## Table 1. Scheme of Instruction and Evaluation

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**Table showing the credits for the programme**

**First language-English**

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<tr>
<td>Sem 4</td>
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**Total No. of credits = 12**

**Additional language (Hindi/Malayalam)**

<table>
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</tr>
<tr>
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**Total No. of credits = 6**
**Complementary course (Chemistry)**

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<td>7</td>
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<tr>
<td>Sem 2</td>
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<td>7</td>
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# The additional 2 hrs as per university regulation of work load for practicals if number of students exceeds 15 in a batch

*Practical Examinations will be conducted only on even semester by the university

**Total No of Credits 12+4=16**

**Foundation Course**

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<tr>
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# 2 hrs as per university regulation of work load for practicals; Total No of Credits = 5

*Practical examination for foundation course

**Core Course (Environmental science)**

<table>
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<td>7</td>
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<td>4</td>
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<td>6</td>
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<td>11</td>
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<td>6+4**</td>
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<td>4+4#</td>
<td>13</td>
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#2 hrs as per university regulation of work load for practicals

* Practical examination for foundation course and core course are conducted together as part I & II and the credit is included with core course of 2 credits

**At the end of 4th semester; ***At the end of 6th semester

*Practical Exam will be conducted by the university*

**Total No of credits 32+6=38**
Vocational Course (Water Management)

<table>
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#2 hrs as per university regulation of work load for practicals

Practical Exam will be conducted by the university;

Total No of Credits 27+8=35

B.Sc Environmental Sciences & Environment and Water Management

Six semesters; One semester-18 weeks

Total No of Courses : 43

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<tr>
<td>4</td>
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Total No of Credits = 12+6+16+5+38+35+2+2+4=120
### Semester 1

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<td>EE1132</td>
<td>Complementary Course Practical</td>
<td>2. Chemistry lab</td>
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Eng-4; SL-3; FC-3; CoreC-5; Vo C-5; Comp C-5; Total=25 Instructional Hrs/week

### Semester II

<table>
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<td>EE1211.3</td>
<td>English II</td>
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<td>EE 1242</td>
<td>Core Course practical</td>
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<td>EE1271</td>
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<td>EE1231</td>
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<td>1. Organic and Environmental Chemistry</td>
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Eng-4; SL-3; FC-2; Core C-6; Vo C-5; Comp C-5; Total=25 Instructional Hrs/week

### Semester III

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<td>2. Environmental Management</td>
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<td>EE1343</td>
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<td>EE1371</td>
<td>Vocational III</td>
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<td>2. Biophysics, Biostatistics and Computer Application</td>
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### Semester V

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<td>2. Water quality Management- II</td>
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<td>EE1641.3</td>
<td>b. Environmental Aspects of Estuarine System</td>
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<td>EE1641.4</td>
<td>c. Disaster Management</td>
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<td></td>
<td>d. Elementary Concepts in GIS &amp; GPS</td>
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Core C-9; Vo C-10; Project -4; Elective-2; Total = 25 Instructional Hrs/week

**CORE COURSES**

I. Research Methodology & Perspectives of Science

II. Environmental Studies

III. (1) Natural Resources and Conservation

   (2) Environmental Management

IV. (1) Environmental Biotechnology and Microbiology

   (2) Biophysics, Biostatistics and Computer Application

V (1) Environmental Geology and Mineralogy

   (2) Natural Hazards and Meteorology

VI. (1) Environmental Pollution and Control Measures I

   (2) Environmental Pollution and Control Measures II

**VOCATIONAL COURSES**

I. Water Resources and Fluid Mechanics

II. Water Resources Management

III (1) Hydrology

   (2) Water Quality Parameters and Assessment

IV Water Quality Management -I

V (1) Water Pollution

   (2) Water Quality Management-II

**Semester 5 (Open Course)** Solid Waste Management

VI (1) Water Analysis

   (2) Watershed Management

**Semester 6 (Elective Course)**

a. Rain Water Harvesting

b. Environmental Aspects of Estuarine System

c. Disaster Management

d. Elementary Concepts in GIS & GPS
COMPLEMENTARY COURSES

I. Theoretical Inorganic Chemistry
II. Organic and Environmental Chemistry
III. Analytical Chemistry and Biomolecules
IV. Physical Chemistry

FOUNDATION COURSE

I. Computer Basics & Informatics
II. Computer Application for Biostatistics

FOUNDATION COURSE

I. Computer Basics & Informatics

Computer

History and development of computers - basic knowledge of computer systems - softwares and hardwares - free softwares - M.S Word, Excel, Power point.


Internet - managing bodies of the internet - Internet Society - Internet Service Provider - Internet application software.

Overview of Information Technology

Features of the modern personal computer and peripherals - Computer network.

Knowledge Skills

Data information and knowledge - Internet as knowledge repository - Introduction to use of IT in teaching and learning. Educational softwares. INFLIBNET - academic services.

Social Informatics

IT and society - overview of it’s application in medicine, health care, environmental studies-defence, crime detection, communication.

Applications of IT in weather forecasting, education, film and media - virtual reality.

References


II Computer Application for Biostatistics

Collection and representation of data - collection and classification tabulation of data.

Graphical representation of data - methods of preparation of graph - Frequency curve relative frequency map - cumulative frequency map - relative frequency map or ogive. Dot diagram -significance of graphic representation - limitations of graphic representation. 9hrs

Measures of central tendencies - mathematical average, average of position - measures of dispersion - range-mean deviation - standard deviation - distribution patterns. 9 hrs

Types of variability - experimental variation - biological variability, real variability - experimental variability, error, subjective, objective instrumental and sampling error. 9 hrs

References

FOUNDATION COURSE - PRACTICALS

Semester II  Computer Application for Biostatistics
1. Create a power point presentation of wild life population.
2. Graphical representation - Bar, Pie charts of flora and fauna.
3. Plotting straight lines
4. Determination of Central tendencies

CORE COURSE

SEMESTER I   Research Methodology & Perspectives of Science  54 hrs

Introduction to research Methodology

Research fundamentals and terminologies. Introduction - scientific method - meaning of research - comparison of scientific method & non scientific method - objectives of research-research methodology - types of research. 12 hrs

Defining research problems - formulation of the problem - developing the research plan. Research design – design – experimentation – evaluation - validity of experiment. 10 hrs

Statistical analysis and interpretation of data. Report writing and presentation. Writing and formatting of reports - report presentation. 8 hrs

Perspective of science

Design of an experiment – experimentation - data collection - interpretation and deduction repeatability and replication - documentation of experiments - record keeping - planning of experiment – designs - instrumental requirements - types of instrumentation - accuracy and precision. 14 hrs

Data handling in science

Significance of statistical tools in data interpretation - errors and inaccuracies. Ethics in science -scientific information - digital sources. 10 hrs
References

SEMESTER I Core course (Practicals)
1. Sampling methods - Plant or animal community on land.
2. Population censusing methods - Total count, sampling.
3. Estimation of beetle in wheat flour.

II Environmental Studies 72 Hours
Unit 1: Multidisciplinary nature of environmental studies; Definition, scope and importance, need for public awareness. (2 hrs)
Unit 2: Natural Resources : Renewable and non-renewable resources : Natural resources and associated problems. a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources : World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. (12 hrs)
Unit 3: Ecosystems : Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystems :-
   a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem
   d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (10 hrs)
Unit 4: Biodiversity and its conservation : Introduction – Definition : genetic, species and ecosystem diversity:Biogeographical classification of India. Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity. (12 hrs)
Unit 5: Environmental Pollution : Definition, cause, effects and control measures of:- a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution e. Noise pollution, f. Thermal pollution, g.
Nuclear hazards; Solid waste Management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies.; Disaster management: floods, earthquake, cyclone and landslides. (12 hrs)

Unit 6: Social Issues and the Environment: From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns. Case Studies; Environmental ethics: Issues and possible solutions; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies; Wasteland reclamation; Consumerism and waste products; 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. (12 hrs)

Unit 7: Human Population and the Environment: Population growth, variation among nations; Population explosion – Family Welfare Programme; Environment and human health; Human Rights; Value Education; HIV/AIDS; Women and Child Welfare; Role of Information Technology in Environment and human health; Case Studies. (7 hrs)

Unit 8: Field work: Visit to a local area to document environmental assets river/ forest/grassland/hill/mountain; Visit to a local polluted site-Urban/Rural/Industrial/Agricultural; Study of common plants, insects, birds; Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lecture hours). (5 hrs)

REFERENCES

2. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India, Email:mapin@icenet.net
7. Down to Earth, Centre for Science and Environment
9. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay
18. Survey of the Environment, The Hindu (M)

SEMESTER II   Core course (Practicals)
1. Identification of flora and fauna – terrestrial, marine and freshwater ecosystems
2. Estimation of primary productivity – light and dark bottle method
3. Community study : quadrat and line transect method
4. Construction of food chain/ food web : terrestrial and aquatic ecosystems

III  Paper (1)  Natural Resources and Conservation 54 hours

Natural resources- definition and classification-Natural resources with reference to India. Renewable and non-renewable resources - Exhaustible and non- exhaustible resources; Mineral resources – distribution – production-coal fossil fuel 10 hrs

Biotic resources-forest and wild life – Biodiversity-hot spots in India-threat to biodiversity. In situ & Exsitu conservation. Soil and Land Land use pattern - Green revolution; River systems-climate and climatic regions of India. Seasons - onset and retreat of Monsoon –Drought – flood; Flood control programme. 12 hrs


Man and population, density, distribution-growth trends-sex ratio-age, Population explosion. 12 hrs

References
1. Economic and commercial geography of India T.C Sharma Coutinho, Vikas publishers- New Delhi

SEM III   Practicals
1. Measuring rainfall and calculation of normal rainfall.
2. Recording of maximum -minimum temperature
3. Recording of humidity.
4. Preparing a field map using prismatic compass.

SEM III Paper (2). Environmental Management 54 hrs

Definition - Basic principles of Environmental Management. Environment Impact Assessment-Definition and aim, Principles and Concepts of EIA- EIA assessment methodologies - few case studies. 9 hrs

Concept of Sustainable Development - UN and International conferences - Rio summit Johannesburg conference on sustainable development; Copenhagen summit. 9 hrs

National Environment policies Public Interest Litigation (PIL)-List of cases like M.C.Mehtha vs Union Government of India. 9 hrs

Environment friendly products - pollution abatement technologies; concept of environmental planning - city planning. 9 hrs

Introduction to Environmental Economics.- environmental issues. 9 hrs

References


SEMESTER III  Practicals

2. A report of visit to a factory where Pollution abatement technology is implemented.
3. A report on environmental law case study in India.
4. A case study of EIA

SEM IV  Paper 1 - Environmental Biotechnology and Microbiology (90 hours)


Vectors: Role of vectors in GE. Mention of common vectors such as plasmids, bacteriophages, cosmids, artificial chromosome vectors like HAC, YAC, BAC. Host cells: Role of host cells in GE. Mention of prokaryotic hosts - E coli, Bacillus subtilis. Methods of gene transfer: Mention of transformation, conjugation, electroporation, lipofection, direct transfer. 12 hrs

Salient features of different microbial groups and their current classification - algae, fungi, bacteria, viruses, protozoa, mycoplasma and rickettsia. Microbial nutrition: Photoautotrophy, chemoautotrophy, heterotrophy. Interactions between microorganisms: commensalism, mutualism, parasitism and ammonisation. 12 hrs

Microbial interactions with plants: mycorhiza, rhizobium, actinomycetes and their interactions with legume associations and rhizosphere. Microorganisms in biomass and energy production: Microbes producing protein - single cell protein. Methane (Biogas or Gobar gas) 12 hrs
Environmental Microbiology - Different fields in environmental microbiology. Microbes and geochemical cycles - Nitrogen cycle, Sulphur cycle. Microorganisms as geochemical agents. 12 hrs

Growth of micro organisms - cell cycle, population growth, batch culture, continuous culture. Mycelial growth. Environmental factors and microbial growth. 9 hrs


Epidemiology of microbial diseases of Man - Tuberculosis, Cholera, Hepatitis, AIDS, Histoplasmos, Aspergillosis, Amoebiasis and Malaria. 9 hrs

REFERENCES

2. Environmental Biology & Toxicology, P.D. Sharma.

SEMESTER IV PRACTICALS Paper -I

1. Demonstration of Sterilisation by dry heat and wet heat(Steam Autoclaving)
2. Cultutre media preparation using PDA (Potato Dextrose Agar)

SEMESTER IV Paper( 2) Biophysics, Biostatistics and Computer Application 36 hrs

Biophysics

Light observation effect effect-Beer and Lambert’s law.Absorption spectrum, Redox potential-Laws of photochemistry. Fluorensce, phosphorescence and other photochemical reaction. 9 hrs

Principle and applications of light and electron microscopy, Spectrophotometry, mass spectrometry Absorption spectroscopy, X-ray analytical methods. 9 hrs

Biostatistics Various sampling methods, Measures of dispersion Test of significance, Chi square test and t-test statistical analysis using computer. 9 hrs

Internet browsing and websites for statistical analysis (Basic idea only). 9 hrs
References


SEMESTER V   Paper (1) Environmental Geology and Mineralogy 72 hrs

Introduction to Geology - Environmental Geology - Definition and scope - Geological agents-Exogenous, and endogenous geological agents. Current views on origin of earth. 12 hrs

The classification of rocks based on their origin; concept of rock cycle; weathering. River as a geological agent; development of river. Rivers in India. 12 hrs

Streams - Drainage basin - Drainage pattern; energy in streams; factors controlling formation of soil; soil profiles. 12 hrs

Glaciers - Types and geological activity - wind -geological activity of wind. Meteorology -elements and factors of climate-influence weather and climate in agriculture; heat island - effect of climate change in ecosystem. 12 hrs

Crystals and minerals - Physical properties of minerals such as colour, streak lustre, hardness and specific gravity. Composition and diagnostic properties of minerals – Quartz, feldspar, tale gypsum, galena, beryl, corundum. 12 hrs

Nature and genetic relationship with igneous rocks-Textures of igneous rocks Mescopic features of the following rock types - granite, syenite, gabbro, basalt. 12 hrs

A brief study of the origin of sediments and sediment rocks. Feature of the following sedimentary rocks - sand stones. 12 hrs

References


SEMESTER V   PRACTICALS   Paper -II

1. Identification of common minerals & rocks
2. Identification of soil types - red soil, alluvial soil, black soil
3. Determination of soil moisture content.
4. Determination of soil pH
5. Determination of conductivity.
6. Estimation of organic carbon of soil

SEMESTERV   Paper (2)   Natural Hazards and Meteorology 72 hrs

Basic concept and definition of natural hazard and disaster - earth quake - distribution and causes; volcanoes - types and causes of volcanic eruptions. 12 hrs
Introduction to landslides, (Tsunami), cyclones, floods, hurricane, tornadoes, drought, fire; Causes, mitigation and management. 12 hrs

Anthropogenic disasters: chemical, industrial hazards, nuclear power plants, occupational hazards; hazards due to dam break. Mitigation measures. 12 hrs

Differences between natural disaster and artificial disasters. Environmental health hazard and risk management; Risk identification and assessment – prevention and mitigation. 12 hrs

Meteorology - elementary concept of climate, weather and climate. Clouds – types and classification; wind – forces affecting wind; types of wind and measurement; precipitation – measurement of precipitation; micrometeorology 12 hrs

Climate change in agriculture; urban climatology; drivers of climate change – green house gases; effect of climate change on ecosystems, factors affecting climate. 12 hrs

References

2. Rutley’s elements of Minerology CBS.Publishers. New Delhi
4. Principles of Petrology, Tyrrel G. W. 1948

SEMESTER VI. Paper (1) Environmental Pollution and Control Measures–I (54 hrs)

Air pollution - basic definitions and requirements - structure of atmosphere - composition of air, primary and secondary pollutants - unit for quantification of air pollution. Classification of air pollutants. 12 hrs

Automobiles exhaust - Emission standards - COx, NOx, SOx. Indoor air pollution. Effect of pollutants on plants and human beings. 9 hrs

From Factories - hydrocarbons, polychlorinated hydrocarbons; photochemical smog. 6 hrs

Control of air pollution - from factories-Automobile Exhaust-Automobile emission standards-Specific emission standards; Bharath Stages -I, II, III. Measures to check Industrial pollution. 9 hrs

Sources of correction - Control of particulate - removal of particulate matter. Control strategies -control of specific gaseous pollutants - Air Quality standards. 6 hrs


References

1. A text book on Environmental Pollution and Control, Dr. H S. Bhatia, Galgotia Publications Private Ltd-5, Ansari road, Darya Ganj, Delhi-110 002.
2. Industrial Pollution, V.P. Kudesia, Pragati Prakashan, Meerut 250 001.
3. Air pollution, V.P. Kudesia, Pragathi Prakasan Meerut 250 001.

SEMESTER VI. Paper (2) Environmental Pollution and Control Measures -II 36 hrs

Parameters of water pollution - standards of aquatic life. Classification of industrial wastes. 6 hrs

Land and soil pollution - Disposal on land - pesticides pollution- control of soil pollution. 6 hrs

Noise pollution – definition; measurement - decibels; effect of noise pollution on people; traffic noise pollution; industrial noise pollution. 6 hrs
Railway noise; aircraft noise; reduction of noise; absorption of sound. Control of noise pollution. 6 hrs

Radioactive pollution - Kinds of radiation; nuclear reactions; natural sources of radioactive pollution; anthropogenic sources of radiation. Radioactive waste; biological effects of radiation pollution; dangers from nuclear plants. 6 hrs

Control from radiation - methods of control; minimizing X-ray hazard - Hazards of Radioactive pollution - Preventive measures from radiation. 6 hrs

References
2. Industrial Pollution. V.P. Kudesia-Pragati Prakashan, Meerut 250 001.
3. Air pollution. V.P. Kudesia, Pragathi Prakasan Meerut 250 001.

SEMESTER VI PRACTICALS Paper -I

INSTRUMENTATION (Demonstration)
1. pH meter
2. Conductivity meter
3. Turbidity meter
4. Colorimeter
5. Spectrophotometer

SEMESTER VI PRACTICALS Paper -II

1. Determination of COD
2. Analysis of anion mixture solution (2 Anions) among the following – Carbonate, sulphide, Thiosulphate, Oxalate, Chloride, Nitrate, Flouride, Sulphate, Phosphate
3. Thin layer Chromatographic separation of plant pigments.

Semester 6 (Elective)

a. Rain water Harvesting
b. Environmental Aspects of Estuarine System
c. Disaster management
d. Elementary concepts in GIS & GPS

3x18 = 54 hrs

Semester 5 (Open) Solid Waste management

Solid wastes and its characteristics; classification of solid waste – source; factors affecting quality & quantity. Physical and chemical characteristics - collection & transportation. 9 hrs

Solid wastes from households, institutions, commercial establishment, public amenities; demolition sites; construction sites; mining & quarrying; sewage treatment plants. Types of solid wastes – municipal; agriculture; biomedical; hazardous; radioactive wastes.

Waste Management - global perspective - source reduction - Reuse and recycling. Disposal techniques - composting; principles of composting; factors affecting composting. Types of composting - Windrow layout and management.

Methane recovery; sanitary landfill - advantages and disadvantages of sanitary landfill. Methods of landfill. Incineration - types of incinerators - reactions involved - advantages and disadvantages of incineration. 9 hrs

54 hrs
Estimation of moisture content; determination of combustible matter; determination of calorific value; reactions involved. Functional elements of solid waste management. Disposal system with or without recoveries.


References

A text book on Environmental pollution and Control. Dr. H.S. Bhatia, Galgotia Publications private limited-5, Ansari road, Darya Ganj, Delhi-110 002.

Semester 6 (Elective)

a. Rain water Harvesting

Rain water harvesting- Rainwater collection for drinking purpose; domestic rain water collection-community rain water collection.

Artificial recharge; methods of artificial recharge; roof water harvesting-surface water harvesting; dug cum borewells.

Mini artificial aquifer systems; borewell and hand pumps; artificial recharge in roads and colonies. Recycling and treating- methodology land use planning in watershed.

Rain water harvesting for sustainable development - water related sustainability issues in cities-Depletion of ground water table- concept of zero run off. Urban RWH practices.

The importance of watershed management in Kerala - Rain water harvesting in Institutional buildings.

Legal provisions in rain water harvesting in India and Kerala.

References

1. A.Keldho .T.I Sustainable watershed management strategies in semi arid regions of India .II Bombay email.eldho@civiliitb.ac.in.
2. KRG Rainwater Harvesting Foundation.

Semester 6 (Elective)

b. Environmental Aspects of Estuarine System

The Estuary- definition - Physical features- salinity, temperature, circulation and mixing processes-Major and minor elements- chemical speciation in estuarine waters- Suspended matter in estuaries- adsorption and desorption processes- Sediment transport and sedimentation- Sediment- water interaction and the geochemistry of interstitial waters.

Nutrients, dissolved gases, and general biogeochemistry in estuaries- Biotic aspects of the chemistry of estuaries - Carbon dioxide - calcium carbonate system in estuaries.

Inorganic pollutants, particularly heavy metals in estuaries - Chlorinated hydrocarbons in estuaries- Oil pollution of the marine environment - with an emphasis on estuarine studies - Recovery and decontamination of estuaries.

References

2. Estuaries: monitoring and modeling the physical system. By Jack Hardisty. Blackwell Publishing, 350 main street malden MA 02148-5020, USA


4. Practical handbook of estuarine and marine pollution.

By Michael J. Kennish CRC press marine science series (For Oil Pollution and halogenated hydrocarbons)

**Semester 6** **(Elective)**

d. **Elementary concepts in GIS & GPS**

36 hrs

Map language – introduction; map as model; spatial elements terminology; classification of maps; map scale; map projection; grouping of map projection; commonly used map projections - Computer in map production; linkage of GIS to Remote Sensing.

9 hrs

Remote sensing; basic principles – Introduction; electromagnetic remote sensing process; nature of electromagnetic radiation. Electromagnetic spectrum; Energy interaction with earth’s surface materials. 9 hrs

Fundamentals of GIS - roots of GIS; over view of information system; contribution; disciplines; GIS definition and terminology – Topology – Models - GIS queries - GIS architechture -Components of a GIS.

9 hrs


9 hrs

References


**Semester 6 (Elective)**

**Disaster management**

36 hrs

Natural disasters : Introduction to - earthquake, volcanic eruptions, landslides, flash flood (Tsunami), major flood, storm surge, hurricane, tornadoes, drought

9 hrs

Anthropogenic disasters - disasters due to chemical, industrial, nuclear, domestic, dam break.

9 hrs

Pre-disaster, during disaster, post disaster; possibility of disaster - warning system - preparedness relief operations - National, State level, Local level – Agencies; concepts in remote sensing, GIS, GPS – applications. Rehabilatations - immediate, first stage, permanent.

9 hrs

Disaster assessment - casualty assessment; ecosystem damage - assessment. Introduction to disaster management. Management plan - preparedness, vulnerability of disaster, safety measures Role of NGO’s - International, National, Regional (UN, Red Cross Army, Paramilitary NCC, NSS)

9 hrs

References


VOCATIONAL COURSES

SEMESTER I. **Water Resources and Fluid Mechanics** 36 hrs

- Water as a resource material - multiple uses of water - consumptive uses - irrigation; Partial consumptive uses - public water supply - Fire demand - Industrial uses - thermal uses. 9 hrs
- Nuclear power generation - non consumptive uses - hydropower generation - inland navigation water resources – rivers, ponds, lakes. 9 hrs
- Introduction to fluid mechanics - properties of fluids – density – viscosity - surface tension- types of flow - laminar flow - turbulent flow. 9 hrs
- Reinhold’s Number. Reynold’s experiment - flow of water in open channels - pipes, calculation of flow velocity. Head losses – Dary-Weisbach equation; Hazen William’s formula; Manning’s formula (No derivation). 9 hrs

Reference

2. Water resources Asit.K. Biswas Tata Macgraw Hill publishing company Ltd.

Practical

**SEM- I**

1. Measurement of rain fall
2. Measurement of Evaporation (Relative Humidity)
3. Measurement of atmospheric temperature
4. Record of humidity

SEMESTER II. **Water Resources Management** 54 hrs

- Water resources : types – surface water, ground water, water availability and uses. Water requirement for various uses - Industrial uses – aquaculture - recreational uses; Irrigational uses - definition of irrigation – necessity – benefits; ill effects - systems. 12 hrs

Freshwater shortage; impact of climate on freshwater resources; management and conservation

Reference
1. Irrigation Engineering, N.N.Basak.

SEMESTER- II Practical
1. Determination of pH of water sample
2. Determination of Alkalinity of water sample
3. Determination of SPM load of water.
4. Determination of Surface tension by drop weight method.
5. Determination of Surface tension by drop number method
6. Determination of Viscosity of a sample by Ostwalds Viscometer method
7. Determination of Humidity by Psychrometer.

SEMESTER III Paper (1)
Hydrology - I

Surface water hydrology
Hydrology (surface water); definition; importance. Hydrologic cycle; climatic factors influencing hydraulic cycle – humidity, temperature, radiation, wind. Precipitation - condition for occurrence of precipitation.

Measurement of rainfall - different types of rain gauge; rainfall measurement by radar; errors in measurement; estimation of missing rainfall data; average rainfall over an area. Mean and annual rainfall; measurement of snow fall.

Characteristics of precipitations of India. Evaporators; factors affecting evaporation - Estimation of evaporation - evaporation pan method - Evaporation from soil surface.

Transpiration - Factors affecting infiltration rates. Infiltration rate; infiltration capacity; Infiltration indices; runoff; estimation of runoff; hydrograph; global water balance; water losses-inter basin transfer.

Ground water hydrology
Hydrology - ground water hydrology; occurrence of ground water; different types; Aquitard- Aquifuge - ground water collecting systems – wells.

Types of wells-collection – conveyance and distribution-general study-Ground water movement-Darcy's law (No derivation required); Ground water and well hydraulics.

Ground water and environmental influence-ground water level fluctuation due to stream flow-Evapo-transpiration; urbanization - ground water pollution by municipal, industrial, agriculture, domestic sources.
Saline water intrusion - Investigation of Ground water (Outline study only). Surface and ground water intrusion. Various types of underground sources. Infiltration galleries - Infiltration wells - Spring wells - open wells or dug wells - tube wells - different types. 9 hrs

Reference

SEMESTER III Paper (2) Water Quality Parameters and Assessment 54 hrs

Water quality parameters - USPHS Scale and WHO scale, sampling; preservation. Water as a solvent. Collection of water sample. Analysis of natural and waste water sampling procedures. Main quality characteristics of water a) Alkalinity b) Hardness c) Total solids. 18 hrs

Physical properties of water- like BP, MP, critical temperature, viscosity, Surface tension, dielectric constant, dipole moment, Heat of vaporization; tolerance limits for trace metals in drinking water (Al, B, Cd, Co, Pb, Mn, Ni, Fe, Zn, Cr, Cu, Mo, Se, Sc). 16 hrs

International standards for Drinking water - pH, BOD, COD, B, As, Cd, Cr, NH\textsubscript{3}, Fe, Cl, Hg, Mg, total hardness, pesticides, \textit{E. Coli}, TDS; International standards for drinking water prescribed by WHO. 12 hrs

Water pollution - types of water pollution; Sources of water pollution; Harmful effects of water pollution - Strategies for water pollution control. 8 hrs

Reference

SEMESTER - III Practicals
1. Determination of Chlorine percentage in a sample of bleaching powder.
2. Determination of concentration of chloride ion in a sample of water sample
3. Determination dissolved oxygen in a sample of water.
4. Determination of density of water

SEMESTER IV Paper (2) Water quality Management -I 72 hrs

Water quality requirement and standards for various uses - drinking, industrial, irrigation aquaculture, cooling, recreation. 9hrs

Quality of water from different sources - water quality monitoring, sampling methods for waste water; stream and lake water, sediment. 9 hrs
Sampling equipments: Niskin water sampler, Nansen water sampler, Dussart flask.  

Water treatment processes; conventional process – sedimentation, coagulation, flocculation, filtration, disinfection.


Water softening - hardness and measurement of hardness - effects of hardness - removal of hardness.

Specific water treatment; removal of iron, manganese, chromium; Desalination. Reverse osmosis; electrodialysis; freezing method; multi flash evaporators


Reference
3. Waste Water Treatment for Pollution Control and Reuse, Tata Macgraw Hill publishing company.

SEMESTER IV   Practical
1. Determination of BOD of a sample of water.
2. Determination of COD of a water sample
3. Determination of TDS in a sample of water.
4. Determination of Salinity in a sample of water
5. Determination of hardness of water

SEMESTER V Paper (1) Water Pollution  
Sources of water pollution; physical pollution of water; chemical pollution of water; biological pollution of water.

Common impurities in water; testing of water; physical test; chemical test; bacteriological test.  

Standards of drinking water. Water bone diseases; Maintenance of purity of water. Ground water pollution, factors affecting ground water pollution, harmful effects of ground water pollution.

Surface water pollution; Factors affecting surface water pollution - factors affecting nutrient loss in surface water - lake water pollution.

River water pollution - global river water pollution - sea water pollution-marine pollution. Control of pollution in seawater; role of microorganisms in cleanup operation.

Organic pollutants - synthetic detergents; ecofriendly detergents containing enzymes; eutrophication thermal pollution in water; esticide pollutants.
Reference


**SEMESTER V Paper (2) Water quality management-II**

<table>
<thead>
<tr>
<th>Hours</th>
<th>Topic</th>
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<tbody>
<tr>
<td>9</td>
<td>Quality and characterization of domestic waste water - physical Chemical and Biological Properties of waste water. Determination of COD, BOD.</td>
</tr>
<tr>
<td>9</td>
<td>Natural methods of sewage disposal: Dilution method, Sewage farming method, Self purification theory; Sanitary water management - sanitary waste; Definition-importance, historical back ground. Systems of sewage disposal. Dry conservancy system &amp; water carriage system.</td>
</tr>
<tr>
<td>9</td>
<td>Sewage sickness - primary and secondary treatment - conventional and low cost - advanced waste water treatment including nitrogen and phosphorous removal - miscellaneous treatment of sewage.</td>
</tr>
<tr>
<td>9</td>
<td>Oxidation pond – cesspool - septic tank - soak pit. Waste water disposal and reuse. Characteristics and treatment of industrial waste water : breweries and wineries; distilleries; paper and pulp mill; sugar mill; oil refineries.</td>
</tr>
<tr>
<td>9</td>
<td>Petrochemical industries; tanneries; pharmaceutical plants; fertiliser plant; electroplating industries; textile mills.</td>
</tr>
<tr>
<td>9</td>
<td>Treatment and disposal of sludge : thickening and digestion; conditioning and dewatering-incineration - ultimate disposal.</td>
</tr>
</tbody>
</table>

References


**SEMESTER - V Paper –I Practicals**

1. Determination of chlorine demand a sample of water.
2. Determination of residual chlorine in a municipal water sample.
3. Determination of moisture percentage of soil.
4. Determination of PH of soil.

**SEMESTER - V Paper –II Practicals**

1. Gravimetric estimation of-
   a) Sulphate, oxalate
   b) Barium, Calcium, Iron, Nickel
2. Colorimetry & turbidimetry
   a) Sulphide, fluoride, silicate, ammonia & sulphate
Various methods of analysis; Monitoring techniques and methodology; Determination of pH - Specific conductance - Dissolved Oxygen, NH$_3$, NO$_3$, & NO$_2$, Cl$^-$, F$, CN^-$, S$^2$, SO$_4^{2-}$, PO$_4^{3-}$. 6 hrs

Total hardness (Ca& Mg), B, silica, metals and metalloids As, Se, Be, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ag, Zn. 6 hrs

Chemical Oxygen Demand, Biological Oxygen Demand, Total Organic carbon, phenols, pesticides, surfactants, tannin and lignin. Microbial examination: Coliforms (Escherichia coli) and total bacteria. 6 hrs

Laboratory analysis of water sample; Determination of Turbidity of water sample - By Jacksons Turbidimeter, Baylis Turbidimeter and Nephelometers. Method to find the odour of a given water sample. 6 hrs

Method to find the colour of a given water sample. Method to determine the pH of given sample of water by colorimetric and electrometric method. 6 hrs

Method to find the carbonate, bicarbonate and hydroxide alkalinity of a water sample. Method to determine the concentration of chlorides of a given water sample. 6 hrs

Method to determine the total hardness of a water sample by standard EDTA method. Determination of residual chlorine in a given sample of water by (a) Orthotoludine Test; (b) Starch Iodide Test; (c) DPD Test 6 hrs

Method to determine the chlorine demand of a water sample; Method to determine the available chlorine percentage in a given sample of bleaching powder. 6 hrs

Method to determine the amount of dissolved oxygen (DO) of a water sample by Winkler Method; Method to find out the Suspended solids (SS), Dissolved solids(DS) and Total Solids (TS) of a water sample. 6 hrs

Watershed – definition - classification of watershed - sub, milli, micro and mini watershed. Hydrology of watershed. 6 Hrs

Eco system in a watershed - Land use changes and resource degradation in watersheds - Agronomic measures for resource management in a watershed - choice of vegetation. 6 hrs

Land preparation - timely planting. Contour farming - multistoried cropping-mixed cropping-Inter cropping - strip cropping; mulching-cover cropping- crop rotation. 6 hrs

Vegetative hedges - barrier grass land management - agroforestry. Engineering measures - tank-vented cross bars and diversion weirs; stone pitched 6 hrs

Contour bunds, contour trenches and embankments of drains. 6 hrs

Water harvesting cum sediment detention tanks, earthen bunds, subsurface dams. 6 hrs

Watershed management for flood control. Geo textiles in watershed management. 6 hrs

Soil conservation; national water grid and river networking; initial attempts for watershed management in India. 6 hrs

An outline study of watershed management in Western Ghats Development Programme. 6 hrs
SEMESTER VI  Paper I  Practical

1. Volumetric Estimations
   a) Carbonate hardness-Hehner’s method
   b) Non- Carbonate hardness- Hehner’s method
   c) Mixture of Carbonate-Bi carbonate-warders method (N/20 HCL & std. sodium carbonate (2600 ppm)
   d) Sulphate ion in H$_2$SO$_4$ (N/20 NaOH & std sodium carbonate(2600 ppm)
   e) Iodine in the solution (N/50 thiosulphate & std pot. dichromate (1000 ppm))

SEM -VI  Paper II  Practical

f) Colorimetric estimations of
   i. nitrite
   ii. nitrate
   iii. phosphate
   iv. total nitrogen
   v. total phosphorous
   vi. sulphide
   vii. ammonia
   viii. silicate
   ix. fluoride
   x. ferrous iron and total iron.

Project :- An investigatory Project report. This work may be based on Environmental Science (significance for Environment) or, project based on Water quality parameters (Local, Regional, state level, or National level important issues can be the topic of interest) 

COMPLEMENTARY COURSES

I Theoretical Inorganic chemistry 3x18=54 hrs
II Organic and Environmental chemistry 3x18=54hrs
III Biomolecules and Analytical chemistry 3x18=54 hrs
IV Physical chemistry 3x18=54 hours

COMPLEMENTARY COURSES (Auxiliary Chemistry)

Semester-I Theoretical and Inorganic Chemistry 54 hours

Module-1: Atomic Structure

Atomic spectrum of Hydrogen - different series, Bohr theory - postulates - statement of Bohr energy equation - derivation of spectral frequency from Bohr equation. Schrodinger wave equation (no derivation mention only) concept of orbitals, the four quantum numbers and their significances. Orbital wise electron configuration, energy sequence rule - Pauli’s principle, Hund’s rule, stability of filled and half filled orbitals

Module - II Radio Activity and Nuclear Chemistry

Radio active equilibrium (qualitative only). Detection of radio activity by Wilson’s cloud chamber and Geiger Muller Scintillation counter - units of radio activity - Curie and Rutherford - Radio Carbon dating, Rock dating, Neutron activation analysis Applications in agriculture and medicine. A brief study of the biological effects of radiation such as pathological and genetic damage, Dosimetry - Units - rad, gray and roentgen. Nuclear Chemistry - stability of Nucleus - n/p ratio, artificial transmutation and radio activity, mass defect, binding energy, atomic fission and fusion.

Module III - Chemical bonding

Energetics of bond formation - Types of Chemical bonds - Energetics of ionic bond formation - Lattice energy - Born Haber Cycle - partial covalent nature of ionic bond - Fajan’s rules, polarity of covalent bond
its relation with electronegativity - electro negativity scales - Paulings Scale factors influencing polarity, dipole moment - its relation to geometry.

**Module IV - Chemical bonding II**  
9 hrs

Hydrogen bond - inter and intra molecular - its consequences on boiling point - volatility and solubility.  
Hybridisation and structure of molecules - SP, SP², SP³, dSP², dSP³, SP²d², and SP²d³ hybridisation with examples.  
Explanation of bond angle in water and ammonia VSEPR theory, geometry of molecules with bond pairs of electrons only, geometry of molecules containing bond pairs and lone pairs of electrons, limitations.  
A brief review of molecular orbital approach, LCAO method - bond order, bond distance and stability of O₂, O₂²⁺, O₂²⁻, NO, NO⁺, CO and HF.

**Module V- Metallurgy**  
9 hrs

General principles of occurrence and extraction of metals - purification, roasting, calcination and smelting, reduction to metal, different method with examples, refining of metals- electrolytic and zone refining. Van-Arkel method. Metallurgy of titanium, thorium and uranium.

**Module VI- Coordination Chemistry**  
9 hrs

Types of ligands, Werner’s coordination theory, Valence bond theory of bonding in octahedral and tetrahedral complexes, Drawbacks of valence bond theory crystal field theory of octahedral and tetrahedral complexes, examples - high and low spin complexes, magnetic properties, application in qualitative and quantitative analysis.

**Semester II Organic and Environmental Chemistry**  
(54 hours)

**Module I - Introduction to organic reaction mechanisms**  
9 hrs

Types of reactions - substitution, addition, elimination and rearrangement reactions. Electrophilic and nucleophilic reagents - concept of inductive effect, hyper conjugative effect and resonance effect - reaction intermediates - carbocations, carbanions, carbenes, and free radicals - their formation, stability and configuration.

**Module II - Stereochemistry**  
9 hrs

Optical isomerism- chirality, racemisation and resolution- relative and absolute configuration- DL and RS notations- asymmetric synthesis- optical isomerism due to restricted rotation- geometrical isomerism- EZ- nomenclature- conformation of ethane, propane, butane and cyclo hexane - Axial and equatorial bonds in cyclo hexane.

**Module III - Polymer Chemistry**  
9 hrs

Classification of polymers based on origin, structure, synthesis, and molecular forces. Commercially important polymers: structure and application of polyethylene, polystyrene, polyhaloolefines, Nylon-6, Nylon-66, Melamine, Terylene, Bakelite, Natural and synthetic rubber, vulcanization, inorganic polymer-silicones.

**Module IV - Carbohydrates**  
9 hrs

Classification- Configuration of glyceraldehydes, erythrose, threose, ribose, arabinose, glucose, fructose and mannose- properties of glucose and fructose- inter conversion of glucose and fructose- Industrial uses of cellulose- of macromolecules.

**Module V - Environmental Chemistry**  
9 hrs

Air Pollution: Types of pollutants in air- carbon monoxide, carbon dioxide, Nitrogen oxides, Sulphur dioxide, hydrogen sulphide, Cl₂, CFC, particulate matter, metals, fly ash, asbestos, hydrocarbons- source
and influence. Acid rain, Green house Gases, Green house effect, ozone layer and its depletion- Sulphatic, phosphatic, nitrogenous, chloride fertilizers-pollution due to long term use of fertilizers. Pesticides like chlorinated hydrocarbons, car bamates, organophosphorous compounds, organometallics, inorganic compounds- Non biodegradable pesticides - Environmental impact of pesticides. Detergents - cationic, anionic and non ionic- water pollution by detergents.

**Module VI - Organometallic compounds**

9 hrs

Definition and classification - preparation, properties and applications of Grignard reagents, Ferrocene. Biological and environmental aspects. Applications in medicine, agriculture and horticulture - antitumour drugs.

**Semester III Analytical Chemistry and Biomolecules**

(54 hours)

**Module I - Spectroscopy I**

9 hrs

Regions of electromagnetic spectrum- interaction of radiation with matter-Various types of molecular spectra- Microwave spectroscopy- spectra of diatomic molecules-selection rule-frequency of separation of spectral line- determination of bond length- Infra red spectra-selection rule-frequency of separation- calculation of bond length.

**Module II - Spectroscopy II**

9 hrs

Raman spectroscopy: Stoke’s and antistoke’s lines - Quantum theory of Raman spectra-advantage and disadvantage -complementary nature of Raman and IR spectra- Mutual exclusion principle.

**Module III - Instrumental methods of analysis**

9hrs


**Module IV - Analytical Chemistry**

9 hrs


**Module V - Chromatography**

9 hrs

Outline study of adsorption and partition chromatography-column, paper, thin layer, ion exchange , and gas chromatography- Rf value - relative merits of different techniques- Separation of amino acids from mixtures.

**Module VI- Bioinorganic compounds**

9 hrs

Metalloporphyrins - photosynthesis and respiration- haemoglobin – myoglobin - mechanism of O₂ - CO₂ transportation - nitrogen fixation-carbon fixation - carbon cycle - biochemistry of iron toxicity and nutrition-essential and trace elements of biological systems

**Semester IV Physical Chemistry**

(54 hours)

**Module I- Colloids**

9hrs

Module II- Electrochemistry

Conductance- specific, equivalent and molar conductance-measurement using conductivity meter-variation with dilution - conductometric titration- principle-merits- strong acid-strong base titration & weak acid - strong base titration.

Electrochemical cell- cell potential and electrode potential- standard electrode potential -electro chemical series-SHE -measurement of electrode potential- Nernst equation for electrode potential( No derivation)-Calomel electrode, pH electrodes-Glass electrode, Quinhydrone electrode- fuel cell.

Module III- Binary liquid systems

Completely miscible liquid pairs, vapour pressure - composition curves, boiling point- composition curves, fractional distillation, Azeotropic mixtures, critical solution temperature, Conjugate layers, phenol-water system. Theory of steam distillation, distribution law, limitations of distribution law, application of distribution law solvent extraction.

Module IV- Thermodynamics

First law - intrinsic energy and enthalpy - work done during reversible isothermal expansion-second law of thermodynamics-entropy and free energy - concept of spontaneity and reversibility, Gibb’s Helmholtz equation - derivation of relation between heat of reaction at constant pressure and constant volume - Hess’s law - bond energy and bond dissociation energy -measurement based on Hess’s law - Third law of thermodynamics.

Module V- Equilibrium

Chemical equilibrium - relation between Kp and Kc-Vant Hoff’s isotherm equation and isochoric equation- relation connecting equilibrium constant and degree of dissociation for the following systems: 2NH₃, N₂ +3H₂ , PCl₅ PCl₃ +Cl₂ - degree of dissociation- determination from density measurement- Le Chatelier principle and its applications. Concept of acid and bases-ionic product of water- pH, pOH, pKw- ionization constants of weak acids and bases- Buffer solution- Henderson equation-calculation of pH of solutions.

Module VI- Chemical Kinetics, Catalysis and Photochemistry

Order and molecularity, derivation of rate equation for zero, first and second order reactions (same initial concentrations) - determination of order of reactions—effect of temperature on rate of reactions-concept of activation energy-illustration of exothermic and endothermic reactions based on it- Arrhenius equation-determination of Arrhenius parameters -intermediate compound formation theory and adsorption theory of catalytic reactions.

Practicals

Semester I & II- Qualitative Analysis

1) Reactions of anions - carbonate, sulphide, sulphate, thiosulphate, oxalate, nitrite, nitrate, chloride, phosphate, fluoride (No exam)
2) Identification by flame colouration : Lithium, sodium, potassium, barium, calcium, strontium(No exam)
3) Reactions of cations:Ag⁺, Pb²⁺, Bi³⁺,Cu²⁺, Al³⁺, Fe²⁺, Fe³⁺, Zn²⁺, Mn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, Mg²⁺, NH₄⁺
4) Analysis of solution containing mixture of two cations- at least 10 mixtures (Avoid same group)

Semester III  &  IV- Quantitative Analysis

I. Volumetric Analysis
a) Acidimetry and alkaliometry
1) Estimation of NaOH using Na$_2$CO$_3$
2) Estimation of KOH using Na$_2$CO$_3$
3) Estimation of K$_2$CO$_3$ using Na$_2$CO$_3$
4) Estimation of H$_2$SO$_4$ using oxalic acid
5) Estimation of HNO$_3$ using oxalic acid

b) Permanganometry
1) Estimation of Fe$^{2+}$ using oxalic acid
2) Estimation of sod.oxalate using Mohr’s salt
3) Estimation of Fe$^{2+}$ using oxalic acid
4) Estimation of Mohr’s salt using oxalic acid

c) Dichrometry
1) Estimation of Fe$^{2+}$ using internal indicator
2) Estimation of Fe$^{2+}$ using external indicator

d) Iodometry and Iodimetry
1) Estimation of iodine
2) Estimation of copper

e) Complexometry
1) Estimation of Zinc
2) Estimation of Mg

II Gravimetric Analysis (No Exam)
1) Estimation of water of hydration in barium chloride crystals
2) Estimation of barium in barium chloride solution

References
1) Atomic structure and chemical bonding with introduction to molecular spectroscopy, Manas Chanda.
2) Concise Inorganic Chemistry, J.D. Lee
3) Elements of Nuclear Chemistry, Arnikar
4) Environmental Chemistry, A.K. De.
6) A. I. Vogel, “Text book of Qualitative Analysis”
8) A. K. Srivasthava and P. C. Jain, “Chemical Analysis”.
9) Coordination Chemistry : Bosolo and Johnson.
11) Instrumental Methods of Analysis, B.K. Sharma.
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