**VEER NARMAD SOUTH GUJARAT UNIVERSITY**
**M.Sc. (ENVIRONMENTAL CHEMISTRY) SEMESTER-III**
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

**Paper-I (Chemistry in Industry-I)**

**Max. Marks: 70** **Total Periods: 45**

**UNIT-I: Unit Processes** **(15 Periods)**

***Nitration:*** Nitrating agents. Mechanism of aromatic nitration. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using nitration unit process.
***Sulphonation and Sulfation:*** Sulphonating and Sulfating agents. Mechanism of aromatic Sulphonation. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Sulphonation unit process.
***Halogenation:*** Halogenating agents. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Halogenation unit process.
***Amination:*** Aminating agents, Amination by reduction, Amination by Ammonolysis. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Amination unit process.
***Hydroxylation:*** Industrial chemicals derived from Benzene, Naphthalene, Anthracene using hydroxylation unit process.
***Alkylation:*** Alkylating agents. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using alkylation unit process.

***Recommended books:***
1. Unit process in Organic Synthesis by P. M. Groggins.
2. Chemical Process Industries by R. N. Shreve.
3. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent.
4. Industrial Chemicals by Faith, Keyes, Clark.

**Unit II: Chemical Engineering Principles, Chemical Safety and Management, Waste** **(15 Periods)**

***Chemical Engineering Principles:*** Stoichiometry, material balance, and energy balance, thermochemistry, heat flow, mechanisms, condensation and evaporation, heat exchangers, evaporators, mass transfer, principles, distillation (principles, types and concept of theoretical plates), extraction and leaching, Filtration, Crystallization, drying, industrial dryers, pumps, pipelines, industrial reactors and other vessels.
***Chemical Safety and Management:*** A basic course in chemical laboratory safety, MSDS of chemicals, safe handling and storage of chemicals, Environment safety, care and use of safety equipment, Risk assessment, Hazard classification and management.
***Waste and its disposal:*** Solid waste, Waste management disposal methods, Types of recycling, Hazardous waste: Management and disposal/destruction technologies, Waste separation technologies, Waste bioremediation technologies, Human resource and management

***Recommended book:***
Handouts from the teacher

**Unit III: Green Chemistry** **(15 Periods)**

***Introduction:*** Twelve principles of Green chemistry, Atom economy and Waste minimization.

***Green solvents and their applications:*** Ionic liquids, types, properties and applications, IL's as solvents, Use of ionic liquids in reactions such as Heck reaction, Knoevenagel condensation

***Super critical fluids:*** The phase diagram of $CO_2$, Supercritical $CO_2$, its properties and applications in dry cleaning and decaffeination of coffee.

***Microwave assisted synthesis:*** Mechanism and advantages with some examples, Biobased materials: Basic idea on Biopesticides, Biofertilizers, Biosurfactant, Biofuels, Biodegradable polymers.

***Aqueous phase reaction:***

1. Baeyer-Villiger Oxidation
2. Claisen-Schmidt Reaction
3. Diels-Alder reaction
4. Knoevenagel Condensation

***Green approach in the synthesis of:***

1. Adipic acid
2. Methyl methacrylate
3. Catechol
4. Paracetamol

***Recommended books:***


1. Green chemistry by V. K. Ahluwalia Narosa Pub New Delhi
2. Green Chemistry, Theory and Practice, Paul T. Anastas and John C. Warner, Oxford University Press, 2000, New York, USA.
3. Green Chemistry: An Introductory Text, Mike Lancaster, Green Chemistry Network, University of York, RSC, 2002.

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TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

**Paper-II (Water: Pollution and Analysis)**

**Max. Marks: 70** **Total Periods: 45**

## Unit I: Introduction to Aquatic Chemistry and Water Pollution (15 Periods)

### (A) Introduction to Aquatic Chemistry

Dissolved gases, water acidity and carbon dioxide in water, alkalinity and Contributors to Alkalinity at Different pH Values, Influence of Alkalinity on $CO_2$ Solubility, calcium and other metals dissolved in water, hydrated metal ions as acids, complaxation and chelation, polyphosphates in water, hydrolysis of polyphosphates, colloidal particles in water, colloidal properties of clays, Flocculation of Colloids by Polyelectrolytes, Algae, fungi, protozoa and bacteria in water

### (B) Water Pollution

***Nature and Types of Water Pollutants:*** Elemental Pollutants, Heavy Metals, Metalloids, Organically Bound Metals and Metalloids, Inorganic Species, Algal Nutrients, Eutrophication, Acidity, Alkalinity, and Salinity, Oxygen, Oxidants, and Reductants.

***Organic Pollutants:*** Pesticides in Water, Polychlorinated Biphenyls, Radionuclides in the Aquatic Environment.

***Recommended books:***

1. Environmental Chemistry by Manhanan. (*Ch 3, 5 and Ch 7*)

## Unit II: Water treatment and Management (15 Periods)

**Water Treatment:** Water Use, Water pollutants, Municipal Water Treatment, water-quality parameters and standards: physical and chemical parameters (pH, hardness, color, odour, taste and turbidity), Dissolved oxygen, BOD, COD, Total organic carbon, Total nitrogen, Total sulfur, Total phosphorus and Chlorine, Treatment of Water for Industrial Use, Sewage Treatment, Industrial Wastewater Treatment, Removal of Solids, Removal of Calcium and Other Metals, Removal of Dissolved Organics, Removal of dissolved inorganics, sludge, water disinfection, Natural Water Purification Processes, Water Reuse and Recycling.

**Water management:** Rainwater harvesting and watershed management.

***Recommended books:***

1. Environmental Chemistry by Manhanan. (*Ch 3 and part of Ch 5, 7*)

## Unit III: Analysis of water and wastewater (15 periods)

General aspects of Environmental Chemical Analysis, Classical methods, spectrophotometric methods, Electrochemical Methods of Analysis, Chromatography, Mass Spectrometry, Analysis of Water Samples, Automated Water Analyses, Water and waste water treatment, aerobic and anaerobic, aeration of water, principle of coagulation, flocculation, softening, disinfection, demineralization and fluoridation.

***Recommended books:***

1. Environmental Chemistry by Manhanan. (*Ch 24*)

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**M.Sc. (ENVIRONMENTAL CHEMISTRY) SEMESTER-III**
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**Paper-III (Waste, Waste Management, Environmental Biology-I)**

**Max. Marks: 70** **Total Periods: 45**

**Unit I: Nature, sources, and environmental chemistry of hazardous wastes.**
**(15 Periods)**

Introduction, Classification of Hazardous Substances and Wastes (Domestic, Industrial, Municipal, Hospital, Nuclear, Agriculture), Sources of Wastes, Flammable and Combustible Substances, Reactive Substances, Corrosive Substances, Toxic Substances Physical Forms and Segregation of Wastes, Environmental Chemistry of Hazardous Wastes, Physical and Chemical Properties of Hazardous Wastes, Transport, Effects, and Fates of Hazardous Wastes, Hazardous Wastes and the Anthrosphere, Hazardous Wastes in the Geosphere, Hazardous Wastes in the Hydrosphere, Atmosphere and in Biosphere.

***Recommended books:***
1. Environmental Chemistry by Manhanan. (*Ch 19*)

**UNIT-II:** **(15 Periods)**
**(A) Biomedical waste**
Introduction, characterization of biomedical waste, handling and disposal of biomedical waste, medical waste treatment techniques, Biomedical waste: Environment standards and guidelines for management, Management and disposal of electronics waste, Basel convention.
**(B) Waste treatment Technologies**
Waste destruction technologies, waste concentration technologies, TSDF cradle to grave concepts, solidification and stabilization technologies, biological treatment, biotreatment by sequencing batch reactors, thermal processes, storage and leak detection- underground storage tanks, leak detection and remediation.

**Unit III: Industrial pollution problems and its remedies** **(15 Periods)**
Petroleum refinery, Cement Industries, Iron and Steel Industries, Paper and pulp industries, Sugar industries, Fertilizer and Pharmaceutical Industries, Thermal power plant, Chemical processing industries.

***Recommended books:***
1. Environmental Chemistry by Manhanan.

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**
**M.Sc. (ENVIRONMENTAL CHEMISTRY) SEMESTER-III**
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**Paper-IV (Global Atmosphere, Chemical Toxicology & Environmental Chemical Analysis)**

**Max. Marks: 70** **Total Periods: 45**

**Unit – I Instrumental Techniques in Environmental Chemical Analysis: (15 periods)**

Neutron Activation Analysis, Anodic Stripping Voltammetry, Atomic Absorption Spectroscopy, X-Ray Fluorescence, Fourier Transform Infrared Spectroscopy, Chemiluminescence, Gas chromatography, HPLC, Ion-selective Electrodes, Ion-chromatography.

**Unit – II Chemical Toxicology: (15 periods)**

Toxic chemicals in the environment, Impact of Toxic Chemicals on Enzymes, Biochemical Effects of Metals ( Arsenic, Cadmium, Lead, Mercury), Biochemical Effects of Gases (Carbon Monoxide, Nitrogen Oxides ,Sulphur Dioxide), Biochemical Effects of Ozone and PAN, Biochemical Effects of Cyanide, Biochemical Effects of Pesticides,Carcinogens,Bio-Warfare Agents, Environment and public health, Health and Disease.

**Unit – III The Endangered Global Atmosphere: (15 periods)**

Anthropogenic change in atmosphere, Urban problems related to energy, Global warming, green house effect, acid rain, ozone layer depletion, photochemical smog and nuclear accidents, Wasteland and their reclamation, Environmental scenario in India.

***Recommended Books:***


1. Environmental Science by Dr. Suresh K. Dhameja
2. Environmental Studies by Dr. B. S. Chauhan
3. Environmental Chemistry by Dr. A.K.De

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**
**M.Sc. (ENVIRONMENTAL CHEMISTRY) SEMESTER-III**
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

**Practicals**
**Marks: 200 [External-120 + Internal-60 + Viva- 20]**

1. Precipitation Titration: Determination of Chloride by the Mohr Method.
2. Estimation of halides in water samples by potentiometry.
3. Separation of amino acids by Paper chromatography.
4. Removal of hazardous dyes/metals by Cloud Point Extraction using nonionic surfactant.
5. To determine the COD value of KHP sample using conventional method.
6. To determine the dissolve Oxygen (DO) in given water sample.
7. Ion-Exchange separation of $Fe^{+3}$ + $CO^{+2}$ and determination $Fe^{+3}$ by spectrophotometer.
8. Electro gravimetric determination of $Cu^{+2}$ in given stock solution.
9. To estimate the amount of $As_2O_3$ in the given solution by coulometric titration.
10. To determine the amount of $PO_4^{-3}$ in given sample of soil by spectrophotometrically.
11. Determination of Iodine value.
12. Determination of saponification value.

***Main Books:***

Manahan, Stanley E. Environmental Chemistry, Boca Raton: CRC Press LLC, 2000

***Recommended books:***

Evironmental Pollution, A.K. De
Evironmental Pollution, B.K. Sharma & H.Kaur

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**

**M.Sc. (ENVIRONMENTAL CHEMISTRY) SEMESTER-IV**
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

**Paper-I (Chemistry in Industry-II)**

**Max. Marks: 70** **Total Periods: 45**

**Unit I: Introduction to Environmental Chemistry (15 Periods)**

Objectives and guiding principles of environmental studies, scope and importance, science of environment (hydrosphere, atmosphere and lithosphere), Need for public awareness (role of Ministry and NGOs).

***Recommended books:***

1. Basic Concept of environmental Chemistry by Des. W. Connell
2. Environmental Chemistry, 7th Ed., By S. E. Manahan.
3. A textbook of environmental chemistry, By O. D. Tyagi and M. Mehara
4. Fundamental concept of environmental chemistry, By G. S. Sodhi.

**Unit II: Environment management and Pollution Control Board (15 Periods)**

Methods of environmental management, Radio active waste management, Environmental impact assessment, Definition and terminologies, Basic Description of EIA processes. Natural resources of energy-consumptions and conservation.

***Recommended books:***

1. Industrial Safety and Pollution control handbook. Published by National Council and Associate (Data) Publishers Pvt. Ltd.
2. Environmental Pollution Monitoring and control by S. M. Khopkar.
3. Waste and Disposal Panlk T. Williams. 2nd Ed. John Wiley & Sons

**Unit III: Environmental Protection Legislations (15 Periods)**

Pollution control boards, GPCB, Legislation and legal aspects: Water (Prevention and control of Pollution) Act 1974, Air (Prevention and control of Pollution) Act 1981, Wild Life protection act, 1972, The India Forest Act, 1927, The Environment protection Act, 1986 and issues involved in enforcement of environmental legislation.

***Recommended books:***

1. Fundamentals of Computers by Rajaraman.
2. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**
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**Paper-II (Air: Pollution and Analysis)**

**Max. Marks: 70** **Total Periods: 45**

**Unit I: Air pollutants** **(15 Periods)**

Inorganic Pollutant Gases, Particulates, Aerosols, Production and Control of CO, Fate of atmospheric SOx, NOx, COx and Hydrocarbon emission sources. Sulphur dioxide Reactions in the atmosphere, Nitrogen Oxides in the atmosphere, Ammonia, Fluorine, Chlorine, and their gaseous compounds, Hydrogen Sulfide, Carbonyl Sulfide and Carbon Disulfide in the atmosphere.

***Recommended books:***
1. Environmental Chemistry by Manhanan. (*Ch 11*)

**Unit II: Organic air pollutants** **(15 Periods)**

Organic Compounds in the atmosphere, Organic compounds from Natural Sources Pollutant Hydrocarbons, Aryl Hydrocarbons, Aldehydes and Ketones, Miscellaneous Oxygen-Containing Compounds, Organohalide Compounds, Organosulfur Compounds, Organonitrogen Compounds.
Introduction to Bhopal gas tragedy, Chernobyl, Three Mile Island and Minamata disasters

***Recommended books:***
1. Environmental Chemistry by Manhanan. (*Ch 12*)

**Unit III: Air and gas control and analysis** **(15 Periods)**

Method of control of air pollution, electrostatic precipitation wet & dries scrubber, filters, gravity and cyclonic separation, Adsorption, absorption and condensation of gaseous effluent, Atmospheric Monitoring, Sampling, Methods of Analysis, Determination of Sulfur Dioxide, Nitrogen Oxides, Analysis of Oxidants and analysis of Carbon Monoxide. Determination of Hydrocarbons and Organics, Analysis of Particulate Matter, Direct Spectrophotometric Analysis of Gaseous Air Pollutants

***Recommended books:***
1. Environmental Chemistry by Manhanan. (*Ch 26*)

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**Paper-III (Waste, Waste Management, Environmental Biology-II)**

**Max. Marks: 70** **Total Periods: 45**

**Unit I: Radioactive Pollution, Waste and Treatment (15 Periods)**

**(A) Radioactive Waste**

***Nuclear or Radioactive Waste****:* Principles of radioactivity, types, sources and consequences of nuclear radiations, sampling methods, models of radioactive decay.

***Detection of nuclear radiation's:*** G. M. Counter, Scintillation counter, semiconductor detector.

***Interaction of radiation's with matter:*** Classification & Biological effects of ionizing radiations on human. ICRP recommendations, characteristics of nuclear waste, radioactive materials and its decay, half-life, health effects of ionizing radiation. Factors affecting radiation doses**,** Safety standards.

**(B) Disposal and Analysis of radioactive waste**

Detection and Analysis of radioactive materials, mining and recovery, low-level radioactive waste, high-level radioactive waste.

***(C) Protection and control from radiation***

Transport of radioactive materials, storage and disposal of radio active waste, new waste reduction technologies.

**UNIT-II: Characterization of Soil and Soil Contaminants (15 Periods)**

**(A)**

- pH
- Lime requirement of soil
- Nitrogen analysis
- Phosphorous analysis
- Exchangeable Cation Analysis
- Micro nutrient analysis
- Trace element in soil analysis
- Analysis of pesticides- Standard and polarographic analysis

**(B)**

- Introduction
- Sources of Soil Contaminants
- Chemical Nature of soil Contaminants
- Important environmental Properties of Soil Contaminants
- Ecological and Health effects soil Contaminants

***Recommended books:***

1. Environmental Chemistry by Manhanan.

**Unit III: Environmental Microbiology (15 Periods)**

Microbes – classification and their applications in the environmental sciences. Cultivation and growth of microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents, Extremophilic microorganisms, Microbial metabolism, Toxic chemicals in the environments, Impact of toxic chemicals on enzymes, Biochemical effects of arsenic, cadmium, lead, mercury, carbon mono oxide, nitrogen oxides, sulphur oxides, ozone, PAN, cyanide, pesticides, insecticides and carcinogens. Toxic effects of Pb, Cd, Hg, As Cr, Ni and Mn,

***Recommended books:***

1. Environmental Chemistry by Manhanan.

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**Paper-IV (Energy, Agriculture and Environment)**
**Max. Marks: 70** **Total Periods: 45**

**UNIT-I: Energy (15 periods)**

**(A) Fossil Fuel -** Origins of Fossil Fuels, Fuel Energy, Composition and Refining of Petroleum, Advantages and Disadvantages of Petroleum, Gas and Coal, Decarbonization.
**(B) Renewable Energy** - Solar Heating, Solar Thermal Electricity, Photovoltaic Electricity- Principles of PV cell, Photosynthesis and Photoelectrochemistry, Biomass- Ethanol and Methane from biomass, Hydroelectricity, Wind Power, Ocean Energy, Geothermal Energy.
**(C) Energy Utilization** - Electricity Storage-The Hydrogen Economy, The Materials Connection- Material's properties, recycling and dematerialization.

**UNIT-II: Atmosphere (15 periods)**

**(A) Climate**- Radiation balance, Albedo- particles and clouds, Greenhouse Effect-IR absorption and molecular vibrations, greenhouse gas trends.
**(B) Oxygen Chemistry**- Nitrogen Oxides- free energy and equilibrium constant, free energy and temperature, Nitrogen Oxides- kinetics, Free Radical Chain Reactions- Oxygen radicals, organic oxygen radicals, hydroxyl radicals and transition metal activation of $O_2$.
**(C) Stratospheric Ozone**- Ultraviolet Protection by Ozone, Ozone Chemistry- formation and destruction, calculating the ozone steady state, Catalytic Destruction of Ozone-hydroxyl radical, chlorine and bromine, nitric oxide, Polar Ozone Destruction, Ozone Projections, CFC Substitutes.

**UNIT-III: Agriculture and Environment (15 periods)**

**(A) Nitrogen And Food Production**- Nitrogen Cycle, Carbon Cycle, Oxygen Cycle, Sulfur Cycle, Agriculture-fertilizer and the green revolution, environmental degradation, Nutrition- energy and calories, protein, minerals and vitamins, antioxidants.
**(B) Pest Control- Insecticides**- organochlorines, bioaccumulation, organophosphets and carbamates, natural insecticides, Herbicides, Genetically Modified Organisms (GMOs)- actualities and potential, resistance to GM food.

***Recommended Books:***


1. Chemistry of the environment 2nd Ed. By Thomas G. Spiro and William M. stigliani
2. Environmental Chemistry by Dr. A. K. De.

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**Practicals**
**Marks: 200 [External-120 + Internal-60 + Viva- 20]**

1. Estimation of alkali metals in various samples by flame-photometry.
2. Estimation of sulphates by turbidimetry.
3. Quantitative analysis of constituents in ores and alloys.
4. To estimate the amount of D-glucose in given solution colorimetrically.
5. Determination of BOD in water sample.
6. To determine concentration of $Cr^{+3}$ and $CO^{+2}$ in given mixture using spectrophotometer.
7. Total salt ( dowex cation Exchange column).
8. Titrimetric determination of L-ascorbic acid.
9. To determine the individual concentration of Cu(II) and Ca(II) in a mixture using EDTA titration.
10. Determination of ammonia by Phenate method.
11. Determination of Nitrogen by kjeldhal method.
12. Separation of Sugar/dyes using Thin Layer Chromatography/ Paper Chromatography.

***Main Books:***
Manahan, Stanley E. Environmental Chemistry, Boca Raton: CRC Press LLC, 2000
***Recommended books:***
Evironmental Pollution, A.K. De
Evironmental Pollution, B.K. Sharma & H.Kaur