VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. ENVIRONMENTAL SCIENCE

With Effect from July 2008-2009

Syllabus

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. ENVIRONMENTAL SCIENCE

1. The course will run on semester basis
2. Each semester will be of fourteen weeks (14). The whole course will be of two years. (i.e. Four Semester)
3. Proposed teaching and examination scheme will be as per annexure-I
4. Examination system and passing standards will be as per annexure-II

Eligibillity

Candidates with Bachelor's Degree of a recognized University in Bio-Sciences/ Life Sciences, Chemistry, Zoology, Botany, Microbiology, Environmental Sciences, Medical Technology, Bio-Technology, Engineering with at least 50% marks will be Eligible.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. ENVIRONMENTAL SCIENCE

First Semester

Course No.	Course Title	Marks
Ens. 101	Fundamentals of Environmental Science& Ecology	100
Ens. 102	Environmental Chemistry	100
Ens. 103	Environmental Microbiology	100
Ens. 104	Analytical Techniques	100
Ens. 105	Practicals	150

Second Semester

Course No.	Course Title	Marks
Ens. 201	Water and Wastewater Management	100
Ens. 202	Biotechnology & Environmental Health, Safety	100
Ens. 203	Statistical Methods and Computer based Modeling	100
Ens. 204	Instrumental Methods of Analysis	100
Ens. 205	Practicals	150

Third Semester

Course No.	Course Title	Marks
Ens. 301	Solid and Hazardous Waste Management	100
Ens. 302	Air Pollution and Control	100
Ens. 303	Industrial Waste Water Treatment	100
Ens. 304	Operation-Maintenance	100
Ens. 305	Practicals	150

Fourth Semester

Course No.	Course Title	Marks
Ens. 401	Environmental Management, Legislation and Policy	100
Ens. 402	Dissertation	400

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M.Sc. ENVIRONMENTAL SCIENCE

Teaching and Examination Scheme

First Semester

Course No.	Course Title	Theory (hrs/wk)	Practical (hrs/wk)	External	Internal	Total
Ens. 101	Fundamentals of Environmental Science& Ecology	4	_	70	30	100
Ens. 102	Environmental Chemistry	4	_	70	30	100
Ens. 103	Environmental Microbiology	4	_	70	30	100
Ens. 104	Analytical Techniques	4	_	70	30	100
Ens. 105	Laboratory/Practical	_				
Total		**16**	**14**	**430**	**165**	**550**

Second Semester

Course No.	Course Title	Theory (hrs/wk)	Practical (hrs/wk)	External	Internal	Total
Ens. 201	Water and Wastewater Management	4	_	70	30	100
Ens. 202	Biotechnology & Environmental Health, Safety	4	_	70	30	100
Ens. 203	Statistical Methods and Computer based Modeling	4	_	70	30	100
Ens. 204	Instrumental Methods of Analysis	4	_	70	30	100
Ens. 205	Laboratory/Practical	_	14	150	45	150
Total		**16**	**14**	**430**	**165**	**550**

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Teaching and Examination Scheme

Third Semester

Course No.	Course Title	Theory (hrs/wk)	Practical (hrs/wk)	External	Internal	Total
Ens. 301	Solid and Hazardous Waste Management	4	_	70	30	100
Ens. 302	Air Pollution and Control	4	_	70	30	100
Ens. 303	Industrial Waste Water Treatment	4	_	70	30	100
Ens. 304	Operation-Maintenance	4	_	70	30	100
Ens. 305	Laboratory/Practical	_	14	70	30	100
Total		**16**	**14**	**350**	**150**	**550**

Fourth Semester

Course No.	Course Title	Theory (hrs/wk)	Practical (hrs/wk)	External	Internal	Total
Ens. 401	Environmental Management, Legislation and Policy	4	_	70	30	100
Ens. 402	Dissertation		_	280	120	400
Total			**_**	**350**	**150**	**500**

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. Environmental Science

FIRST SEMESTER

Ens.: 101 Fundamentals of Environmental Science& Ecology

Section I

1. **Environmental Components**

   Regions of Atmosphere-Troposphere, Stratosphere, Mesosphere and Thermosphere Their Boundaries and Temperature Profiles

   Composition of Atmosphere, Hydrosphere and Lithosphere.

   Important Terms- Pollutant, Contaminant, Source, Sink, Receptor, Speciation, Threshold Limit Value (TLV).

2. **Global Issues related to Environment:**

   Ozone Depletion

   Greenhouse Effect and Global Warming

   Acid Rain

3. **Bio-geochemical cycles:** Sulfur, Carbon, Nitrogen, Phosphorus, Oxygen,

4. **Energy**

   Renewable Sources of Energy (Wood, Hydropower, Wind power, Geothermal Energy, Solar Energy, Tidal and Wave power, Nuclear Energy)

   Renewable source- A promising approach in sustainable development

   Non-renewable Sources of Energy (Fuels, Fossil Fuels, Petroleum products, Natural Gas),

   Bio-fuels: Introduction, Production and Application of Gasohol, Bioethanol, Biodiesel, Hydrogen and Biogas, Bioconversion of agriculture waste

Section II

5. **Basic concepts of Ecology:**

   Definition, Scope of Ecology

   Matter and energy in the environment,

   Laws of thermodynamics

6. **Wet Lands** of India, Types, Important and conservation of Wet Lands,

   Arid and Semi Arid Habitats of India- Definitions, Distribution, Ecological Status, Vegetation, and their Conservation,

   Wild Life conservation, Protected areas and protected species in India,

Reason for the loss of wild life in India,

Important project in Conservation of Wild Life in India,

Role of Local communities in Wild Life Management

7. Principle and concept of Ecosystem:

Energy flow in ecosystem, productivity concept,

Food chain, food web and trophic levels.

Habitats in the ecosystem: Fresh water, marine, estuarine, terrestrial,deserts.

Ecological pyramids; limpiting factors, laws and combined concept of limiting factors

Population dynamics, Communities

References

1. Environmental Chemistry- A.K De, (6^{th} Edition), New Age International.
2. Environmental Chemistry- B.K sharma (9^{th} Edition), Krishna Prakashan
3. Ecology: Principles and applications, Chapmen and Reis.
4. Chemistry for Environmental Engineering and Science, C.N Sawyer, P. L. McCarty and G. F. Parkin (5th Ed.) Tata -McGrill Hill
5. Principles of environmental science, Cunningham and Cunningham,
6. Paradigms Lost: Theory Change in Ecology, Eds. K. Cuddington & B. E. Beisner Elsevier A. P.,
7. Fundamentals of Ecology, Eugene P. Odum, (5^{th} Edition), Thomson Brooks Cole
8. Principles of Terrestrial Ecosystem-Ecology, F. S. Chapin, P. Matson & H. A. Moogey, Springer
9. Modern Concepts of Ecology, H. P. Kumar, 2005, Vikas Publishing House Pvt. Ltd.
10. Ecology: Theories and Applications, Peter D. Stiling, 4th Edition, PHI
11. Text book of environmental chemistry, Singh A
12. Essentials of ecology and environment science, S. V. S. Rana, 2005, PHI
13. Renewable Energy Sources and their Environmental Impact, S. A. Abbasi & N. Abbasi, 2006, PHI
14. Ecology and vegetation of Indian desert, Sen, D.N.

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M.Sc. Environmental Science

FIRST SEMESTER

EnS.: 102 Environmental Chemistry

Section: I

1. **Atmospheric Chemistry:**

   Particles, ions and radicals in the atmosphere,

   Chemical and photochemical reaction in the atmosphere

   - Oxygen and ozone chemistry
   - Sulphur dioxide
   - Nitrogen oxides
   - Organic compounds

2. **Hydrosphere (Aquatic) Chemistry:**

   Geometry of water molecule

   Water- The Universal Solvent

   Physical chemistry of sea water- composition, pH, pE

   Complexation in natural water and waster water

   Humic substances

3. **Lithosphere/ Soil Chemistry:**

   Composition of Soil

   Water and Air in soil

   Inorganic and organic components in soil

   Acid- base and ion exchange reaction in soil

   Micronutrients and macro nutrients

   Nitrogen pathways and NPK in soil

   Wastes and pollutants in soil

4. **Chemical Toxicology**

   Toxic Chemicals in the Environment – Air, Water

   Impact of toxic chemicals on Enzymes

   Biochemical effects of As, Pb, Hg, CO, NO_x , SO_2, Ozone, PAN, CN^-

   Biochemical effects of Pesticides- mode of action of Insecticide, DDT in food chain, Methyl Iso Cyanate

Section: II

5. Surfactants

Classification – Anionic, Cationic, Nonionic surfactants

Cleansing action of Surfactants

Analysis of Surfactants in wastewater by – specific properties i.e. surface tension, foaming- chemical methods to determine anionic surfactants i.e. methylene blue, sulfate determination by turbidity – For nonionic surfactants IR, GC, complex formation method, Miscellaneous methods – BOD, COD, combustion, microbial growth

Degradation of cationic, anionic, nonionic surfactants

Toxicity mechanism- mechanism of Enzyme inhibition

Use in pesticide and herbicide industry

Role in Eutrophication

Modified detergents

6. Polymers

Classification of Polymers

Preparation , properties and Uses of - PVC - Polyethylene
Polypropylene - Buna-S - Buna-N - Polystyrene - Nylon:- - Polyesters
-Teflon

Polymer Decay- biological (microbial) decomposition- nonbiological (oxidation) decomposition, biochemical decomposition, mechanical decomposition

Ecological consideration

Photosensitized additives

Biodegradable and Bio-non-degradable Polymers

5. Fundamentals of General and Physical Chemistry

Chemical Equilibrium - Factors Affecting - Ways of Shifting Chemical Equilibria

Electrochemistry - current flow in solution- conductivity- current and chemical change (electrolysis of HCl solution)- electrochemical cell- galvanic protection

Chemical kinetics- order of reactions i.e. zero order, first order, gas liquid mass transfer kinetics, second order reactions- consecutive reactions- enzyme reactions- temperature dependence of reaction rates

Solvents Extraction

Thermodynamics –first and second law of thermodynamic- Enthalpy- Entropy- Gibbs free Energy.

Environmental Applications of above topics

References

1. Environmental Chemistry: Stanley. E. anahan, 6th Edition, lewis Publishers.
2. Environmental Chemistry: A. K. De, 6thedition, New Age International Publisher
3. Environmental Chemistry: Sameer K. Banerjee, 2nd Edition, Prentice Hall of India Pvt. limited.
4. Environmental Chemistry, C. N. Sawyer, P. L. McCarty and G. F. Parkin (5th Ed.) Tata -McGrill Hill
5. Environmental Chemistry, B. K. Sharma, (9th Edition), Krishna Prakashan Pvt. Ltd.
6. Text book of environmental chemistry, Singh A.
7. Environmental Chemistry and pollution control, S. S. Dara, 7th ed, 2004, S Chand

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FIRST SEMESTER

Ens.: 1O3 Environmental Microbiology

Section: I

1. **Introduction to Microbiology**

   Discovery of microorganisms

   Development of microbiology

   Spontaneous generation theory

   Role of microbes in disease and Koch Postulates

   Scope and relevance of Microbiology

   Classification of Microbes (Whittaker five kingdom concept and carl woese three domain concept)

   Major groups of eubacteria based on 16S rRNA- An overview,

   Archaebacteria: Characteristics, Classification and Habitat,

   Extremophiles: Application and Adaptation (Acidophiles, Alkalophile, Halophiles, Thermophiles, Hyperthermophiles, Psychrophiles, Xerophiles, Barophiles) and Polyextremophile,

2. **Microbiological Techniques**

   Sterilization: Introduction, principle, method (physical and chemical),

   Microscopy: Introduction, construction and specimen preparation,

   Principle and application of different microscopy (Simple and Light microscopy, Bright field, Dark field, Fluoroscence, Phase contrast, Electron microscopy)

   Staining: Introduction, chemistry of dye and stains, Application, factors affecting staining process, Classification, Types of staining

3. **Prokaryotic cell structure**

   Size, shape and arrangement of bacterial cells

   Organization of Prokaryotic cell

   Cell external structure (Flagella, Fimbriae, Pili, Prosthecae)

   The cell envelope (Capsule (Glycocalyx), Cell wall, Cell membrane)

   Internal structures (Cytoplasm, Inclusion bodies , Nucleoid, Ribosomes

   Spores – Size, Location , formation, structure

4. **Cultivation and Growth of prokaryotes**

   Bacteriological media,

   Growth requirements (Temperature, pH, Salinity, Gaseous, osmotic pressure etc.)

   Nutrition of bacteria- Requirements and metabolic functions

   Sources of macroelements, microelements and growth factors

   Nutritional types of bacteria

   Growth curve and growth phase

Section –II

5. **Fungi-** Introduction, distribution, classification overview, Reproduction, economic importance and application in environment cleaner bioprocess
6. **Algae**- Introduction, Classification overview, Role of Algae, **Protozoa**- Introduction, Classification overview, Role of Protozoa
7. **Virology**

   History of virology

   Characteristics of bacteriophages, Plant and Animal viruses

   Modes of phage multiplication: Lytic cycle (T4) & Lysogenic cycle(λ)

   Method for cultivation of viruses,

   introduction to viroid and prions
8. **Soil Biology**

   Microbial flora of soil (*Rhizobium, Azotobacter, Azospirillium, Cyanobacteria*, etc.)

   Association and Interaction of microbes with plants, animals and other microbes,

References:

1. Microbiological Methods for Environmental Scientists & Engineers, A. F. Gaudy, Mc graw- Hill
2. Introduction to Environmental Biotechnology, A. K. Chatterjee, PHI
3. Introductory mycology, Alexopoulos, C.J., (3rd Edition), Willey Eastern Ltd.
4. Principles of Microbiology, Atlas, R.M., WcBrown
5. Aquatic ecosystem, Kumar, A.
6. Introduction to Fungi, H. C. Dubey,
7. Microbiology, M. J. Pelczar, Chan and Kreig, 5th, Ed., Tata McGraw Hill
8. Microbiology, Prescott, Harley and Klein, 6th, McGraw Hill
9. Disinfection, Sterilization and Preservation, Seymour Block, 5th, Lippincott
10. Environmental Science: Towards a sustainable future, T Weight & B. J.Nebet, 8th Edi,PHI

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FIRST SEMESTER

Ens.: 104 Analytical Techniques

Section: I

1. **Method of Sampling**

   ISI Methods for Collecting Samples of Water

   Preservation of Samples,

   Permissible Limits According to ISI & WHO

2. **Volumetric Analysis**

   Preparation of Standard Solutions-Primary and Secondary' Standards

   Principle, reaction mechanism and application of **Aqueous titration:**

   Acid-base Titrations-alkalinity,

   Complcxometric Titration-hardness,

   Redox Titrations- iron,

   Role of buffers and its preparations

   DO and COD, Precipitation Titrations-chloride

   Non aqueous titration- benzoic acid

3. **Analysis of Water and Waste water**

   One Methods of Analysis with Description and Calculations. Determination of Parameters like

   - Colour, pH
   - Solids by drying method
   - Oil and grease by solvent extraction method
   - Hardness, Fe, alkalinity, chloride, DO, BOD, COD by volumetric titration.
   - Ammonical nitrogen by kjeldahl method

   Environmental significance of above parameters.

Section: II

- **FLOW MEASUREMENT TECHNIQUES:**

1). Ultrasonic Flow Transmitters
- Measuring Principle,Different types of measurement sensors and transmitters available in the market
- Installation of Instruments,- Application in the STP and WTP

2). Magnetic Flow Transmitters
- Measuring Principle,Different types of measurement sensors and transmitters available in the market
- Installation of Instruments,Application in the STP and WTP

3). Orifice / Venturi Type Flow Transmitters
- Measuring Principle,Different types of measurement sensors and transmitters available in the market
- Installation of Instruments,Application in the STP and WTP

4). LOH / ROF
- Measuring Principle,Installation of Instruments
- Application in the STP and WTP

- **ON-LINE ANALYZERS:**

1). Online pH Analyzers
- Measuring Principle,Types of different pH electrodes
- Fibre- Optic pH Measurement,Selection of application
- Installation Methods,Calibration

2). Online DO Analyzers
- Measuring Principle,Types of different cells and sensors
- Application

3) ORP Measurement
- Principle of ORP Measurement,Equipment for ORP Measurement
- Application of ORP,ORP Control

4) On-line Turbidity, Sludge and suspended solid Measurement
- Turbidity Units,Forward scattering transmission types
- Dual beam design,Laser type
- Suspended solid and sludge density sensors,Scattered light detectors
- Backscatter turbidity analyzers,Summary

5) Online FRC Analyzers
- Measuring Principle,Types of FRC sensors,Applications

6) Water Quality Monitoring
- Purpose of water quality measurement,Sampling Syatem
- Different sensors and analyzers

- **AUTOMATION**

1) Variable Frequency Drives
- Speed Control by varying Frequency
- Different types of drives,Applications

2) Programmable Logic Controllers and SCADA System
- Implementation,Variants in PLC
- SCADA Implementation,Applications

References

1. Quantitative Analysis–R.A Day, A.L Underwood, (6th Edition) Prentice-Hall
2. Chemistry of Environmental Engineering - C. N. Sawyer and P. L. Mc Carty, (4th Ed.) Tata McC.raw Hill Ltd
3. Standard Methods for Examination of Water & Wastewater – Andrew D Eaton, Lenore S Clesceri, Eugene W Rice, Arnold Greenberg, (21st Ed) 2005, APHA (USA)
4. Environmental Chemistry - A. K. De , (3rd Ed.) New Age international (P) Ltd.
5. Official Methods of Analysis – Dr. William Harwitz, Dr. George W Latimer (2005), published by Association of Officiating Analytical Chemists (AOAC) USA.
6. Instrumentation systems manual

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FIRST SEMESTER

Ens.:105 Practicals

Environmental Chemistry and Environmental Microbiology

Environmental Chemistry (Analytical Techniques)

1. Determination of DO - Winkler Method.
2. Determination of BOD
3. Determination of COD – Conventional and spectrophotometer Method
4. Determination of Oil and Grease
5. Determination of Anionic surfactants
6. Determination of TDS, TSS
7. Determination of Total Hardness - Calcium and Magnesium Hardness -
8. Determination of Chlorides
9. Determination of Iron
10. Determination of Total Alkalinity
11. Preparation and Standardization of Standard Solutions: NaOH - $KMnO_4$ - Iodine - Sodium Thiosulphate
12. Determination of Ascorbic Acid by Oxidation with Iodine.
13. Estimation of Polyhydric Alcohol
14. Non-Aqueous Titrations (To Determine Percentage Purity of Sodium Benzoate)
15. Conductometric Titration.
16. pH - Meter Calibration and pH - Metric Titration

Environmental Microbiology

1. Total count of bacteria by SPC (Standard Plate count) from soil
2. Observation of Indian weather maps (IMD) and Compare seasonal variation
3. Simple Staining and Negative staining
4. Gram Staining
5. Spore Staining and Capsule Staining
6. Preparation of Media - Nutrient Agar, Mac Conekey Agar, EMB Agar
7. Cultural and Biochemical Studies of *E.Coli* and *Enterobacter aerogenes*
8. Growth Study of *E.Coli*, Calculation of Generation Time and Growth rate.
9. To Assess Microbiological Quality of Water by MPN Technique
10. Isolation of bacteria from marine environments (Halophiles, Alkalophiles)
11. Isolation of moderate thermophiles from arid and semi arid environments

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SECOND SEMESTER

Ens.: 2O1 Water and Wastewater Management

Section I

Water Management

Sources of Water

Water Demand

Population Forescasting

Fluctuations in demand of water

Factors affecting water demand

Definitions: Wholesome water, Potable water, Polluted water, contaminated water.

Impurities in water/Characteristics of water: Physical, Chemical & Biological

Objects of water treatment

Water Intake Structures

Layout of Conventional Water Treatment Plant

Water Treatment Processes: (Screening, Sedimentation (Plain & With coagulation), Mixing, Flocculation, Filtration, Disinfection)

Miscellaneous water treatment processes

Water Quality Standards.

Section II

Waste water management

- Definitions of terms used in sanitary engineering
- Systems of sanitation
- Methods of collection: Conservancy system, water carriage system
- Sewerage systems: combined, separate, partially separate
- Sources of sanitary sewage
- Peak rates of flow
- Characteristics & Examination of sewage: Physical, chemical & biological
- Methods of disposal

  Dilution

  Factors affecting self purification

Self purification of streams/ Zones of pollution

Disposal of sewage in sea water

Oxygen sag analysis

Land treatment

Sewage farming

Application of sewage

Sewage sickness

Sewage treatment processes

Objects of sewage treatment

Layout of conventional sewage treatment plant

Treatment processes: (Screening and skimming, Grit removal, Sedimentation, Detritus tank, Chemical precipitation: (optional treatment)

Biological treatment: aerobic and anaerbic treatment

Sludge management: (Sludge thickening, Sludge digestion, Sludge conditioning, Sludge dewatering, Final disposal)

Tertiary treatment

Effluent Standards for Disposal of Wastewatcr

References

1. Water supply and sanitary engineering - G. S. Birdie and J. S. Birdie, (7th Edi), Dhanpat rai Publishing company
2. Water Supply Engineering – B.C Punamia, Laxmi publications
3. Waste water Engineering – B.C Punamia, Laxmi publications
4. Waste water Engineering – G. L Karia and R.A Christian, PHI
5. Waste water Engineering treatment and reuse – Metcalf & Eddy, (4th Edi), Tata Mc Graw Hill.
6. Water Supply Engineering – S.K Garg, Khanna publishers
7. Waste water Engineering – S.K Garg, Khanna publishers
8. Indian Standards: IS 24W (19H3), IS 3306 (1965). IS 3307 (1965), IS 2488 I – IV.

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SECOND SEMESTER

Ens.: 2O2 Biotechnology and Environmental Health, Safety

Section I

1. **Biodiversity**

   Origin, speciation, extinction and ecological role of biodiversity

   Types of biodiversity, alpha, beta, and gamma diversity

   Causes of Biodiversity loss

   Rare, Endemic and endangered species of India

   Threaded species categories of IUCN and Red Data Book.

   Role of Biotechnology in Conservation of Species, *in Situ* and *Ex Situ* Conservation

2. **Bio-fertilizers**

   Nitrogen fixation by symbiotic and non-symbiotic bacteria,

   Phosphate solubilizing microorganisms,

   Additional Plant growth promoting microorganisms;

   Biopesticide

   Toxin of *Bacillus thuringiensis*,

   Baculoviruses as bio control agent and

   Entomopethic fungi

   Advantageous and limitation of biopesticide

3. **Biodegradation**

   Principles and mechanisms of biodegradation,

   Biodegradation of lignin, hydrocarbons & xenobiotic compounds-dyes, Pesticides

   Bioleaching

   Principles and application, different microbial role

   Bioleaching of Copper and Uranium

4. **Bioremediation**

   Principle and techniques

   Biosorption, Bioaccumulation and Co-metabolism,

   Bioremediation of oil spills, metal, hazardous wastes,

   Bio-surfactant

   Introduction, Microbial production and application

5. Biodeterioration

Principle, microbial mechanism, prevention and control of wood, petroleum, textile, metal, paper, leather and food biodeterioration,

Biopolymers

Introduction, Characteristics, Microbial production of polymers, Merits and Demerits

Section II

6. Introduction

Perspectives and concerns, Interrelationship and interactive approach between safety, health & environment

7. Toxicology

Toxicants entry to Biological organisms

How toxicants are eliminated from Biological organisms

Effects of toxicants on biological organisms

Toxicological studies

Dose - response studies

Threshold Limit Value

8. Safety and Health Hazards

Identification of potential safety

Occupational Health

Role of government organizations for occupational health

Factories Act

ISO 18OOO

9. Health and Safety Risk Management

Risk identification,

Allocation and mitigation strategies

Risk assessment

Risk Management

10. Role of organizations

WHO and other bodies and their role in public health project development, eradication programs and their efficacy, development impacts in urban and rural sectors, psychological impacts, Role of NGOs.

References

1. Biodiversity and environment, Aditya A.K.
2. Research and management technique for wildlife habitats, Bookhout, T.A.
3. Chemical Process Safety, Crowl , Louvar, (2nd Edi), PHI
4. Handbook of environmental Health and Safty, Herman Koren, Michel Bisesi, 1999, Lewis Publiser
5. Environmental Risk Analysis, Ian Larche, Paleologes, 2001, Mc Graw Hill
6. Safety at work, John Ridley, Butterworth Heinemann
7. Global biodiversity and environmental conservation, Khan, T.I.
8. Handbook of hygiene and public health, Yashpal Bedi, (2^{nd} Edi.)Anand Publishing Co.
9. Environmental Toxicology, M Satake, Y Mido, M.S Sethi, Discovery Publishing house
10. Principles of Microbiology, Atlas, R.M., WcBrown
11. Microbiology, Baumann, Mc Graw Hill
12. Application of Recombinant DNA technology, Bernard Glick,
13. Environmental Pollution, C S Rao, (2^{nd} Edition), New Age International.
14. Environmental Biotechnology Basic Concepts and applications, Indu Shekhar Thakur, IK International
15. Elements of Biotechnology, P. K. Gupta, Rastogi
16. Microbiology, Prescott, Harley and Klein, (6^{th} Edition), Mc Graw Hill
17. Industrial Microbiology- An introduction, Waites, Blackwell
18. Biodiversity, W.B.M. Winger, Spinger

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SECOND SEMESTER

Ens.: 203 Statistical Methods and Computer based Modeling in Environmental Sciences

1. **Introduction to Statistics**

   Use of statistics in Environmental Sciences, Limitations of Statistics, Sources of Environmental Statistics, concept of biostatistics

2. **Data Collection and Processing**

   Types of Data - Organization of Data – Sampling, Biological data, biological Database, database management system (DBMS), concept of bioinformatics and ecoinformatics,

3. **Statistical Techniques**

   Descriptive Statistics - Measures of Central Tendency and Dispersion Analysis with Statistical Packages

4. **Statistical Methods**

   Probability and Distribution. Distributions: Poisson, Binomial, Normal distribution and its application, frequencies and cross-tabulations. Distributions and distribution fitting. Experimental designs. Statistical Model for Pollution (air, water, soil, waste), Air Quality Index. Introduction to remote sensing and CIS

5. **Statistical Methods**

   Hypothesis testing, significance and correlation Correlation: Linear models and regressions. Pearson and other correlation coefficients. Multiple regressions. Difference among means: F-test: One way ANOVA; P-test: Two way ANOVA Analysis with Computer Packages, t-test, single sample, two samples

6. **Computer applications** in environmental modeling

7. **Computer based modeling**

   Linear, regression, validation, forecasting and modeling for population and population studies

8. **Introduction to time series analysis**

   Importance of time series, method of moving averages, three years, four years, five years moving averages to find the trend values and short term variations. Method of least squares to find the trend values & short term variations. linear equation only

References

1. Introduction to bioinformatics, Rastogi
2. Biometry, Soka', Robert and James Rohif (1997). Freeman Press, N.Y
3. Statistics for Engineers and Scientists, Walpole, R. and R. Myers (1993). (5^{th} Edi). MacMillan, N.Y.
4. Environmental Statistics and Data Analysis, Wayne, K. OH (1995). CRC Press.
5. Bio-stalislieal Analysis, Zar, Jarrold H. (1998). Prentice Hall

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SECOND SEMESTER

Ens.: 204 Instrumental Methods of Analysis

Section: I

1. Spectroscopy: Atomic absorption spectroscopy

Regions of EMR - UV - Visible Region

Law of Absorption of Radiation- Lambert & Beer's law and its Deviation

Single beam Spectrophotometer – Instrumental set up

Continuous Source of radiation for UV region-Hydrogen or Deuterium discharge lamp, for visible & IR region – Tungsten filament lamp

Line source of AAS for UV, Visible, IR region- Hollow cathode lamp

Wavelength selector: Monochromator –prism

Sample holder

Detector: PMT for UV and Visible region

One illustration of single and double beam spectrophotometer

Calibration of instrument by calibration curve method

Applications in Environmental Analysis.

2. Flame Emission Spectroscopy

Principle, Primary Idea about Instrumental set up,

Limitations and its Applications

One Illustration of Flame and Non-Flame/Electrothermal Atomizer i.e. Graphite Furnace Atomizer

Electrical Methods of Excitation - Inductively Coupled Plasma spectroscopy its Principle, Source - Elementary Idea – Applications

3. IR Spectroscopy

Use of Nondispcrsive IR (gas Analysers)

Elemental Analysis

Estimation of Carbon - Hydrogen - Nitrogen -Sulphur and Oxygen in Organic Compounds. (Modern Elemental Analyzer)

4. Principles und Applications

Florescence, Phosphorescence and Chemiluminescence, Turbidimetry and Naphelomelry:

Section: II

5. Gas Chromatography

GSC and GLC

Stationary and Mobile Phase

Principle of Separation

Basic parts of Instruments: carrier gas,

sample injection system,

column- packed column and WCOT, SCOT, PLOT column,

detector-FID - TCD - ECD –ASD

Applications

Only Principle & Applications of GC-HS, GC-MS

6. HPLC

Principle and layout

Components of Instruments: High pressure pump system, pneumatic pump, syringe pump, reciprocating pump, hydraulic pump,

sample injection system,

column,

detector- UV detector, refractive index detector, evaporative light scattering detector

Selective Applications in Separation and Estimations.

7. Ion Exchange Chromatography

Ion Exchange Resins – mineral & organic

Types of Ion Exchange Resins- cation and anion exchanger

Principles of Ion Exchange – classification of Ion Exchanger

Detector – conductivity detector

Applications.

8. Analytical techniques

Heavy metals: Al, Cr, Mn, Cu, Fe by HACH spectrophotometer

Anions like NO_3^-,PO_4^{-3}, F^- by HACH spectrophotometer

Nitrate, nitrite, phenol, sulphate by spectrophotometric method

Environmental significance of above parameter

TOC by $K_2S_2O_8$ digestion method – by TOC analyzer

Pesticides by GC method

References:

1. Principles of Instrumental Analysis : Skoog, Holler and Niemann, 2006, Thomson Brooks Cole
2. Instrumental Methods of Analysis: By Willard, Meritt and Dean, (7th Edi.), CBS Publishers and Distributors
3. Handbook of Analytical Instrument, Khandpur R.S.(2005) Tata Mc Graw Hill publishers
4. Instrmental methods of analysis, B.K. Sharma, (9^{th} Edi), Krishna prakashan Pvt. Ltd.
5. Analytical chemistry- Christian G.D, (6^{th} Edi), John Wiley & Sons.
6. Water Analysis Handbook – (2^{nd} Edi) – HACH
7. H2O Water Analysis Handbook – (4^{th} Edi) – HACH
8. Analytical Chemistry Principles & Techniques: Lerry G Hargis

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SECOND SEMESTER

Ens.: 205 Practicals

Instrumental Methods of Analysis and Biotechnology

Instrumental Methods of Analysis:

1. Spectrophotometric Determination: Iron, Copper, Nitrite, Ammonia, Manganese, nitrate
2. Flame Photometric Determination of Na and K in Water Sample.
3. Gas Chromatography: Separation and Estimation of Hydrocarbon Mixture - Separation and Estimation of Natural Gas and LPG.
4. Determination of Total Cation Content of Water Sample using lon-Exchange Chromatography.
5. Determination of Trace Pesticides using GC.
6. Separation and Determination of Pesticides Mixture by HPLC.
7. Determination of TOC of Water Sample.
8. Determination of As, Pb, Hg using AAS.
9. Use of "HACH" Spectrophotometer to Determine Al, Cr, Mn, Cu, Fe, PO_4^{-3}, F^-, No_3^-

Biotechnology:

10. Isolation of actinomycetes from soil
11. Isolation of microorganisms from polluted soil/water
12. Screening of symbiotic and non-symbiotic nitrogen fixing bacteria
13. Screening of Phosphate solubilizing bacteria and measure Phosphate Solubilization Index
14. Isolation and identification of fungi from soil
15. Study on degradation of Starch, Gelatin and cellulose by bacteria
16. A study of biosurfactant production (Drop collapse technique)
17. Screening of hydrocarbon degrading bacteria
18. Screening of pesticide degrading bacteria

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THIRD SEMESTER

Ens.: 3O1 Solid & Hazardous Waste Management

Section I

1. **Municipal solid wastes**

   Definition

   Sources

   Composition: Physical, Chemical

   On-site Handling, Storage and Processing

   Types of Collection Systems: Hauled Container system, Stationary Container system

   Transfer and transport

   Processing Techniques

   Ultimate Disposal methods

   Energy recovery systems.

   Waste concentration technologies, TSDF cradle to grave concepts

2. **E-Waste Management**

   Definition

   Sources and Characterization

   Disposal Methods

SECTION II

3. **Hazardous wastes**

   Definition

   Sources and Characteristics

   Hazard ranking system

   Sampling and analysis of hazardous waste

   Hazardous waste management treatment technologies

   Transportation, treatment and disposal

4. **Bio-medical waste (10 hrs)**

   Sources

   Characteristics

   Treatment and disposal

References :

1. Environmental Engineering, Howard Peavy, Donald Rowe, George Tchobanoglous, 1985, Mc Graw Hill International
2. Integrated Solid Waste Management: Engineering Principles and Management Issues, George Tchobanoglous, Hilary Theisen, Samuel A Vigil, McGraw-Hill
3. Handbook of Solid waste management, George Tchobanoglous, McGraw-Hill
4. Handbook of Solid waste management, Frank Kreith, 1994, McGraw-Hill
5. Textbook Of Solid Waste Management, Khan; Ahsan, CBS Publishers and Distributors
6. Hazardous Waste Management, Michael D LaGrega, Phillip L Buckingham, Jeffrey C Evans, (2nd Edition), McGraw-Hill Science/Engineering/Math
7. Hazardous waste management, Charles A. Wentz, (Second edition 1995), McGraw Hill International.
8. Standard handbook of hazardous waste treatment and disposal Harry M. Freeman, 1997, McGraw Hill.

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THIRD SEMESTER

Ens.: 3O2 Air Pollution and Control

Section I

1. **Sources and Classification of air pollutants:**

   Introduction

   Classification of pollutants: Natural, Aerosols (Particulates), Gases and vapours

   Sources of Air pollution

   Primary and secondary air pollutants

   Stationary and Mobile sources

2. **Meteorology:**

   Meteorological factors influencing air pollution

   Methods for measurement of meteorological variables

   Plume behaviour

   Wind rose

3. **Effects of air pollution**

   On Animals

   On Plants

   Economic effects

4. **Sampling Procedures**

   Classification of sampling methods

   Instruments for sampling waste gases and for atmospheric sampling

   Location of sampling sites

   Sampling methods

   Stack sampling techniques

   Gaseous sampling

SECTION II

5. **Air pollution due to automobiles**

   Exhaust emissions

   Air fuel ratio

   Control of Exhaust emissions

   NOx in exhaust gases

Control of emissions

Alternatives

6. **Control of air pollution by equipment**

   Objectives of using Control equipment

   Types of control equipment

7. **Control of gaseous contaminants**
8. **Control of air pollution by process changes**
9. **Air quality standards**
10. **Industrial Air pollution & control**

References:

1. Air Pollution M.N. Rao, 1993, McGraw Hills
2. Air Pollution – Murlikrishnan, Tata McGraw Hills
3. Air Pollution Control and Engineering, DeNevers, 1993, McGraw Hills
4. An introduction to air pollution, R. K Trivedi, Goel P.K, 2005, BS Publications,
5. Textbook Of Air Pollution And Its Control, S C Bhatia, Indian books
6. Textbook Of Air Pollution And Its Control, S.c. Bhatia, 2007, Atlantic publishers

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THIRD SEMESTER

Ens.: 3O3 Industrial Waste Water Treatment

Section I

1. Characterization and degree of treatment of waste water

Undesirable Waste Characteristics

Disposal Standards and Stream Standards for disposal of wastewater

2. Necessity of Treatment

Primary treatment:

Secondary treatment: (Various biological treatments)

Tertiary treatment

Sludge treatment and disposal

3. Waste volume and Strength Reducing

Neutralization, equalization and proportioning

4. Industrial waste treatment

5. Sources, types & characteristic of industrial wastewater for different industries like:

Textile waste

Pulp & Paper waste

Sugar waste

Fertilizer waste

Pharmaceutical waste

Distillary waste

Dairy waste

Petrochemicals waste

Steel waste

SECTION II

6. Treatment methods for the removal of:

Color by sorption, precipitation, membrane, oxidation, reduction and innovation system

Odour by physical, chemical and biofiltration techniques

Hardness (Ca and other metals) by lime soda process and cation exchange

Solids by coagulation/ filtration

Fe, Mn by oxidation

Heavy metals by lime treatment, eletro deposition, ion exchange, solvent extraction by organic soluble chelating agent, activated carbon adsorption

Dissolved organic material by adsorption on synthetic polymer, elctro oxidation or oxidation method

Dissolved inorganic by electro dialysis, ion exchange, reverse osmosis

Phosphorus/ phosphate by precipitation

Nitrogen by nitrification and denitrification

Oil and grease by solvent extraction method

References

1. Industrial Wastewater Treatment, M. N. Rao, A. K. Dutta, 1987, Oxford &, IBH Publishing House
2. Water Supply and Sanitary Engineering. G.S. Birdie & J. S. Birdie, 6th edition 1993, Dhanpat Rai Sons Publishers
3. Chemistry of Environmental Engineering - C. N. Sawyer and P. L. Mc Carty, (4th Ed.) Tata McC.raw Hill. Ltd.
4. Hand book of drinking water quality by John DeZuane, (2nd edition) JOHN WILEY & SONS, INC.
5. Environmental Problems Protection and Control – Arun kumar, Anmol Publications pvt ltd

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M.Sc. Environmental Science

FIRST SEMESTER

Ens: 304 - Operation & Maintenance for Water & Wastewater Treatment Plants

SECTION I

1. **Operation and Maintenance Data Log & Recording**

   - Maps and Profile
   - Operational Data, Analysis Data, Attendance Sheet of staff etc.
   - Record of routine maintenance
   - Data regarding the construction, repair, rehabilitation

2. **Testing and Commissioning & Plant Stabilization**

   The Plant Commissioning activities include:

   Plant Start up
   Initial running
   Operatability adjustment
   Stable operation
   Final adjustment

   - Mechanical Equipments Check
   - Electrical Equipments Check
   - Commissioning Tests
   - Overall Testing of the Plant.
   - Optimization of chemical dosing

3. **Operation & Maintenance of Mechanical Equipments**

   - Mechanical equipment details & function
   - Daily Observation (Routine Maintenance)
   - Semi Annual & Annual Inspection
   - Facilities for Maintenance and Repairs

4. **Operation & Maintenance of Electrical/ Instrument Equipments**

   - Electrical/ Instrument equipment details & function
   - Daily Observation (Routine Maintenance)
   - Facilities for Maintenance and Repairs
   - Preventive Maintenance

SECTION II

5. Safety

- Safety Practice Programme
- Keeping Records of Injury
- Searching Out Hazards
- Safe Equipment, Working Methods

6. Training

- Training of operating staff - Technical work
- Academic training in public health engineering.
- Information about the latest technology in the field.
- Library references

7. Trouble Shooting of Water Treatment Plant

- Prepare chart of trouble shooting for different units of plant, which include Symptoms, Problem Occurs, and Suggestion/ Remedy and Follow Action.

8. Trouble Shooting of Waste Water Treatment Plant

- Prepare chart of trouble shooting for different units of plant, which include Symptoms, Problem Occurs, and Suggestion/ Remedy and Follow Action.

9. Sampling & Quality Check of Water and Waste water

- Method of sampling
- Sample Volume
- Selection of Sampling Points
- Daily, Weekly & Monthly Analysis of Different Parameters at specific intervals.

References:

Operation and Maintenance manuals for water, sewage and Effluent treatment plants.

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THIRD SEMESTER

EnS.: 305 Practicals

Solid Waste, Air Pollution Monitoring & Industrial Wastewater Analysis:

Solid Waste Analysis

1. Determination of calorific value for solid waste.
2. Proximate analysis of solid waste
3. Determination of N, P, K value for solid waste
4. Ultimate analysis of solid waste

Air Pollution Monitoring :

5. To determine the concentration of SOx in ambient air
6. To determine the concentration of NOx in ambient air
7. To determine the Suspended Particulate Matter in ambient air
8. To study the Stack Monitoring Kit.
9. To measure the RSPM in ambient air
10. Microbiological analysis of air from different location

Industrial Wastewater Analysis:

To study Chemical characteristics of effluent from various industries:

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Fourth Semester

Ens. 401- Environmental Management, Legislation and Policy

SECTION I

1. **ISO 14000: International Environmental standards**

   Introduction

   Evolution of ISO 14000: Background

   Step by step preparation for EMS Certification

   ISO 14001:Environmental Management Systems (EMS)

   - Introduction
   - Scope
   - Normative References
   - Definitions
   - Environmental Management System Requirements
   - Guidance

   Basic ISO 14004 Guidance documents

   ISO 14010 Audit Standards

   ISO 14020 Labelling Standards

2. **Environmental Impact Assessment (EIA)**

   Introduction

   Methodology of EIA

   Environmental Risk Assessment

   EIA of hazardous waste

   Limitation of EIA

   Case Study

3. **Environmental Audit (EA)**

   Introduction

   Environmental Audit-Prevailing practices in developed countries

   Range of audit objectives

   Audit Methodology

   EA report

   Benefits of Environmental Audit

Case Study

4. **International Environmental Laws:**

   Nairobi Declaration

   Rio Conference

SECTION II

5. **Legislation on Environmental Protection**

   Water (Prevention & Control of Pollution) Act, 1974 & Rules, 1975

   Air (Prevention & Control of Pollution) Act, 1981 & Rules, 1982

   Environment (Protection) Act, 1986 & Rules, 1986

   Hazardous Waste (Management & Handling) Rules, 1989

   Bio-Medical Waste (Management & Handling) Rules, 1998

   Re-Cycled Plastics Manufacture & Usage Rules, 1999

   Noise Pollution (Regulation & Control) Rules, 2000

   Ozone Depleting Substances Rules, 2000

   Batteries (Management & Handling) Rules, 2001

References

1. Environmental Engineering and Management: Suresh K Dhameja, 2002, S.K Karataria & Sons
2. Declaration of The Stockholm conference, Rio, Rio+5 and Rio+10. Anti Pollution Acts (3) and Commentaries published theorem.
3. Handbook of environmental management and technology: Gwendolyn
4. Holmes, Ben Ramnanne Singh, Louf: Theodore
5. The ISO 14000 Handbook: Joseph Cascio
6. Industry and Environment, R.K Trivedi, 2002, Daya Publishing house.