aqueous, complexometric and redox titrations, gravimetry and separation techniques, indicators, buffer solutions. buffer equations and buffer capacity in general	**13**	**CO102.6**

Text Books:

1. Puri; Sharma;Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co.
2. Puri;Sharma; Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co.
3. Vasishta S.L.(2010); Organic Chemistry, R Chand & CO.

Reference Books:

1. Kapoor, K.L.(2015),A Textbook of Physical Chemistry,Vol 2, 6th Edition, McGraw Hill Education.
2. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Chandra, R. ; Singh, S.; Singh, A. (2019), Organic reactions and their nomenclature, Arcler Press.
4. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K.International.
5. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016),Organic Chemistry, 12th Edition, Wiley.
6. Atkins, P.W.; Paula, J.de. (2014),Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.

7. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009),Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.
8. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
9. Laidler K.J. (2003),Chemical Kinetics, 3rd Edition,Pearson Education India.
10. Khopkar, S.M. (2008), Basic Concepts of Analytical Chemistry, New Age International Publisher.
11. Lee, J.D.; (2010),Concise Inorganic Chemistry, Wiley India
12. Bruice, P. Y. (2017),Organic Chemistry, 8th Edition, Pearson.
13. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014),Inorganic Chemistry, 5th Edition, Pearson.

Course Code: IWM 103	**Course Name:** English communication	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic communication skills	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO103.1	Developing intellectual, personal and professional abilities through effective communication skills, ensuring high standards of behavioral attitude through literacy subjects and shaping the students' socially responsible skills.
CO103.2	Understand the role of communication in personal and professional success, Develop awareness of appropriate communication strategies.
CO103.3	Recognize and comprehend different varieties of English language and develop a writing style of their own, Becoming an active listener, Recognize signal words and phrases that introduce organizational structures within lectures , and new concepts of vocabulary.
CO103.4	Understand the purpose of interviews, Be aware of the processes involved in different types of interviews, and Know how to prepare for an interview, Be clear about the importance of self-presentation.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**Cos**
1	**Communication Skills**: Introduction, Definition, The importance of communication, The communication process - Source, Message, Encoding, Channel, Decoding, context' Receiver, Feedback, Barriers to communication: Physiological barriers, physical barriers, cultural barriers. Language barriers, Gender barriers, Interpersonal barriers, psychological barriers, Emotional barriers, Perspectives in communication: Introduction, Visual perception, Language, other factors affecting our perspective - Past experiences, Prejudices, Feelings and Environment.	**8**	**CO103.1**
2	**Elements of Communication**: Introduction, Face to face communication - Tone of voice, Body language (Nonverbal communication), Verbal communication, physical communication. Communication Styles: Introduction, The communication styles	**8**	**CO103.2**

	matrix with examples. For each Direct communication style, Spirited communication style, Systematic communication style, Considerate communication style.		
3	**Basic Listening Skills:** Introduction, Self-awareness, Active listening, Becoming an active Listener, Listening in difficult situations. Effective written communication: Introduction, when and when Not to use written communication - complexity of the topic, amount of discussion required, Shades of meaning, formal communication. Writing effectively subject lines. put the main point first, Know your audience, organization of the message.	**8**	**CO103.3**
4	Interview Skills: Purpose of an interview, Do's and Don't's of an interview. Giving presentations: Dealing with fears, Planning your presentation, Structuring your presentation, Delivering your presentation, Techniques of delivery. Group discussion: Introduction, communication skills in group discussion, Do's and Don'ts of group discussion. Correspondence: personal, official and business. report writing, drafting an email, writing of c.v.	**6**	**CO103.4**

Text Books:

1. Interview skills and Group discussion **,** Praveen Joe I.R. Laxmi Publication.
2. Group discussion , job interview skill, Nitin Sharma, Unicorn books pvt Ltd.
3. Adair , John effective communication, London : Pan Macmillan Ltd.
4. Basic communication skills , SonuMarwah.

Reference Books:

1. Personality development and communication skills, Dr. S.S. Narula, Taxmann publications pvt ltd.
2. Listening skills, Master the art of listening and communication skills, Michele Gilbert.
3. Communication skills, Sanjay kumar, Pushplata, Oxford University Press.
4. Active listening, the forgotten skill, Corbison, Nitor publication.

Course Code: IWM 104	**Course Name:** Practical	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**1stYear** **1st Semester**	**Contact hours per week:** (2 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic practical of Biology and Chemistry	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO104.1	Design and carry out scientific experiments as well as accurately record and analyze the result of such experiments.
CO104.2	Explore new areas of research in chemistry and allied fields of science and technology.
CO104.3	Describe different quantitative methods of analysis of organic and inorganic substances.
CO104.4	Gain knowledge about titration method, identification of biomolecules, and preparation of buffers.
CO104.5	Study the pattern and distribution of stomata on leaf surfaces

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	Cos
1	Calibration of volumetric glassware, Pipette, Burette and Volumetric flask.	**3**	**CO104.1**
2	Preparation of Standard solutions and Buffers	**3**	**CO104.1**
3	Determination of pKa value of acids	**3**	**CO104.1** **CO104.2**
4	Simple volumetric redox titrations	**3**	**CO104.1** **CO104.2**
5	To learn principles of fixation and staining	**3**	**CO104.1**
6	Identification of permanent slides (cell organelles, DNA etc.), Slides of life cycle of Plasmodium and amoeba	**3**	**CO104.1** **CO104.5**
7	To study the pattern and distribution of stomata in both the upper and lower leaf surfaces	**3**	**CO104.5**
8	Qualitative test for identification of carbohydrates, amino acids, lipids and DNA	**3**	**CO104.1** **CO104.4**
9	Preparation of chelated complexes	**3**	**CO104.1** **CO104.2**
10	Adsorption of acetic acid on charcoal	**3**	**CO104.1** **CO104.2**

Books :

1. Usharani S. Analytical chemistry "Techniques and Instrumentation," First Edition, Laxmi Publications, 2019.
2. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
3. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989),Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson.
5. Sachdeva Monika, Dholpuria,R.; Remedial Biology, Nirali publications.
6. Kumar, A.; Garg, S.; Garg, N. (2012), Biochemical Tests: Principles and Protocols.Viva Books.
7. Aggarwal V.P. Maheshwari S.C. Lab manual Biology, Arya publications.
8. Chandra Arun Sahu, Essentials of biomolecules and Cell Biology Kalyani publications.

SEMESTER-II

Course Code: IWM 201	**Course Name:** Instrumentation and techniques-1	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**Ist year** **IInd Semester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course		**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO201.1	Define principles and concepts of air and water sampling
CO201.2	Discuss and select appropriate methods of sterilization
CO201.3	Learn basic knowledge about calibration and working of analytical instruments
CO201.4	Understand different concepts and relative strength of acids and bases
CO201.5	Learn basic instrumentation and applications of UV-VIS spectrophotometer.
CO201.6	Explain theoretical principles of microscopy.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**Cos**
1	**Sample collection method:** Defining the problem and designing of analytical methods; Sampling: Types and methods for collection of Air, water analysis; Sample storage; Sample preparation, preservation, measurement and assessing of data; Good laboratory practices.	**13**	**CO201.1**
2	**Distillation and Sterilization Techniques:** Chemistry of water, physical properties, the process of distillation of water. Heat sterilization, Autoclave, Oven, Filter sterilization, UV sterilization, incubators.	**17**	**CO201.2**
3	**Preparation of solutions:** Nature of acids and bases, strong and weak acids, dissociation constant, pKa of an acid and its determination, concept of buffers, buffering capacity, preparation of buffer, measurement of pH. Working of pH meter. Use of balances, pH -meter, Conductivity meter, TDS meter, DO meter, Salinity meter and Ion selective meters.	**16**	**CO201.3 CO201.4**
4	**Basic Microscopy and Spectroscopy:** Optical Microscopy (Light, Bright field, Darkfield, Phase Contrast, Fluorescence, Confocal); Principle, working and applications of UV-visible spectrophotometer.	**14**	**CO201.5 CO201.6**

Text Books:

1. Yuncong Li, Kati Migliaccio,;(2019) "Water Quality Concepts, Sampling, and Analyses",Ist Edition CRC Press, .
2. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
3. Murphy Douglas, B.;Davidson Michael.W. 2012) Fundamentals of Light Microscopy and Electron Imaging, 2nd Edition, Wiley-Blackwell.
4. Usharani,S.; (2019) Analytical chemistry "Techniques and Instrumentation," First Edition, Laxmi Publications.

Reference Books:

1. Willard, H.H.(1988),Instrumental Methods of Analysis, 7th Edition, Wadsworth Publishing Company.
2. Khopkar, S.M. (2008), Basic Concepts of Analytical Chemistry, New Age International Publisher.
3. Thomas, M. (1996) "Ultraviolet and Visible Spectroscopy",2nd Edition, Wiley..
4. Cappuccino, James G, (2014) "Microbiology A Laboratory Manual", 10th Edition, Pearson India, .
5. Timothy J. Sullivan, Alan T. Herlihy, James R. Webb.(2014) "Air Pollution and Freshwater Ecosystems Sampling, Analysis, and Quality Assurance", First Edition, CRC Press.
6. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd.
7. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.

Course Code: IWM-202	**Course Name:** Environmental Sciences	**L**	**T**	**P**	**C**
		4	**-**	**-**	**0**
Year and Semester	**I year** **II nd Semester**	**Contact hours per week:** (4 Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	Basic knowledge of Environment	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO308.1	Understand the relationship between humans and their environment, predict the consequences of human actions on the environment, global economy and quality of human life.
CO308.2	Gain in-depth knowledge on natural processes that sustain life.
CO308.3	Develop critical thinking for environmental protection and conservation of biodiversity, social equity and sustainable development.
CO308.4	Acquire values and attitudes towards understanding complex environmental-socioeconomical challenges, knowledge of pollution and environmental degradation.
CO308.5	Understand the fundamental concepts of various ecosystems.
CO308.6	Adopt sustainability as a practice in life, society and industry.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction to environmental studies** Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere. Scope and importance; Concept of sustainability and sustainable development. (2 Lectures)	**8**	**CO308.1, CO308.5**

	Ecosystems What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (6 Lectures)		
2	**Natural Resources:** Renewable and Non-renewable Resources Land Resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Heating of earth and circulation of air; air mass formation and precipitation. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 Lectures) **Biodiversity and Conservation** Levels of biological diversity :genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot Spots. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. (8 Lectures)	**16**	**CO308.2, CO308.3**
3	**Environmental Pollution** Environmental pollution : types, causes, effects and controls; Air, water, soil, chemical and noise pollution Nuclear hazards and human health risks Solid waste management: Control measures of urban and industrial waste. Pollution case studies. (8 Lectures) **Environmental Policies & Practices** Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife	**15**	**CO308.3, CO308.4**

	Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC). Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context. (7 Lectures)		
4	**Human Communities and the Environment** Human population and growth: Impacts on environment, human health and welfares. Carbon foot-print. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquakes, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan). (6 Lectures) **Field work** Visit to an area to document environmental assets; river/forest/flora/fauna, etc. Visit to a local polluted site Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems-pond, river, ridge, etc. (5 Lectures)	**11**	**CO308.1, CO308.6**

Text Books:

1. Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India
2. Bharucha, E. (2013). Textbook of Environmental Studies for Undergraduate Courses. Universities Press.
3. De, A.K., (2006). Environmental Chemistry, 6th Edition, New Age International, New Delhi.
4. Masters, G. M., &Ela, W. P. (1991).Introduction to environmental engineering and science. Englewood Cliffs, NJ: Prentice Hall.
5. Kaushik A. and Kaushik C.P., (2011) Perspectives in Environmental Studies, New age International Publishers, New Delhi, India.

Reference Books:

1. Carson, R. *2002. Silent Spring.* Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This *Fissured Land:* An Ecological History of India Univ. of California Press.
3. Gleick, P.H. 1993. Water in *Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

4. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. *Principles of Conservation Biology.* Sunderland: Sinauer Associates, 2006.
5. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
6. McCully, P.1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
7. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
8. Odum, E.P., Odum, h.T. & Andrews, J.1971. *Fundamentals of Ecology.* Philadelphia: Saunders. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
9. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment.* Oxford and IBH Publishing Co. Pvt. Ltd.
10. Raven, P.H., Hassenzahl, D.M. & Berg, L R. 2012. *Environment.* 8th edition. John Wiley & Sons.
11. Rosencranz, A., Divan, S., & Noble, M.L. 2001. *Environmental law and policy in India.* Tripathi 1992.
12. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation.* S. Chand Publishing, New Delhi.
13. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voice from the Tropics.* John Wiley & Sons.
14. Thapar, V. 1998. *Land of the Tiger: A Natural History of the Indian Subcontinent.*
15. Wilson, E.O. 2006. *The Creation: An appeal to save life on earth.* New York: Norton.

Course Code: IWM 203	**Course Name: Environmental pollution**	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**Ist year** **2ndSemester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Environment pollution	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO203.1	Identify and understand the sources of water pollution, control measures and effects on water bodies and discharge standards of water pollution. Case study of thermal and marine pollution
CO203.2	Distinguish the common sources of soil pollution, effects of pesticides, heavy metals, waste disposal, industrial effluents and surfactants of soil. Understand the concept of soil analysis by chemical methods
CO203.3	Understand the harmful effects of air pollution, characteristics of air pollutants, meteorological aspects of air pollutant dispersion, air quality index and criteria pollutants
CO203.4	Able to understand sources, effects and control measure of noise pollution, National ambient air quality standards
CO203.5	Develop an understanding on radioactive pollution, sources and control measures and case studies of radioactive pollution

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**Cos**

1	**Water Pollution:** Definition, Sources, effects and control measures of water pollution, characteristics of domestic industrial and agricultural wastes, their effects on water bodies, Eutrophication, water quality parameters (WHO, BIS and MINAS), criteria and standards, Marine pollution: thermal pollution and case studies.	**6**	**CO203.1**
2	**Soil Pollution:** Definition, sources and effect. Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, industrial effluents and surfactants. Remedial measures for soil pollution, soil sediments as pollutant. chemical methods of soil analysis- sample preparation and soil analysis.	**8**	**CO203.2**
3	**Air Pollution:** Definition, Sources, classification and properties of air pollutants, behavior and fate of air pollutants, effects of air pollution on human health & materials, meteorological aspects of air pollutant dispersion, air quality index, criteria pollutants and case studies.	**7**	**CO203.3**
4	**Noise and Radioactive pollution:** Definition, major sources' effects and control measures of noise pollution. National ambient air quality standards for noise in different zones, Sound level meter. Radioactive pollution: types of radiations, major sources effects and control measures of radiation pollution, E-wastes and e- goods as pollutants, case studies.	**9**	**CO203.4** **CO203.5**

Text Books:

1. Introduction to environmental engineering and science ,Gilbert M. Masters / Wendell P. Ela, Pearson Education India.
2. Environmental pollution control engineering, C.S. Rao, New age international publishers.
3. Environmental pollution, Principles analysis and control, P. Narayan, CBS Publications.
4. Environmental chemistry and pollution control, Dr. S.S. Dara, Dr. D.D. Mishra, S. Chand and publication.

Reference Books:

5. Environmental chemistry, A.K. De, New age publisher international pvt ltd.
6. Environmental chemistry, Stanley E. Manahan, New age international publishers.
7. Water , Air and soil pollution , An international journal of environmental pollution.
8. Nuclear and thermal pollution , Dr. AaradhanaSalpekar, Dr. Gurusamy Gandhi, Jnanada Prakashan.

Course Code: IWM 204	**Course Name:** Practical	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**Ist year** **II Semester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic practical knowledge	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					
CO204.1	Describe basic principles of spectrophotometry.				
CO204.2	Measure pH and electrical conductivity of unknown samples				
CO204.3	Identify the various ways of sterilization techniques				

CO204.4	Know the functions of the different parts of a cell, the differences between animal and plant cells and the chemical reactions within cells.
CO204.5	Learn collection methods of waste samples
CO204.6	Determine water holding capacity of a given soil profile.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	Cos
1	Working, standardization of Spectrophotometer and plotting calibration curve for water samples.	**4**	**CO204.1**
2	To determine the lambda max of an unknown solution and verification of Beer's law	**4**	**CO204.1**
3	Methods for the collection of waste and soil samples.	**2**	**C0204.5**
4	Determination of pH and Temperature of soil and water samples.	**4**	**CO204.2**
5	Determination of Electrical Conductivity (EC) of soil and water samples.	**4**	**CO204.2**
6	Determination of salinity in soil and water samples.	**2**	**C0204.6**
7	Determination of Moisture content and water holding capacity of soil.	**4**	**C0204.6**
8	Use of microscope: study of plant and animal cells.	**2**	**C0204.4**
9	Study of various sterilization techniques	**2**	**C0204.3**

Books:

1. Yuncong Li, Kati Migliaccio, "Water Quality Concepts, Sampling, and Analyses", CRC Press, 2019.
2. Usharani, S.(2019),; Analytical chemistry "Techniques and Instrumentation," First Edition, Laxmi Publications.
3. Michael Thomas,(1996) "Ultraviolet and Visible Spectroscopy", 2nd Edition, Wiley.
4. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
5. Kanwaljit Kaur, "Handbook of Water and Wastewater Analysis", Atlantic; Edition (1 January 2007).
6. Cappuccino, James G,(2014), "Microbiology A Laboratory Manual", 10th Edition, Pearson India.

SEMESTER-III

Course Code: IWM 301	**Course Name:** Environmental Chemistry	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (4 Hrs.) **Exam: (3hrs.)**			

Pre-requisite of course	General chemistry	Evaluation	
		CIE: 50	TEE: 50

Course Outcomes: On completion of the course, student would be able to:	
CO301.1	Develop understanding on the chemistry of the lithosphere, hydrosphere and atmosphere.
CO301.2	Focus on different methods to understand the functioning of atmospheric processes and air pollution chemistry.
CO301.3	Know about different water pollutants and determination of BOD, COD and DO in water.
CO301.4	Gain knowledge on fundamental principles of soil science, the processes of soil development and the criteria of soil classifications and soil characteristics.
CO301.5	Gain understanding on the chemistry of different types of pollutants in the environment.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	Cos
1	**Atmospheric Chemistry** Chemical composition of atmosphere, the changing global atmosphere, gaseous transformation in the atmosphere and removal mechanisms, residence-time, acid-rain, ozone layer depletion Nuclear winter, Atmospheric photochemical reactions: Monoatomic oxygen and ozone formation, role of nitrogen in photo oxidation, hydrocarbons in atmospheric photo-chemistry, oxidants in photochemical smog. Hydrocarbon reactivity. Radioactivity in the atmosphere and air pollution chemistry.	**18**	**CO301.1, CO301.2**
2	**Water Chemistry** Solubility products, Solubility of gases in water, carbonate system in carbon-dioxide in water, pH, alkalinity, Nitrates, Sulphates, Phosphates, BOD, COD, DO determinations, Water pollution due to Heavy metals, organic pollutants, pesticides and radionuclide.	**15**	**CO301.1, CO301.3**
3	**Soil Chemistry** Physio-chemical composition of soil, humus, inorganic and organic components of soil, nutrients (NPK) in soil, significance of C:N .ratio, cation exchange capacity (CEC), Reactions in soil solution, Ion exchange (Physiosorption, Ligand exchange (chemosorption), Complexations, Chelation, Precipitation / dissolution. Environmental geochemistry: concept of major, trace and REE. Classification of trace elements and mobility of trace elements.	**15**	**CO301.2, CO301.4**
4	Chemistry of waste substances: Nature and types of various wastes such as mining, industrial, agricultural, municipal, biomedical and radioactive wastes. chemistry of toxic inorganic and organic compounds in the environment and their interactions with the living system.	**12**	**CO301.5**

Text Books:

1. DE Anil K (2019), "Environmental Chemistry", 9th Edition, New Age International (P) Ltd. Publishers.
2. Masters Gilbert M. and Ela P. Wendell (2019), "Introduction to Environmental Engineering and Science", 10th Edition, Pearson Publications.

3. Dara S.S. and Mishr D.D.(2004),"A textbook of Environmental Chemistry and Pollution control", 7th edition, S.Chand and company.
4. Pani, B. (2007), "Textbook of Environmental Chemistry", IK international Publishing House
5. Manhan Stanley E. (2008)," Fundamentals of Environmental Chemistry", 3rd Edition, Lewis Publishers.

Reference Books:

1. Stumm W. and Morgan J.J. (2012), "Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters", John Wiley & Sons.
2. Williams, I. (2001)," Environmental Chemistry –a modular approach", Willey John & Sons.
3. Sawyer, C.N., McCarty, P.L., Perkin, G.F. (2017), "Chemistry for Environmental Engineering and Science", 5th Edition, McGraw-Hill India.
4. Benefield D. L., Judkins F. J., Weand L. B. (1982), "Process Chemistry for Water and Wastewater Treatment", 1st Edition, Prentice Hall, USA.
5. Weiner, E.R. (2010), "Applications of Environmental Chemistry - A Practical Guide for Environmental Professionals", 1st Edition, CRC Press, USA.
6. Connell, D.W. (2005), "Basic Concepts of Environmental Chemistry",2nd editioN, CRC Press.

Course Code: IWM 302	**Course Name**: Fundamentals of Mathematics and Statistics	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic mathematics	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO302.1	Understand sets, relation and function and analyze average, ratio and proportion, profit/loss, discount, simple interest and compound interest.
CO302.2	Learn about significant figures, Probability and its application and understand about vector, 3-D and integration and their applications.
CO302.3	To analyze areas under the graph, tabulation, line, bar graph and their applications.
CO302.4	Understand the basics of descriptive statistics and analyze statistical data using MS office.
CO302.5	Know about measures of central tendency, frequency curves, skewness and kurtosis.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**COs**
1	Sets, Relation and function, Quadratic equation, Average, Ratio profit/ Loss and Discount, Simple interest and compound interest	**6**	**CO302.1**
2	Vectors, 3D integration (Definite and indefinite integration) Area under the graph, bar graph and Mixed graph. Differentiation, Probability, Tabulation, Line graph, bar graph and mixed graph.	**8**	**CO302.2, CO302.3**
3	Descriptive Statistics: Meaning, need and importance of statistics' Attributes and variables, Measurement and measurement scales.	**8**	**CO302.4**

	Collection and tabulation of data using MS office. Diagrammatic representation of frequency distribution using MS office:		
4	Measures of central tendency- mean, mode and median; and whisker plot), skewness and kurtosis. Histogram, frequency polygon, frequency curve' Ogives and pie chart.	**8**	**CO302.5**

Text Books:

1. Aggarwal R.S. (2013), "Quantitative Aptitude", 20th Edition, S Chand Publishers.
2. Sinha P.K. (2003), "Computer Fundamentals", 6th edition, BPB Publications.
3. G.B. Thomas and Finney R.L.(2005), "Calculus", 9th edition, Pearson Education.

Reference Books:

1. Kothari C R and Garg (2019), "Research Methodology", 4th Edition, New Age International Publishers.
2. Kumar Romesh (2016), "New Course Mathematics", 30th Edition, Pradeep Publications.
3. Bhargava M.L.Dinodia Janardan, Kharbanda G.K. and Gulati Naveen (2019), 20th Edition "Elements of Mathematic", Jeevanson Publications.
4. Hogg Robert V., McKean Joseph W. and Craig Allen T.(2007), "Introduction to Mathematical Statistics", Pearson Education, Asia.
5. Ross Sheldon , "Introduction to Probability Model", 9th Ed., Academic Press, Indian Reprint.
6. Maity, K. C. and Ghosh, R. K.(2001), " Differential Calculus", New Central Book Agency Pvt Ltd.

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Course Code: IWM 303	**Course Name:** Microbiology	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**2nd year 3rd Semester**	**Contact hours per week:** (4 Hrs.) **Exam: (3hrs.)**			
Pre-requisite of course	Basic Microbiology	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO303.1	Appreciate the diversity of microorganisms and application of microbes from extreme environments.
CO303.2	Recognize and use microorganisms as bio indicators of contamination and other environmental impacts.
CO303.3	Understand the role of microbes in bioremediation of environmental pollutants, nutrient transformation, degradation of xenobiotics, mineral and oil recovery.
CO303.4	Apply the knowledge in designing microbial based processes for pulp, textile and biofuel production industries.
CO303.5	Identify fundamental causes and mechanisms of various infections like bacterial infections, viral infections, protozoan infections and parasitic infections.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	Cos
1	**Introduction** Definition and scope of microbiology, Microbial diversity in the environment, classification, role of microbes in environmental protection and management of resources. Bio-indicators, biosensors - types and applications in environmental pollution detection and monitoring. Gram positive and Gram negative bacteria.	**12**	**CO303.1, CO303.2**
2	**Environmental Interactions** Biogeochemical cycling: role of microorganisms in carbon, nitrogen, phosphorus and sulfur cycles. Bioremediation, biotransformation and biodegradation of xenobiotics, microbial interactions with inorganic pollutants - Microbial metal resistance; Microbial transformation; accumulation and concentration of metals; biosorption, bioleaching, biodeterioration, Bioaccumulation and biodegradation.	**18**	**CO303.1, CO303.3**
3	**Applications of microbes** Application of natural and genetically engineered micro-organisms from extreme environments: like thermophiles, alkaliphiles; acidophiles, and halophiles in waste treatment of different industries. Biofuel production (bioethanol, biogas, biohydrogen etc), Fermentation, Petroleum pollutant biodegradation. Microbial leaching of low grade mineral ores, Petroleum pollutants and improved oil recovery.	**18**	**CO303.1, CO303.3, CO303.4**
4	**Infectious diseases** Relationship between normal microbiota and host, opportunistic and nosocomial infections. Development and spread of infectious diseases. Role of poor waste disposal as a causative agent for infectious diseases. Bacterial infections (Tetanus, Typhoid, Tuberculosis), Viral infections (Measles, Influenza, HIV), protozoan infections (Plasmodium, Trypanosorna), Parasitic infections (Candida, Aspergillus).	**12**	**CO301.5**

Text Books:

1. Mohaptra Pradipta K.(2008)," Textbook of Environmental Microbiology", I K International Publishing House Pvt. Ltd.
2. Thakur Indu Shekhar (2011), "Environmental Biotechnology", 2nd Edition, I K International Publishing House Pvt. Ltd.
3. Johri B.N.(2000), "Extremophiles", Springer V erlag. , New York.
4. Hurst Christon J. (2001), "A Manual of Environmental Microbiology",2nd edition, ASM Publications.

Reference Books:

1. Varnam A.H. and Evans M.G (2000),"Environmental Microbiology", Manson Publishing Ltd.
2. Sharma P.D. (2015), "Ecology and Environment", 12th Edition, Rastogi Publications.
3. Shuler M. L. and Kargi F. (2015), "Bioprocess Engineering: Basic Concepts", 2nd edition. Pearson Education India.

4. Nelson KE and Williams C.M. (2019), "Infectious Disease Epidemiology: Theory and Practice", 4th edition. Jones and Bartlett.
5. Mitchell R., Gu J.D. (2009)," Environmental Microbiology", 2nd Edition, Wiley-Blackwell, USA.

Course Code: IWM 304	**Course Name:** Practical	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**2nd year 3rdSemester**	**Contact hours per week:** (2 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Water parameters basic knowledge	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO304.1	Learn and understand the concept of chemistry in soil and water.
CO304.2	Learn and analyze the anions and cations in soil and water.
CO304.3	Determine phenol compounds and total/Kjeldahl nitrogen in water.
CO304.4	Understand preparation of broth media, bacterial cultures for storage and isolation of bacteria.
CO304.5	Comprehend the various methods for identification of unknown microorganisms.

Module No	**CONTENTS OF MODULE**	**Hrs.**	**COs**
1	1. To determine cations (Na and K) in soil/ water.	**2**	**CO304.1 CO304.2**
2	To determine anions (sulfate, nitrate and fluoride) in soil/ water.	**6**	**CO304.1 CO304.2**
3	To determine phenol compounds and total/Kjeldahl nitrogen in water/wastewater.	**4**	**CO304.3**
4	To determine total phosphate in wastewater.	**2**	**CO304.1 CO304.2**
5	Determination of chloride content in soil/ water.	**2**	**CO304.1 CO304.2**
6	Preparation of media - solid (LA), liquid (LB) and autoclaving.	**2**	**CO304.4**
7	Isolation of bacteria by streaking method.	**2**	**CO304.4**
8	Characterization of microbes by colony characterization/staining methods	**4**	**CO304.5**
9	Inoculation of polluted water samples.	**2**	**CO304.5**
10	Gram's staining and acid fast staining (permanent slide only).	**2**	**CO304.5**
11	Preparation of bacterial culture for storage (glycerol stock, slants).	**2**	**CO304.4**

Text Books:

1. **Fresenius**, Wilhelm, **Quentin**, Karl E., **Schneider**, Wilhelm, "Water AnalysisA Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance; springer (1988).
2. Leo ML Nollet, Leen SP De Gelder, "Handbook of Water Analysis", CRC Press,Jun 2007

Reference Books:

1. Kanwaljit Kaur, "Handbook of Water and Wastewater Analysis", Atlantic; Edition (1 January 2007).

SEMESTER-IV

Course Code: IWM 401	**Course Name:** Bioprocessing and Utilization of Agro-industrial waste	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**2nd year** **4th Semester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic knowledge of terms and processes related to agriculture waste utilization.	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO401.1	Understand the methods for utilization of agriculture waste and to impart knowledge about the basic facts of agroforestry and various agroforestry systems.
CO401.2	Learn about various biomass conversion technologies and their environmental attributes.
CO401.3	Understand the biomass pretreatment processes for successful fractionation of lignocellulose.
CO401.4	Understand the biogas production techniques and operation of biogas plants.
CO401.5	Demonstrate general knowledge and understanding of some of the basic facts, concepts and principles relating to plant biomass and the different ways in which plant biomass have been utilized by humans.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**COs**
1	**Introduction** Agriculture waste, biomass properties, Agro forestry for Bio-Energy, biomass, energy from solid waste, cell wall and plant anatomy. Biofuels- Introduction, Uses & importance. Various methods used for the treatment of agricultural waste.	**8**	**CO401.1, CO401.5**
2	**Biomass Pretreatment** Biomass pretreatment/fractionation, dilute acid pretreatment, Steam explosion pretreatment, Biological pretreatment. Biomass Briquetting- Definition – potential agro residues and their characteristics for briquetting, fundamental aspects and technologies involved in briquetting, economic analysis of briquetting, appliances for biomass briquettes. (PK)	**6**	**CO401.3, CO401.5**
3	**Biogas production** Screening of suitable lingo cellulosic substrate for biogas production, determination of bio-energy potential of agro-waste by	**10**	**CO401.4, CO401.5**

	estimating total solids, volatile solids, Calorific value- per cent total carbohydrates, moisture, lignin and cellulose contents, preparation of feedstocks for anaerobic bio- digestion, types of digesters, factors affecting, nutrient value and utilization of biogas slurry. (PK) handling of slurry, optimization of solid waste Ratio for types of biomass cook stoves, rural energy needs.		
4	**Biofuel** Biofuel- Introduction, history, 1 st Generation Biofuels – Corn Ethanol & Sugarcane Ethanol, 2 nd Generation Biofuels – Cellulosic Ethanol, 3rd Generation Aquatic Biomass – Cyanobacteria, Diatoms & Algae, Biochemical conversion of lignocellulose to alcohol/ethanol-pretreatment-fermentation-distillation (PK) and Consolidated Bioprocessing (CBP), biohydrogen and energy plantation. Biodiesel- Introduction, production, uses & importance. (PK).	**6**	**CO401.2**

Text Books:

1. Rai G.D.(1988), "Non Convetional Energy Sources", Khanna Publishers
2. Raymond C Loehr, Agricultural Waste Management- problems, processes and approaches. First edition, Academic press, 1974.
3. Uta Krogmann, Ina Korne and Luis F. Diaz.2010. Solid waste technology and management (Vol 1 and2). Blackwel Pub Ltd., Wiley Online library.
4. Magdalena Muradin and Zenon Foltynowicz, Potential for Producing Biogas from Agricultural Waste in Rural Plants in Poland. Sustainability, 2014, 6, 5065-5074.
5. Robert C. Brown, Biorenewable Resources: Engineering New Products from Agriculture. Wiley-Blackwell Publishing (Second Edition)
6. Sunggyu Lee and Y.T. Shah, Biofuels and Bioenergy Processes and Technologies. CRC Press (2013) (Recommended)

Reference Books:

7. Sergio Capareda, (2013)," Introduction to Biomass Energy Conversions", CRC Press, USA.
8. Robert C. Brown, (2019)," Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power", John Wiley and Sons, USA.
9. Wanger K.D.(1998), "Environmental Management", W.B. Saunders Co. Philadelphia, USA.
10. Rao M.N., Sultana Razia and Kota Sri Harsha(2017)," Solid and Hazardous Waste Management", BS Publications.
11. Klee, G.A. (1991)," Conservation of Natural Resources", Prentice Hall Publ. Co., New Jersey.

Course Code: IWM 402	**Course Name:** Solid Waste Management	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**2nd year** **4th Semester**	**Contact hours per week:** (4 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic knowledge of solid waste	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					

CO402.1	Understand various aspects of solid waste management (starting from its generation to processing with options for reuse and recycle, transport, and disposal).
CO402.2	Plan segregation, collection, transportation, recycling and disposal of municipal solid waste in such a way that its impact is minimal on environment, economy and community.
CO402.3	To manage construction and operations of landfill facilities, energy recovery systems and management of leachate systems.
CO402.4	To design composting systems, maintain and operate the aerobic and anaerobic composting process for effective organic waste recycling.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	**Introduction to Solid Waste** Solid waste: Definition, overview of solid waste management, types of solid wastes, sources of solid wastes, properties of solid wastes, Factors affecting the type and quality of waste, causes of Solid waste generation, associated risks of solid wastes, Physical and chemical composition of municipal solid waste, hierarchy of waste management options.	**14**	**CO402.1, CO402.2**
2	**Solid Waste Management** Solid waste management: Key components of solid waste management, Generation, storage (containers), collection, transportation (human powered, animal powered and motorized) and Disposal (Landfills, composting, incineration and pyrolysis), Recycling and resource recovery, layout of routes. Methods of handling and processing of solid wastes: separation, screening, size reduction, densification, baling, cubing, compaction and pelleting.	**16**	**CO402.1, CO402.2**
3	**Landfilling** Landfilling: Site selection criteria, landfill layout, landfill sections, Occurrence of gases and leachate in landfills: composition and characteristics, generation factors, initial adjustment phase, transition phase, acid formation phase, methane formation phase, maturation phase of gases and leachate, advantages and disadvantages.Bioremediation or biomining of legacy wastes	**16**	**CO402.3**
4	**Composting** Composting: definition, types, process description, design and operational consideration of aerobic composting; process. description, design and operational consideration of anaerobic Composting, Vermicomposting; Thermal conversion methods: incineration/combustion, pyrolysis and gasification, energy recovery system.	**14**	**CO402.4**

Text Books:

1. Masters Gilbert M. and Ela P. Wendell (2019) , "Introduction to Environmental Engineering and Science", 10th Edition, Pearson Publications.
2. Garg Santosh Kumar (2008), "Sewage Disposal and Air Pollution Engineering", 37th Edition, Khanna Publishers.

Reference Books:

1. Rao M.N., Sultana Razia and Kota Sri Harsha (2017)," Solid and Hazardous Waste Management", BS Publications.
2. Singh Jagbir and Ramnath AL. (2019), "Solid Waste Management", Dreamtech Press.
3. Vesilind, P.A. and Worrell W.A. (2016), "Solid Waste Engineering", 2nd Edition, Cengage India.
4. CPHEEO (2016), "Manual on Municipal Solid Waste Management", Ministry of Urban Development", India.
5. John Pichtel (2014), "Waste Management Practices: Municipal, Hazardous and Industrial", 2nd Edition, CRC Press, USA.
6. Tchobanoglous G., Theisen H., Vigil S.A. (2014), " Integrated Solid Waste Management, Engineering Principles and Management Issues", 2nd Edition, McGraw-Hill, USA.

Course Code: IWM 403	**Course Name:** Pollution Control and Management	**L**	**T**	**P**	**C**
		4		**-**	**4**
Year and Semester	**2nd year** **4th Semester**	**Contact hours per week:** (4 Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	Environmental pollution	**Evaluation**			
		CIE:50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO403.1	Wastewater treatment methods such as primary treatment methods, secondary treatment methods and tertiary treatment methods; sludge treatment methods
CO403.2	Control of particulates and gaseous pollutants from polluted air
CO403.3	Noise pollution control methods such as absorbing materials, barrier materials, damping materials, acoustical enclosures, reactive silencers and filters
CO403.4	Soil pollution control methods such as physical remediation techniques which includes vacuum extraction, soil washing, flushing, heating, leaching
CO403.5	Biological methods of soil remediation such as phytoremediation, phytoextraction, hyperaccumulation, phytodegradation, phytovolatization
CO403.6	Learn the various parameters and their interrelationship, able to solve numerical problems with series, cascade, and parallel connection using two port parameters.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Wastewater management:** Primary treatment methods: screening, grit removal, primary sedimentation; Secondary treatment methods: Activated sludge process, trickling filters, rotating biological contactors (RBCs), oxidation ponds and lagoons. Tertiary/advanced treatment methods: removal of nutrients, flue gas, ions and solids. Sludge treatment methods: preliminary operation, thickening, conditioning, dewatering. filtration, digestion and disposal.	**16**	**CO403.1, CO403.2**
2	**Air Pollution control:** Source correction methods, control gravitational settling chambers, centrifugal collectors, wet collectors, precipitators. control methods for gaseous pollutants- adsorption, combustion. methods for particulates- Fabric filters, electrostatic absorption, condensation	**10**	**CO403.3,**

3	**Noise Pollution control:** Absorbing materials, barrier materials, damping materials, acoustical enclosures, Reactive silencers and filters; Active noise control methods.	**8**	**CO403.4, CO403.5**
4	**Soil pollution control:** Physical remediation methods: incineration, vacuum extraction, soil washing / flushing, leaching, heating; Biological remediation methods (bioremediation): Role of microbes and plants in controlling and decreasing soil pollution. phytoremediation- phytoextraction. hyperaccumulation, enhanced rhizosphere phytoremediation, phytostabilization, phytodegradation and phytovolatilization.	**11**	**CO403.6**

Text Books:

1. Rao M N, "Wastewater Treatment", Oxford & IBH Publishing; 3rd edition (1 January 2020).
2. Karia G. L, "Wastewater Treatment: Concepts and Design Approach", Prentice Hall India Learning Private Limited; 2nd edition (1 January 2013).
3. KVSG Murali Krishna, "Industrial Water and Wastewater Management", Paramount Publications Hyderabad, 2019.
4. Pallavi Saxena &Vaishali Naik, "Air Pollution Sources, Impacts and Controls", CABI, December 2018.
5. M Rao& H.V.N. Rao, "Air Pollution", McGraw Hill Education; 1st edition (1 July 2017).

Reference Books:

1. C.S. Rao, "Environmental Pollution Control Engineering", New Age International Publishers; Third edition (1 January 2018).
2. Rajat Sethi, "Air Pollution: Sources, Prevention & Health Effects (Air, Water and Soil Pollution Science and Technology: Pollution Science, Technology and Abatement)", Nova Science Publishers Inc; UK ed. edition (1 July 2013).

Course Code: IWM 404	Course Name: Practical	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**2nd year 4thSemester**	**Contact hours per week:** (2 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Water parameters	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					
CO404.1	Learn and understand the concept of solid waste measurement and its management				
CO404.2	Learn and analyze the physico-chemical parameters of water i.e., TSS, TDS, TS, Total hardness.				
CO404.3	Understand and analyze the TOC, total alkalinity of samples.				

CO404.4	Flocculation and coagulation studies of water samples, MPN test and determination of indicator organisms.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	Cloning and quartering method.	**2**	**CO404.1**
2	Characterization of municipal solid waste.	**4**	**CO404.1**
3	Analysis of solid waste/sludge for moisture content.	**2**	**CO404.1**
4	Analysis of solid waste /sludge for particle size.	**2**	**CO404.1**
5	Determination of TSS, TS, TDS, VSS and total settleable solids in water samples.	**4**	**CO404.2**
6	Bacterial water quality: Measuring quality of water by using coliform organisms (MPN).	**2**	**CO404.4**
7	Indicator and Indices: Fecal streptococci, anaerobic bacteria.	**4**	**CO404.4**
8	Flocculation and coagulation studies of wastewater samples.	**4**	**CO404.4**
9	Determination of Total organic carbon (TOC) in soil and wastewater samples.	**4**	**CO404.3**
10	Determination of Total Alkalinity in water and wastewater samples.	**2**	**CO404.3**

Text Books:

1. Fresenius, Wilhelm, Quentin, Karl E., Schneider, Wilhelm, "Water AnalysisA Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance; springer (1988).
2. Leo ML Nollet, Leen SP De Gelder, "Handbook of Water Analysis", CRC Press,Jun 2007
3. Standard Methods for the Examination of Water & Wastewater, APHA.

Reference Books:

1. Kanwaljit Kaur, "Handbook of Water and Wastewater Analysis", Atlantic; Edition (1 January 2007).

SEMESTER-V

Course Code: IWM 501	**Course Name**: Industrial Health & Safety	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**3rd year** **5th Semester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic knowledge of industrial health hazards	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					
CO501.1	Able to understand environmental & occupational health specific concern to health effects of any worker/population when exposed to contaminated air and water pollution.				

CO501.2	Learn safety education, training & understanding the importance of a safe workplace.Understand and analyze the occupational diseases & consequences of accidents at the workplace.
CO501.3	Understand the role of organizational management & public for workplace safety. Learn about the physical hazards i.e., radiation, heat, vibration, noise etc. Understand the handling techniques for safe use of equipment at work.
CO501.4	Learn the importance of housekeeping at the workplace. Understanding the exposure of chemicals in the workplace. Analyse and learn about the safe transportation and handling of hazardous materials. Understand the HAZCHEM Code.
CO501.5	Learn & analyse the precautionary methods of hazardous substances. Understand the importance of PPE (Personal protective equipment) & its various types used at the workplace.
CO501.6	Understand the methods of use of respiratory & non- respiratory protective equipment and their importance at the workplace. Learn and analyse the safety methods in case of on-site or off-site emergency conditions.
CO501.7	Understand the importance of safety audit and inspection in a plant. Learn & understand occupational health & safety standards & their importance.
CO501.8	Understand the Workmen's compensation Act, 1923, The Factory Act, 1948, The Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016, their role and importance.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	**Introduction** Occupational environment and its relation to health, training, safety education and Safety promotion and publicity schemes, human factors contributing to accidents, Safety and physiology, occupational diseases. Accident hazards, consequences of accidents, role of management and public.	**6**	**CO501.1, CO501.2,**
2	**Hazards** Physical hazards: Unsafe handling. Housekeeping, Ergonomics. Chemical Hazards: classification of hazardous chemicals, transportation, hazardous chemicals, Hazchem code, storage and handling of hazardous substances, Major accidents involving hazardous substances.	**8**	**CO501.3, CO501.4**
3	**Plant safety** Personal protection equipment: Non respiratory protective equipment and respiratory protective equipment, Emergency preparedness (on-site & off- site), Plant safety inspections and safety audits.	**8**	**CO501.5, CO501.6**
4	**Legislation Measures** Occupational health & safety standards, The workmen's compensation Act, 1923, The factory Act, 1948, Public insurance & Liabilities Act,1991.	**8**	**CO501.7, CO501.8**

Text Books:

1. S. Z. Mansdorf, “Handbook of Occupational Safety and Health”, Wiley, 2019.
2. Chester Razer, “OSHA Field Guide: Understand Workplace Safety & Save Money”, Bowker, 2019.
3. Frances Alston, Emily J. Millikin, “Guide to Environment Safety and Health Management”, CRC Press, 2015.
4. M.P. Poonia, S.C. Sharma, “Industrial Safety and Maintenance Management”, Khanna Book Publishing Company Pvt Ltd., 2019.

Reference Books:

1. Dr. R.B. Choudhary and G.R.N. Tagore, “Plant Layout and Materials Handling”, Khanna Publishers, 1987.
2. Fundamentals of Industrial Hygiene. 5th Ed. Plog, Barbara and Patricia Quinlain. Chicago, IL: National Safety Council, 2001.

Course Code: IWM 502	**Course Name:** Wastewater Management	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**3rd year** **5th Semester**	**Contact hours per week:** (4Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Water and wastewater pollution	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO502.1	Understand the importance of water, need for wastewater treatment. Learn about the sampling of water/wastewater samples, Indian standards of wastewater disposal on land and in water bodies.
CO502.2	Learn about the preliminary wastewater treatment process i.e. equalization, neutralization.
CO502.3	Understand the working, theory and design of screens, grit chamber, sedimentation, coagulation and flocculation tanks.
CO502.4	Learn and understand about the physio-chemical and biological treatment processes, Understand and analyze the membrane bioreactors (MBR), Moving bed biological reactors (MBBR), anaerobic baffled reactors (ABR), Activated sludge process (ASP), extended aeration systems, trickling filters (TF), Rotating Biological Contactors, oxidation ditches/ponds, sequential batch reactor, root zone treatment, Up flow anaerobic sludge blanket (UASB) reactor.
CO502.5	Able to understand the advanced wastewater treatment techniques & methods i.e. nitrification and denitrification.
CO502.6	Understand about the various wastewater treatment processes i.e. Biological phosphate removal (BPR), types of membrane processes, lon exchange; Advanced oxidation process: photocatalysis, water disinfection techniques i.e. chlorination, ozonation.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**COs**
1	**Introduction** Self-purification of water bodies, Need of wastewater treatment, classification, sources of water pollutants, Wastewater flow and its characteristics, Wastewater	**12**	**CO502.1**

	collection systems, Estimation and variation of wastewater flows. Problems of industrial wastewaters, Sampling protocol, Indian standards for disposal of treated wastewater on land and in natural streams.		
2	**Preliminary and primary treatment** Preliminary process, Equalization, Neutralization, Proportioning processes. Primary wastewater treatment processes; (Screens, grit chamber, Comminutors and primary settling tanks). Theory and design of screens, grit chambers. sedimentation, coagulation and flocculation.	**16**	**CO502.2** **CO502.3**
3	**Secondary treatment** Physio-chemical and biological treatment strategies and their evaluation, Membrane bioreactors (MBR), Moving bed biological reactors (MBBR), anaerobic baffled reactors (ABR). Activated sludge process (ASP), extended aeration systems, trickling filters (TF), Rotating BiologicalContactors, oxidation ditches/ponds, sequential batch reactor, root zone treatment, Up flow anaerobic sludge blanket (UASB) reactor.	**16**	**CO502.4**
4	**Advanced wastewater treatment** Introduction, Nutrient removal – nitrification, denitrification, Biological phosphate removal (BPR); Membrane processes - Fundamentals, membranes – types, Classifications, microfiltration, ultrafiltration, nanofiltration and reverse- osmosis, electrodialysis, Membrane fouling, cleaning and mitigation techniques; lon exchange; Advanced oxidation process: photocatalysis, ozonation - ozone/UV, ozone/hydrogen peroxide, hydrogen peroxide/UV, applications, oxidation of refractory organic compounds.	**16**	**CO502.5** **CO502.6**

Text Books:

1. RAO M N, “WasteWater Treatment”, OXFORD & IBH PUBLISHING; 3rd edition (1 January 2020).
2. Karia G. L, “Wastewater Treatment: Concepts and Design Approach”, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2013).
3. KVSG Murali Krishna, “INDUSTRIAL WATER AND WASTEWATER MANAGEMENT”, PARAMOUNT PUBLICATIONS HYDERABAD, 2019.

Reference Books:

1. Santosh Kumar Garg, “Environmental Engineering (Vol. II) Sewage Waste Disposal and Air Pollution Engineering”, Khanna Publishers, 1979.
2. Venkateswarlu, K.S., “Water Chemistry-Industrial and Power Station Water Treatment”, New Age International (P) Ltd., Publishers, 1996.

Course Code:	**Course Name:** Instrumentation and Techniques- II	**L**	**T**	**P**	**C**
IWM 503		**4**	**-**	**-**	**4**

Year and Semester	**3rd year** **5th Semester**	**Contact hours per week:** (4Hrs.) **Exam:** (3hrs.)	
Pre-requisite of course	Basic knowledge of instruments	**Evaluation**	
		CIE: 50	**TEE: 50**
Course Outcomes: On completion of the course, student would be able to:			
CO503.1	Learn and understand about the principle and rules of centrifugation, sedimentation, various types of centrifugation processes and motors used in it.		
CO503.2	Understand the principles, working and applications of chromatographic techniques i.e., paper chromatography, thin layer chromatography, Column chromatography Gas liquid chromatography, High pressure liquid chromatography, ion exchange chromatography.		
CO503.3	Learn Electron Microscopy, Principle, working and applications of Spectrophotometry,UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry and Fluorometry.		
CO503.4	Understand Radioactivity, Principles of Radioactivity, Types of radioactivity. Geiger Mueller (GM) Detectors. Alpha Radiation Survey Meter, Dose Rate Meter and Scintillation counters.		

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	**Centrifugation** Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges-Tabletop centrifuge, refrigerated centrifuged, Different types motors, Differential centrifugation, Density gradient centrifugation.	**12**	**CO503.1**
2	**Chromatography** Principles, working and applications of Chromatographic Techniques -Paper chromatography,thin layer chromatography, Column chromatography Gas liquid chromatography, High pressure liquid chromatography, lon exchange chromatography.	**16**	**CO503.2**
3	**Advanced Microscopy and Spectroscopy** Electron Microscopy (Scanning andTransmission Electron Microscopy); Principle, working and applications ofSpectrophotometry,UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry, Fluorometry.	**16**	**CO503.3**
4	**Radioisotopes:** Radioactivity, Principles of Radioactivity, Types of radioactivity. Geiger Mueller (GM) Detectors. Alpha Radiation Survey Meter, Dose Rate Meter, Scintillation counters.	**16**	**CO503.4**

Text Books:

1. Shalinee Naidoo, “Centrifugation Techniques”, Arcler Education Inc (1 November 2017).
2. James M. Miller, “Chromatography: Concepts and Contrasts, Second Edition”, John Wiley & Sons, 2009.

3. Yves Engelborghs, Antonie J.W.G. Visser, "Fluorescence Spectroscopy and Microscopy: Methods and Protocols", Springer Nature; 2014th edition (24 October 2013).
4. Peggy Sparks, "Handbook of Radioisotopes", NY Research Press; Illustrated edition (16 January 2015).

Reference Books:

1. Peggy Sparks, "Applications of Radioisotopes", NY Research Press; Illustrated edition (20 January 2015).
2. Douglas B. Murphy, "Fundamentals of Light Microscopy and Electronic Imaging", Wiley-Liss; 1st edition (December 15, 2001).
3. Vladimir G. Bordo, Horst-Günter Rubahn, "Optics and Spectroscopy at Surfaces and Interfaces", Wiley,December 2005.

Course Code: IWM 504	**Course Name:** Practical	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**3rd year** **5thSemester**	**Contact hours per week:** (2 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic knowledge of water parameters	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO504.1	Learn and analyze the physico-chemical parameters of water i.e., TSS, TDS, TS, Total hardness.
CO504.2	Understand and analyze the BOD, COD, Amino acids in water samples.
CO504.3	Separation of dissolved solid particulate matter using centrifugation, Estimation of protein by Lowry/Bradford methods and Working, standardization of flame photometer and plotting calibration curve for alkali metals.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**COs**
1	**Practical (30 Hours)** 1. Determinations of Total Hardness of water sample (IS 3025: Part-21) 2. Determination of TS, TSS (IS 3025: Part- 17) and TDS (IS: 3025- Part- 16) in water samples 3. To determine the dissolved oxygen (DO) in water samples 4. To determine Biochemical Oxygen demand (BOD) of sample (IS 3025: Part- 44) 5. To determine Chemical oxygen demand (COD) of sample (IS 3025: Part-58) 6. Separation of amino acids by paper chromatography/TLC 7. Separation of dissolved solid particulate matter using centrifugation 8. Estimation of protein by Lowry/Bradford methods 9. Working, standardization of flame photometer and plotting calibration curve for alkali metals.	**30**	**CO504.1** **CO504.2** **CO504.3**

Text Books:

1. **Fresenius**, Wilhelm, **Quentin**, Karl E., **Schneider**, Wilhelm, "Water AnalysisA Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance; springer (1988).
2. Leo ML Nollet, Leen SP De Gelder, "Handbook of Water Analysis", CRC Press,Jun 2007
3. Standard Methods for the Examination of Water & Wastewater, APHA, AWWA, WEF
4. IS 3025: Part- 1 to 60.

Reference Books:

1. Kanwaljit Kaur, "Handbook of Water and Wastewater Analysis", Atlantic; Edition (1 January 2007).

SEMESTER-VI

Course Code: IWM 601	**Course Name:** Air and soil pollution Management	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**3rd year** **6thSemester**	**Contact hours per week:** (2Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Air and soil pollution understanding	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					
CO601.1	Understand the indoor and ambient air pollutants, methods of monitoring and control of air pollution. Learn about the working of High-volume air samplers, Air quality index, greenhouse gases, climate change & global warming.				
CO601.2	Learn about the management practices for industrial air pollutants, greenbelt and sources of vehicular emissions. Learn and understand about the air pollution mitigation technologies i.e. Catalytic converter. National and international pollution standards.				
CO601.3	Understand the soil pollutants, their types and effect on soil quality. Learn about the point and non- point sources of pollution.				
CO601.4	Understand the land degradation, Effect of sewage waste application on soil characteristics and crop responses. Learn about the heavy metal contamination in fertilizers and pesticides as soil pollutants.				
CO601.5	Learn & understand the different techniques of soil conservation, conservation of arable land, techniques of reclamation and restoration of contaminated soil, wasteland reclamation, soil salinity management, remedial measures of soil pollution.				
CO601.6	Understand and learn about Bioremediation- in situ, ex- situ, Legal measures for land conservation at national and international level.				

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	**Air pollution** Air pollutants, movement and diffusion of pollutants, Major air pollutants in India. Indoor air pollutants, Methods of monitoring and control of air pollution- SO_X, NO_X, CO and SPM, High volume air sampler, Air quality index, Greenhouse Gases, climate change and global warming, Case studies on Delhi air pollution.	**6**	**CO601.1**
2	**Management of industrial and vehicular emission pollution** Management practices for industrial air pollutants, Zoning of industries and greenbelt, Case study of an Industry; Principal engine emissions, Sources of engine/vehicular emissions, Air pollution control technologies- Mobile and stationary Sources, Catalytic converter, Pollution standards; nation and international.	**8**	**CO601.2**

3	**Industries & soil pollution** Definition, sources- point and non- point, soil pollutants - types and characteristics and their effect on soil; Land degradation, effect of sewage waste application on soil characteristics and crop responses, Industrial effluents and soil pollution, Heavy metal contaminants in fertilizers and pesticides as soil pollutants.	**8**	**CO601.3, CO601.4**
4	**Soil conservation and management** Strategies for soil conservation, conservation of arable land, techniques of reclamation and restoration of contaminated soil, wasteland reclamation, soil salinity management, remedial measures of soil pollution. Bioremediation- in situ, ex- situ, Legal measures for land conservation at national and international level.	**8**	**CO601.5, CO601.6**

Text Books:

1. Pallavi Saxena &Vaishali Naik, "Air PollutionSources, Impacts and Controls", CABI, December 2018.
2. M Rao& H.V.N. Rao, "Air Pollution", McGraw Hill Education; 1st edition (1 July 2017).
3. Ibrahim Mirsal, "Soil Pollution: Origin, Monitoring & Remediation", Springer; 2nd ed. 2008 edition (20 August 2008)

Reference Books:

2. Daniel Vallero, "Fundamentals of Air Pollution 5th Edition", Academic Press, 13th August 2014.
3. C.S. Rao, "Environmental Pollution Control Engineering", New Age International Publishers; Third edition (1 January 2018).
4. Irena Twardowska, Sebastian Stefaniak, Herbert E. Allen and Max M. Häggblom, "Soil and Water Pollution Monitoring, Protection and Remediation", Springer; 2006th edition (17 January 2007).
5. Rajat Sethi, "Air Pollution: Sources, Prevention & Health Effects (Air, Water and Soil Pollution Science and Technology: Pollution Science, Technology and Abatement)", Nova Science Publishers Inc; UK ed. edition (1 July 2013).
6. Helmut Meuser, "Soil Remediation and Rehabilitation: Treatment of Contaminated and Disturbed Land", Springer; 2013th edition (10 December 2012).

Course Code: IWM 602	**Course Name:** Environmental policies and laws	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**3rd year** **6thSemester**	**Contact hours per week:** (4 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Basic knowledge about env related laws	**Evaluation**			
		CIE: 50	**TEE: 50**		
Course Outcomes: On completion of the course, student would be able to:					
CO602.1	Learn about the Stockholm conference, UNEP and its functions.				

CO602.2	World Earth summit: Agenda 21, UNFCCC, Convention on climate change, Vienna Convention, Montreal protocol, RAMSAR convention, Eco mark scheme.
CO602.3	Understand the constitutional provisions for environmental protection.
CO602.4	Learn and analyze Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention & Control of Pollution) Act, 1981, Environmental (Protection) Act, 1986; Public insurance & Liabilities Act, 1991.
CO602.5	Understand the municipal solid waste management & handling rules, 2000, Hospital waste management, Biomedical waste (management and handling) rules, 1988. Fly ash Management Rules, (1999).
CO602.6	Learn and understand about hazardous waste and its physico- chemical properties, Hazardous waste control, treatment and management, Hazardous waste (management and handling) rules (1989) and (2016) amendments.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	**Conferences/Conventions related to environment** Stockholm conference, Creation of UNEP and its role, World Earth summit; Agenda 21, UNFCCC, Convention on Climate Change,Vienna convention, Montreal protocol, Basel convention, RAMSAR convention, Eco mark scheme.	**16**	**CO602.1, CO602.2**
2	**Environmental policy and laws in India** Constitutional provisions for environmental protection. Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention & Control of Pollution) Act, 1981, Environmental (Protection) Act, 1986; Noise rules…….	**16**	**CO602.3, CO602.4**
3	**Solid waste management plan** Municipal Solid Waste (management and handling) rules, 2016, Biomedical waste (management and handling) rules, 2016. Fly ash Management Rules, (2016). Construction and Demolition waste management rules,2016, Plastic (Waste Management and Handling) rules (2016)	**15**	**CO602.5**
4	**Hazardous waste management** Physico-chemical properties of hazardous waste needed in Management, Hazardous waste control, treatment and management, Hazardous waste (management and handling) rules (1989) and (2016) amendments., E-waste (Management), rules, (2016)	**13**	**CO602.6**

Text Books:

1. Universal's Legal Manual, "Environment and Pollution Laws (Containing Acts & Rules)", Universal Law Publishing - An imprint of LexisNexis (1 January 2015).
2. Sasikumar K, "Solid Waste Management", Prentice Hall India Learning Private Limited (1 January 2009).
3. Dr. Surendra Kumar, "Solid waste management", Northern Book Centre, 2009.

4. Michael D. Lagrega, Phillip L. Buckingham, Jeffrey C. Evans, Environmental Resources Management, "Hazardous Waste Management", Waveland Pr Inc; Reissue edition (1 July 2010).

Reference Books:

1. Divan Shyam, Rosencranz Armin, "Environmental Law and Policy in India: Cases, Material & Statutes", Oxford; Edition (1 February 2002).
2. Jonathan W. C. Wong; Rao Y. Surampalli; Tian C. Zhang; Rajeshwar D. Tyagi; and Ammaiyappan Selvam, "Sustainable Solid Waste Management", ASCE Books.
3. Gayle Woodside, "Hazardous Materials and Hazardous Waste Management", Wiley; 2nd edition (12 April 1999).

Course Code: IWM 603	**Course Name:** Hazardous, Radioactive and E-Wastes	**L**	**T**	**P**	**C**
		4	**-**	**-**	**4**
Year and Semester	**3rd year** **6thSemester**	**Contact hours per week:** (4 Hrs.) **Exam:** (3hrs.)			
Pre-requisite of course	Environment Pollution	**Evaluation**			
		CIE: 50	**TEE: 50**		

Course Outcomes: On completion of the course, student would be able to:	
CO603.1	Learn about definition, sources, types and different- different categories of hazardous waste.
CO603.2	Analyze and understand the sampling, hazardous waste survey, handling, storage and transport and TSDF Concept.
CO603.3	Learn about the physical, chemical and thermal treatments technologies of hazardous waste.
CO603.4	Understand about the hazardous waste landfilling site selection, design and operation. Hazardous waste reduction, recycle and re-use and regulatory aspects of hazardous waste management.
CO603.5	Learn about radioactive waste, its definition, sources, low level and high radioactive waste, their management and radiation standards by ICRP & AERB.
CO603.6	Understand the e-waste, its characteristics, sources of generation, impacts of the e-waste on the environment, WEEE (Waste electrical and electronic equipment), Collection, transport and recycling of e-waste.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**COs**
1	**Hazardous waste** Definition, sources, types and characterization categories and control. Sampling and analysis of hazardous wastes: analytical approach for hazardous waste characterization, proximate analysis, survey analysis, directed analysis, analytical methods. Collection. handling, storage and transport, TSDF concept.	**16**	**CO603.1, CO603.2**
2	**Hazardous waste management** Hazardous waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste: solidification,	**16**	**CO603.3, CO603.4**

	chemical fixation, encapsulation, pyrolysis and incineration. Hazardous waste landfills- Site selections, design and operation. HW reduction, recycling and reuse, Regulatory aspects of HWM. Biomedical waste: Definition, sources, classification, collection, segregation, treatment and disposal.		
3	**Radioactive waste management** Radioactive waste: Definition, Sources, Low level and high-level radioactive wastes and their management, Radiation standard byICRP and AERB.	**12**	**CO603.5**
4	**E-Waste management** Introduction, WEEE (Waste electrical and Electronic Equipment), e-waste characteristics, generation, collection, transport, recycling and disposal methods. Effects of e-wastes on the environment. Plastic waste: Plastic Waste – Sources, Production, Global and Indian Context; Plastic management- recycling, energy production, landfilling. Green synthetic approaches for the preparation of environmentally friendly polymers.	**16**	

Text Books:

1. Stephen M. Roberts (Author), Christopher M. Teaf (Author), Judy A. Bean (Author), "Hazardous Waste Incineration: Evaluating the Human Health and Environmental Risks", CRC Press; 1st edition (19 November 1998).
2. Charles A. Wentz, "Hazardous Waste Management", McGraw-Hill Inc.,US (1 April 1989).
3. James Saling, "Radioactive Waste Management", CRC Press; 2nd edition (7 November 2001).
4. Hosam El-Din Saleh, "Assessment and Management of Radioactive and Electronic Wastes", IntechOpen (8 January 2020).
5. Jalelwad Pooja (Author), Awati Jayashree (Author), "E-Waste Management", LAP Lambert Academic Publishing (7 December 2015).

Reference Books:

1. John Pichtel, "Waste Management Practices: Municipal, Hazardous, and Industrial, Second Edition", CRC Press; 2nd edition (31 March 2014).
2. Debashish Sengupta, Brajesh K. Dubey, Sudha Goel, "Treatment and Disposal of Solid and Hazardous Wastes", Springer; 1st ed. 2020 edition (12 March 2021).
3. Klaus Hieronymi, RamzyKahhat, Eric Williams, "E-Waste Management: From Waste to Resource", Routledge; 1st edition (22 May 2012).
4. Robert E. Berlin, Catherine C. Stanton (Author), "Radioactive Waste Management", Wiley–Blackwell (5 April 1989).

Course Code:	**Course Name:** Practical	**L**	**T**	**P**	**C**
IWM 604		**2**	**-**	**-**	**2**

Year and Semester	**3rd year 6thSemester**	**Contact hours per week:** (2 Hrs.) **Exam:** (3hrs.)	
Pre-requisite of course	Air, water and soil parameters	**Evaluation**	
		CIE: 50	**TEE: 50**
Course Outcomes: On completion of the course, student would be able to:			
CO604.1	Learn and analyze the sampling techniques, various physical-chemical parameters of water/wastewater.		
CO604.2	Understand and learn the monitoring of particulate matter (PM 2.5 and PM 10) in air, sampling & analysis of gaseous air pollutants.		
CO604.3	Analyse the heavy metals in water/wastewater using AAS instruments.		
CO604.4	Understand the analysis of biological activities in water/wastewater i.e. bacteria, algae and protozoa.		
CO604.5	Learn and understand the working culture of a composting/vermicomposting unit, biogas plant and wastewater treatment plant by visits.		

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs.	COs
1	**Practical** 1. Sample preparation and sampling techniques 2. Determination of various physico-chemical parameters of water/wastewater. 3. Determination of particulate air pollutants (PM 2.5 and PM l0). 4. Determination of gaseous air pollutants (SOx, NOx, O3, NH3, CO). 5. Determination of heavy metals in water/wastewater samples using AAS. 5. Biological examination of water/wastewater: Algae, bacteria and protozoa. 7. A visit to a local vermicomposting/composting unit. 8. A field visit to the biogas plant/waste recycling unit.	**30**	**CO604.1, CO604.2, CO604.3, CO604.4, CO604.5**

Text Books:

1. Fresenius, Wilhelm, Quentin, Karl E., Schneider, Wilhelm, "Water AnalysisA Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance; springer (1988).
2. Leo ML Nollet, Leen SP De Gelder, "Handbook of Water Analysis", CRC Press, Jun 2007

Reference Books:

1. Kanwaljit Kaur, "Handbook of Water and Wastewater Analysis", Atlantic; Edition (1 January 2007).
2. CENTRAL POLLUTION CONTROL BOARD Ministry of Environment & Forests, "Guidelines for the Measurement of Ambient Air Pollutants, Vol. I", P R Division, Central Pollution Control Board on behalf of Sh. J. S. Kamyotra, Member Secretary, CPCB, 2013.

Skill Education Component

Semester I

Skill Qualification pack

Sector Skill Council: Green Jobs

Job Role: Wastewater Treatment Plant Technician

NSQF Level: 4

Qualification pack Code: SGJ/Q6601

National Occupation Standards

1. SGJ/Q6601: Operation of Waste Water Treatment Plant
2. SGJ/Q6602: Monitor and maintenance of Waste Water Treatment Plant
3. SGJ/Q6605: Work Safety at Wastewater Treatment Plant

Semester II

Skill Qualification pack

Sector Skill Council: Green Jobs

Job Role: Water Quality Testing Technician

NSQF Level: 5

Qualification pack Code: SGJ/Q6603

National Occupation Standards

1. SGJ/Q6607: Testing and Analysis of Water Sample
2. SGJ/Q6608: Calibrate and Maintain water testing apparatus
3. SGJ/Q6609: Maintain Personal Health and Safety

Semester III & IV

Skill Qualification pack

Sector Skill Council: Green Jobs

Job Role: Manager- Waste Management

NSQF Level: 6

Qualification pack Code: SGJ/Q6501

National Occupation Standards

1. SGJ/N6501: Carry out market analysis
2. SGJ/N6503: Ensure compliance with applicable statutory laws, policies and procedures
3. SGJ/N6504: Ensure health and safety at workplace
4. SGJ/N6505: Manage overall operations of biomass depot
5. SGJ/N6506: Manage overall operations of compost yard
6. SGJ/N6507: Manage overall operations of dry waste collection center

Semester V & VI

Skill Qualification pack

Sector Skill Council: Green Jobs

Job Role: Plant Incharge (Wastewater Treatment Plant)

NSQF Level: 7

Qualification pack Code: Aligned to NSQF level 7

National Occupation Standards

1. An Overview of water and wastewater treatment
2. Water and wastewater quality testing
3. Hydraulic Design and Calculations
4. Design Calculations for Components of wastewater treatment plant
5. Environment Health and Safety (EHS)
6. Quality and Environment management systems (QMS-EMS) as per International and Indian standards
7. Management and co-coordination of the activities at a wastewater treatment plant