Syllabus

B. Voc.

(INDUSTRIAL WASTE MANAGEMENT)

(w.e.f. July 2018)

Deen Dayal Upadhyay KAUSHAL Kendra

Central University of Haryana
Mahendergarh, Haryana

CENTRAL UNIVERSITY OF HARYANA

Deen Dayal Upadhyay KAUSHAL Kendra

B. Voc. (INDUSTRIAL WASTE MANAGEMENT)

(Semester-wise Course Structure)

(w.e.f. July 2018)

Module Code	Name of Course	Credits (T+P)	Marks
YEAR – 1, SEMESTER – I			
GENERAL EDUCATION COMPONENT			
IWM-101	Introductory Biology	**4** (4+0)	100
IWM-102	Concepts in Chemistry	**4** (4+0)	100
IWM-103	English Communication	**2** (2+0)	50
IWM-104	Practical	**2** (0+2)	50
	TOTAL	**12**	300
SKILL COMPONENT			
NSQF level 4 Job role "Wastewater Treatment Plant Technician"		**18**	
YEAR – 1, SEMESTER – II			
GENERAL EDUCATION COMPONENT			
IWM-201	Instrumentation Techniques-I	**4** (4+0)	100
IWM-202	Environmental Science	**4** (4+0)	100
IWM-203	Environmental Pollution	**2** (2+0)	50
IWM-204	Practical	**2** (0+2)	50
		12	300
SKILL COMPONENT			

NSQF level 5 Job role "Water Quality Testing Technician"		**18**	---------
YEAR – 2, SEMESTER – III			
GENERAL EDUCATION COMPONENT			
IWM-301	Environmental Chemistry	**4** (4+0)	100
IWM-302	Fundamentals of Mathematics and Statistics	**2** (2+0)	50
IWM-303	Microbiology	**4** (4+0)	100
IWM-304	Practical	**2** (0+2)	50
	TOTAL	**12**	300
SKILL COMPONENT			
NSQF level 6 Job role "Manager-Waste Management"		**18**	---------
YEAR – 2, SEMESTER – IV			
GENERAL EDUCATION COMPONENT			
IWM-401	Bioprocessing and Utilization of Agricultural Wastes	**2** (2+0)	50
IWM-402	Solid Waste Management	**4** (4+0)	100
IWM-403	Pollution Control and Management	**4** (4+0)	100
IWM-404	Practical	**2** (0+2)	50
	TOTAL	**12**	300
SKILL COMPONENT			
NSQF level 6 Job role "Manager-Waste Management"		**18**	---------
YEAR – 3, SEMESTER – V			
GENERAL EDUCATION COMPONENT			
IWM-501	Industrial Health and Safety	**2** (2+0)	50
IWM-502	Wastewater Management	**4** (4+0)	100
IWM-503	Instrumentation Techniques-II	**4** (4+0)	100

IWM-504	Practical	**2** (0+2)	50
	TOTAL	**12**	300
SKILL COMPONENT			
NSQF level 7 Job role "Plant In-charge (Wastewater Treatment Plant)"		**18**	----------
YEAR – 3, SEMESTER – VI			
GENERAL EDUCATION COMPONENT			
IWM-601	Air and Soil Pollution Management	**2** (2+0)	50
IWM-602	Environmental Policies and Laws	**4** (4+0)	100
IWM-603	Hazardous, Radioactive and E-waste Management	**4** (4+0)	100
IWM-604	Practical	**2** (0+2)	50
	TOTAL	**12**	300
SKILL COMPONENT			
NSQF level 7 Job role "Plant In-charge (Wastewater Treatment Plant)"		**18**	----------

IWM 101 **Credits: 4**

INTRODUCTORY BIOLOGY

Unit 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.

Unit 2: Classification of life

Biological classification: Prokaryotes, Eukaryotes, Archaea, Viruses- animal viruses and microbial virus (bacteriophage), viroids and lichens; Kingdoms of Life: Five kingdoms- Monera, Prostita, Fungi, plantae and animalia.

Animalia: Classification and its basis, General survey of Animal kingdom, 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.

Unit 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).

Unit 4: Energy metabolism

Grouping of organisms based on energy need and mineral nutrition; Biochemical pathway- Oxidation, reduction reactions, NAD^+, Free energy, ATP, Fermentation, Respiration (Aerobic/Anaerobic), Glycolysis, Enzyme activity; Photosynthesis process.

IWM 102

Credits: 4

CONCEPTS IN CHEMISTRY

Unit 1:

Periodic Properties: position of elements in the periodic table, Atomic and ionic radii, ionization energy, electron affinity and electronegativity definition, trends in periodic table and applications in predicting chemical behaviour. Introduction and IUPAC nomenclature of coordination compounds, isomerism in coordination compounds, stereochemistry of complexes with 4 and 6 coordination numbers, Werner's coordination theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding, chelate effect

Unit 2:

Thermodynamics: First law, second law and third law of thermodynamics, concept of enthalpy and entropy, Hess's law; 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, van't hoff reaction isotherm, van't Hoff Equation; Ionic Equilibrium-Acids, bases, pH scale,

Unit 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

Unit 4:

Analytical Chemistry: Significant figures, Accuracy & precision, methods of expressing concentration-molarity, molality, w/v,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.

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IWM 103

Credits: 2

ENGLISH COMMUNICATION – I

UNIT 1:

Communication Skills: Introduction, Definition, The importance of communication, The communication process – Source, Message, Encoding, Channel, Decoding, Receiver, Feedback, Context. 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

UNIT 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 matrix with example. For each – Direct communication style, Spirited communication style, Systematic communication style, Considerate communication style..

UNIT 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.

UNIT 4:

Interview Skills: Purpose of an interview, Do's and dont'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 dont's of group discussion. Correspondence: Personal, official and business, report writing, drafting an email, writing of C.V.

IWM 104 **Credits: 2**

PRACTICAL

(Wherever wet lab experiments are not possible the principles & concepts can be demonstrated through any other materials or medium including videos/ virtual labs etc.)

1. Calibration of volumetric glasswares Pipette, Burette and Volumetric flask.
   Preparation of Standard solutions
2. Preparations of Buffers
3. Determination of pKa value of acid
4. Simple volumetric redox titrations
5. To learn principles of fixation and staining
6. Identification of permanent slides (cell organelles, DNA etc.)
7. Slides of life cycle of Plasmodium and amoeba
8. Qualitative test for identification of carbohydrates, amino acids, lipids and DNA
9. Preparation of $[Ni(en)_2]Cl_2 \cdot 2H_2O$ complex.
10. Adsorption of acetic acid on charcoal

IWM 201

Credits: 4

INSTRUMENTATION AND TECHNIQUES-I

Unit 1: Sample collection method

Defining of the problem and designing of analytical method; Sampling: Types and methods for collection of Air, Water and Soil samples; Sample storage; Sample preparation; reservation, measurement and assessing of data; Good laboratory practices.

Unit 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.

Unit 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.

Unit 4: Basic Microscopy and Spectroscopy

Optical Microscopy (Light, Bright field, Darkfield, Phase Contrast, Fluorescence, Confocal);

Principle, working and applications of UV-Visible spectrophotometer.

IWM 202

Credits: 4

ENVIRONMENTAL SCIENCE

Unit 1: Introduction to Environmental Science

The multidisciplinary nature of Environmental Studies. Definition, scope and importance, need for public awareness

Unit: 2: Natural Resources

Renewable and non-renewable resources: Land resources: Land as a resource, land degradation, soil erosion and desertification. Forest resources: Use and over-exploitation, deforestation, case studies. Water resources: Use and over-utilization of surface and ground water

Unit 3: Ecosystems

Concept of an ecosystem. Structure and function of an ecosystem. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids.

Unit 4: Biodiversity and its Conservation

Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Hot-spots of biodiversity. Values of biodiversity, Threats to biodiversity, Endangered and endemic species of India. Conservation of biodiversity.

Unit 5: Environmental Pollution

Definition, Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Nuclear hazards. Solid waste management

Unit 6: Environment policies & laws

Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

Unit 7: Human Population and Environment

Human population growth, population explosion, Impacts on environment, human health and welfare. Environmental movements: Chipko, silent valley, Bishnois of Rajasthan.

Unit 8: Field Work

Visit to a local polluted site: Urban/Rural/Industrial/Agricultural.

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IWM 203

Credits: 2

ENVIRONMENTAL POLLUTION

Unit 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 study, E-wastes as water pollutant.

Unit 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 and case study. E-wastes as soil pollutant.

Unit 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 study.

Unit 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 study.

IWM 204 **Credits: 2**

PRACTICAL

(Wherever wet lab experiments are not possible the principles & concepts can be demonstrated through any other materials or medium including videos/ virtual labs etc.)

1. To determine the λ max of an unknown solution and verification of Beers law.
2. Methods for the collection of waste and soil samples.
3. Determination of pH and Temperature of soil and water samples.
4. Determination of Electrical Conductivity (EC) of soil and water samples.
5. Determination of salinity in soil and water samples.
6. Determination of Moisture content and water holding capacity of soil.
7. Determination of MPN for water samples.
8. Use of microscope: study of plant and animal cells.
9. Study of various sterilization techniques
10. Working, standardization of Spectrophotometer and plotting calibration curve for water samples.

IWM 301

Credits: 4

ENVIRONMENTAL CHEMISTRY

Unit 1: Chemistry for Environment

Fundamental of environmental chemistry: Mole concept, Solution chemistry, solubility product, Solubility of gases, Phase change thermodynamics, Electrochemistry and redox reactions, Gibbs' free energy; Chemical potential; Activity and fugacity, Chemical kinetics and chemical equilibrium.

Unit 2: 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 photooxidation, hydrocarbons in atmospheric photo-chemistry, oxidants in photochemical smog. Hydrocarbon reactivity. radioactivity in the atmosphere and air pollution chemistry.

Unit 3: Water Chemistry

Solubility products, Solubility of gases in water, carbonate system in water Water acidity and carbon-dioxide in water, alkalinity, BOD, COD, DO determinations, water pollution due to heavy metals, organic pollutants, pesticides and radionuclides.

Unit 4: 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 (Chemisorption), Complexations, Chelation; Precipitation / dissolution. Environmental geochemistry: Concept of major, trace and REE. Classification of trace elements, Mobility of trace elements, Geochemical cycles.

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IWM 302 **Credits: 2**

FUNDAMENTALS OF MATHEMATICS AND STATISTICS

Unit 1:

Sets, Relation and function, Quadratic equation, Average, Ratio and Proportions, Percentage, Profit/ Loss and Discount, Simple interest and compound interest

Unit 2:

Accuracy and precision, Significant figures, Errors, Vectors and 3-D, Integration (Definite and Indefinite integration), Area under the graph, Differentiation, Probability, Tabulation, Line graph, Bar graph and Mixed graph.

Unit 3

Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.

Unit 4

Data, Sampling, and study design, Measures of central tendency- mean, mode and median; dispersion (including box and whisker plot), skewness and kurtosis.

IWM 303 **Credits: 4**

MICROBIOLOGY

Unit 1.

Introduction: Definition and scope of microbiology, Microbial diversity in the environment, classification, role of microbes in environmental protection, management of resources, bioindicators, biosensors - types and applications in environmental pollution detection and monitoring. Gram positive and Gram negative bacteria.

Unit 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.

Unit 3.

Applications of microbes: Application of natural and genetically engineered micro-organisms from extreme environment: like thermophiles, alkalophiles; acidophiles, and halophiles in waste treatment of different industries. Biofuel production (bioethonal, biogas, biohydrogen etc), Fermentation, Petroleum pollutant biodegradation. Microbial leaching of low grade mineral ores, Petroleum pollutant and Improved oil recovery.

Unit 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, Trypanosoma), Parasitic infections (Candida, Aspergillus).

IWM 304 **Credits: 2**

PRACTICAL

(Wherever wet lab experiments are not possible the principles & concepts can be demonstrated through any other materials or medium including videos/ virtual labs etc.)

1. To determine cations (Na and K) in soil/ water.
2. To determine anions (sulfate, nitrate and fluoride) in soil/ water.
3. To determine phenol compounds and total/Kjeldahl nitrogen in water/wastewater.
4. To determine total phosphate in wastewater.
5. Determination of chloride content in soil/ water.
6. Preparation of media – solid (LA), liquid (LB) and autoclaving.
7. Isolation of bacteria by streaking method.
8. Characterization of microbes by colony characterization/staining methods
9. Inoculation of polluted water samples.
10. Gram's staining and acid fast staining (permanent slide only).
11. Preparation of bacterial culture for storage (glycerol stock, slants).

IWM 401 **Credits: 2**

BIOPROCESSING AND UTILIZATION OF AGRICULTURE WASTE

Unit 1:

Agriculture waste, biomass properties, Agro forestry for Bio-Energy, biomass, uses, energy from solid waste, Cell wall and plant anatomy. Various methods used for the treatment of agricultural waste.

Unit 2:

Biomass pretreatment/fractionation, dilute acid pretreatment, Steam explosion pretreatment, Biological pretreatment.

Unit 3:

Type of Biogas plants, Biogas production technique, materials used for biogas production, handling of slurry, optimization of solid waste Ratio for maximum Biogas production. Various types of biomass cook stoves, rural energy needs.

Unit 4:

Biochemical conversion of lignocellulose to alcohol and biohydrogen, fermentation, Consolidated Bioprocess (CBP). Energy plantation and biofuel.

IWM 402 **Credits: 4**

SOLID WASTE MANAGEMENT

Unit-1

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.

Unit-2

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.

Unit-3:

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.

Unit-4:

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.

IWM 403 **Credits: 4**

POLLUTION CONTROL AND MANAGEMENT

Unit 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

Unit 2: Air Pollution control: Source correction methods, Control methods for particulates-gravitational settling chambers, Centrifugal collectors, Wet collectors, Fabric filters, electrostatic precipitators. Control methods for gaseous pollutants- adsorption, absorption, condensation, combustion.

Unit 3: Noise Pollution control: Absorbing materials, barrier materials, damping materials, acoustical enclosures, Reactive silencers and filters; Active noise control methods.

Unit 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.

IWM 404 **Credits: 2**

PRACTICAL

(Wherever wet lab experiments are not possible the principles & concepts can be demonstrated through any other materials or medium including videos/ virtual labs etc.)

1. Coning and quartering method.
2. Characterization of municipal solid waste.
3. Analysis of solid waste/sludge for moisture content.
4. Analysis of solid waste /sludge for particle size.
5. Determination of TSS, TS, TDS, VSS and total settable solids in water samples.
6. Bacterial water quality: Measuring quality of water by using coliform organisms (MPN).
7. Indicator and Indices: Fecal streptococci, anaerobic bacteria.
8. Flocculation and coagulation studies of wastewater samples.
9. Determination of Total organic carbon (TOC) in soil and wastewater samples.
10. Determination of Total Alkanity in water and wastewater samples.

IWM 501

Credits: 2

INDUSTRIAL HEALTH AND SAFETY

Unit 1:

Introduction: - Occupational environment and its relation to health, Safety education and training, 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.

Unit 2:

Hazards: Physical hazards: Unsafe handling, Housekeeping, Ergonomics. Chemical Hazards: Classification of hazardous chemicals, transportation of hazardous chemicals, hazchem code, storage and handling of hazardous substances, Major accidents involving hazardous substances.

Unit 3:

Plant safety: Personal protection equipment: Non respiratory protective equipments and respiratory protective equipments, Emergency preparedness (on-site & off-site), Plant safety inspections and safety audits.

Unit 4:

Legislation measures: Occupational Health and Safety Standards, The workmen's Compensation Act, 1923, The factory Act, 1948, The Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2016.

IWM 502 **Credits: 4**

WASTEWATER MANAGEMENT

Unit 1:

Introduction: Self-purification of water bodies, Need of wastewater treatment, Classification, sources of water pollutants, Wastewater flow and its characteristics, Wastewater collection systems, Estimation and variation of wastewater flows. Problems of industrial wastewaters, Sampling protocol, Indian standards for disposal of treated wastewaters on land and in natural streams.

Unit 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.

Unit 3:

Secondary treatment: Physico-chemical and biological treatment strategies and their evaluation, Membrane bioreactors (MBR), Moving bed biological reactors (MBBR), anaerobic baffled reactor (ABR). Activated sludge process (ASP), extended aeration systems, trickling filters (TF), Rotating Biological Contactors, oxidation ditches/ponds, sequential batch reactor, root zone treatment, Upflow anaerobic sludge blanket (UASB) reactor.

Unit 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; Ion exchange; Advanced oxidation process: Photocatalysis, ozonation – ozone/UV, ozone/hydrogen peroxide, hydrogen peroxide/UV, applications, oxidation of refractory organic compounds.

IWM 503 **Credits: 4**

INSTRUMENTATION AND TECHNIQUES-II

Unit 1: Centrifugation

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges-Table top centrifuge, refrigerated centrifuged, Different types of motors, Differential centrifugation, Density gradient centrifugation.

Unit 2: Chromatography

Principles, working and applications of Chromatographic techniques -Paper chromatography, thin layer chromatography, Column chromatography Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography.

Unit 4: Advanced Microcopy and Spectroscopy: Electron Microscopy (Scanning and Transmission Electron Microscopy); Principle, working and applications of Spectrophotometry, UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry, Fluorometry.

Unit 4: Radioisotopes

Radioactivity, Principles of Radioactivity, Types of radioactivity, Geiger Mueller (GM) Detectors, Alpha Radiation Survey Meter, Dose Rate Meter, Scintillation counters.

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IWM 504 **Credits: 2**

PRACTICAL

(Wherever wet lab experiments are not possible the principles & concepts can be demonstrated through any other materials or medium including videos/ virtual labs etc.)

1. Determinations of Total Hardness of water sample
2. Determination of TS, TSS and TDS in water samples
3. To determine the dissolved oxygen (DO) in water samples
4. To determine Biochemical oxygen demand (BOD) of sample
5. To determine Chemical oxygen demand (COD) of sample
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.

IWM 601

Credits: 2

AIR AND SOIL POLLUTION MANAGEMENT

Unit 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.

Unit 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/Vehicle Emissions, Air pollution control technologies- Mobile and Stationary Sources, Catalytic Converter, Pollution standards: national and international

Unit 3: Industries and 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.

Unit 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 for soil pollution, bioremediation- in-situ, ex-situ, Legal measures for land conservation at national and international level.

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IWM 602 **Credits: 4**

ENVIRONMENTAL POLICIES AND LAWS

Unit 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, RAMSAR convention, Eco mark scheme.

Unit 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; Public Insurance & Liabilities Act, 1991.

Unit 3:

Solid waste management plan, Municipal Solid Waste (management and handling) rules, 2000, Hospital waste management, Biomedical waste (management and handling) rules, 1988. Fly ash Management Rules, (1999

Unit 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.

IWM 603 **Credits: 4**

HAZARDOUS, RADIOACTIVE AND E-WASTES

UNIT 1: Hazardous Wastes:

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.

UNIT 2: Hazardous Wastes Management:

Hazardous waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste: solidification, 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.

UNIT 3: Radioactive Waste Management:

Radioactive waste: Definition, Sources, Low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB.

Unit 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.

IWM 604 **Credits: 2**

PRACTICAL

(Wherever wet lab experiments are not possible the principles & concepts can be demonstrated through any other materials or medium including videos/ virtual labs etc.)

1. Sample preparation and sampling techniques
2. Determination of various physic-chemical parameters of water/wastewater
3. Determination of particulate air pollutants (PM 2.5 and PM 10)
4. Determination of gaseous air pollutants
5. Determination of heavy metals in water/wastewater sample using AAS
6. Biological examination of water/wastewater: Algae, bacteria and protozoa
7. A visit to a local vermicomposting/composting unit
8. A field visits to biogas plant/waste recycling unit