K.R. MANGALAM UNIVERSITY
THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Bachelor of Science (Hons) Chemistry

B.Sc. (Hons.) Chemistry

Programme Code:10

2019-20

Approved in the 20th Meeting of Academic Council Held on 16 July 2019

Academic Council
Member Secretary
K.R. Mangalam University

Registrar
K.R. Mangalam University
Sohna Road, Gurugram (Haryana)

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Content

1. Introduction

The K.R. Mangalam Group has made a name for itself in the field of education. Over a period of time, the various educational entities of the group have converged into a fully functional corporate academy. Resources at KRM have been continuously upgraded to optimize opportunities for the students. Our students are groomed in a truly inter-disciplinary environment wherein they develop integrative skills through interaction with students from engineering, management, journalism and media study streams.

The K.R. Mangalam story goes back to the chain of schools that offered an alternative option of world-class education, pitching itself against the established elite schools, which had enjoyed a position of monopoly till then. Having blazed a new trail in school education, the focus of the group was aimed at higher education. With the mushrooming of institutions of Higher Education in the National Capital Region, the university considered it very important that students take informed decisions and pursue career objectives in an institution, where the concept of education has evolved as a natural process.

K.R. Mangalam University was founded in the year 2013 by Mangalam Edu Gate, a company incorporated under Section 25 of the Companies Act, 1956.

K. R. Mangalam University is unique because of its

i. Enduring legacy of providing education to high achievers who demonstrate leadership in diverse fields.
ii. Protective and nurturing environment for teaching, research, creativity, scholarship, social and economic justice.

Objectives

i. To impart undergraduate, post-graduate and Doctoral education in identified areas of higher education.
ii. To undertake research programmes with industrial interface.
iii. To integrate its growth with the global needs and expectations of the major stake holders through teaching, research, exchange & collaborative programmes with foreign, Indian Universities/Institutions and MNCs.
iv. To act as a nodal center for transfer of technology to the industry.
v. To provide job oriented professional education to the pecia student community with particular focus on Haryana.

2. About School

The school imparts out both teaching and research through its various science disciplines viz Mathematics, Chemistry and Physics.

School of Basic and Applied Sciences imparts students technical knowledge, enhances their skill and ability, motivating them to think creatively, helping them to act independently and take decisions accordingly in all their scientific pursuits and other endeavors. It strives to empower its students and faculty members to contribute to the development of society and Nation.

The faculty is in constant touch with various experts in the relevant field and is willing to experiment with latest ideas in teaching and research.

The School comprises of Discipline of Chemistry, Physics and Mathematics.

3. Programmes offered by the School

School offers undergraduate B.Sc. (Hons) Programmes and postgraduate M.Sc. Programmes. All these programmes are designed to impart scientific knowledge to the students and will provide theoretical as well as practical training in their respective fields.

3.1 B. Sc. (Hons.) Chemistry

This course aims to impart basic and applied knowledge in various branches in Chemistry with a view to produce good academics, researchers and professionals in the field.

Eligibility Criteria:- The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board in Science stream with an aggregate of 50% or more.

Course Outline:- Inorganic chemistry / Organic chemistry / Physical chemistry / Analytical methods in chemical sciences / Environmental chemistry / Biochemistry / Green Chemistry.

Career Options:- Opportunities exist in chemical industry, pharmacy, education and forensics.

Programme scheme: - For Programme scheme see Annexure A.

3.2 B.Sc. (Hons.) Physics

Physics, as a stream of study, helps in understanding fundamentals and develop curiosity in understanding various physical aspects of universe. This course aims to impart basic and applied knowledge in physics with a view to produce good academicians, researchers and professionals in varied fields.

Eligibility Criteria: - The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board in Science stream with an aggregate of 50% or more.

Course Outline: - Mathematical Physics / Mechanics / Electricity & Magnetism/Waves & Optics / Thermal Physics / Digital Systems & Applications/Elements of Modern Physics/Analog Systems & Applications/Quantum Mechanics & Applications / Electromagnetic Theory / Statistical Mechanics/ Solid State physics / Elementary Nuclear Physics/ Elementary Particle Physics/Applied Optics.

Career Options: - Opportunities exist in academics, research laboratories and administration besides all the opportunities applicable to any other graduate like UPSC examination's, defence services and other govt. jobs.

Programme scheme: - For Programme scheme see Annexure B.

3.3 B.Sc. (Hons.) Mathematics

Mathematics is a universal part of human culture. This course aims to impart basic and applied knowledge in Mathematics with a view to produce good Mathematicians and researchers. A degree in mathematics provides you with a broad range of skills in problem solving, logical reasoning and flexible thinking.

Eligibility Criteria: - The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board with an aggregate of 50% or more with Mathematics as a main subject.

Course Outline: - Calculus / Vector Calculus / Business Mathematics / Differential Equations / Solid Geometry / Computer Programming / Modern Algebra / Numerical Analysis / Linear Algebra
/ Real Analysis / Complex Analysis / Probability and Statistics / Operational research / Mechanics.

Career Options: - Mathematicians work in business, finance, industry, government offices, management, education and science.

Programme scheme: - For Programme scheme see Annexure C.

4. Programme Duration

The minimum period required for the B.Sc. (Hons.) Programme offered by the University shall extend over a period of three Academic Years.

The maximum period for the completion of the B.Sc. (Hons) Programme offered by the University shall be five years.

5. Class Timings

The classes will held from Monday to Friday from 09:10 am to 04:10 pm.

6. Scheme of Studies and Syllabi

The syllabi of B.Sc.(H) Chemistry Programme offered by SBAS are given in the following pages. These are arranged as: (a) common courses (b) degree specific courses, in numeric order of the last three digits of the course code.

For each course, the first line contains; Course Code and Credits (C) of the course. This is followed by the course objectives, syllabus (Unit I to IV), Text book and reference books.

6.1 Syllabi of Courses specific to B.Sc. (Hons.) Chemistry

Semester-I

BSCH111A ATOMIC STRUCTURE AND CHEMICAL BONDING (Credits 5)

Overview:

An atom is the smallest constituent unit of ordinary matter that has the properties of a chemical element. Every solid, liquid, gas and plasma is composed of neutral or ionized atoms. It gives complete information about the electrons related to their size, shape, orientation and how they are filled in orbitals. This course helps the students to understand the nature of chemical bonding based on VBT (Valence Bond Theory), MO (Molecular Orbital) theory and LCAO (Linear Combination of Atomic Orbitals). The contents of this course provide an overview on electronegativity and polarity of bonds. Students will be acquainted about the concept and nature of chemical bonding in homonuclear (H to Ne) and heteronuclear molecules (NO, CO, CN^+, CO^+, 22 CN^- etc.).

This course gives knowledge of calibration of instruments, how to prepare standard solutions of different molarities and normalities.

Objective and expected outcome:

The objective of the course is to discuss the structure of atom, concept of orbits and orbitals, how the electrons revolve around the orbits and how they are filled in the orbitals. It will provide knowledge about the elements present in a particular sequence in the periodic table based on their electronic configuration. This course teaches the students how bonds are formed between two atoms using different theories (MO and VBT). After learning these theories, they will get to know about superiority of MO theory for formation of bonds in the molecules and their paramagnetic behavior. Based on the concept of hybridization, students will be able to predict the shape of molecules, their bond angle. Students will learn how to calculate the lattice energy of ionic compounds using Born – Lande equation and Born - Haber cycle.

The lab related with this course also gives the hands-on experience of estimation of elements such as Fe(II) and Fe(III) in a given sample and determination of strength of unknown solution.

UNIT I

Atomic structure-1: The Rutherford model of the atom; Photoelectric effect; Bohr's theory and its limitations; Atomic spectrum of hydrogen atom; The dual nature of electron; De-Broglie equation; Heisenberg's uncertainty principle; Schrodinger's wave equation and its significance.

UNIT II

Atomic structure-II : Quantum numbers and their significance; Probability distribution curves; Shapes of s, p, d and f orbitals; The sequences of energy levels; Pauli's exclusion principle; Hund's rule of maximum spin multiplicity; Aufbau's principle and its limitations; Change of orbital energy with atomic number; Concept of hybridization.

UNIT III

Chemical bonding-I : Electronegativity and polarity of bond; Different scales and methods of determination of electronegativity; Variation of electronegativity along a period and a group; Polarities of bonds and molecules; Dipole moments; Ionic bond: Factors affecting the stability of ionic compounds; Lattice energy; Born Lande equation and its applications; Madelung constant; Born-Haber cycle and its applications; Covalent character in ionic compounds; Polarization and polarizability; Fajan's rules; Factors affecting the ionic radii .

UNIT IV

Chemical bonding-II : Valence bond Theory (VBT); Resonance structures; Bond angles and shapes of molecules and ions (containing bond pairs and lone pairs); Criterion of bond strength and bond length; Molecular orbitals Theory (MOT) and linear combination of atomic orbitals (LCAO Method); Symmetry and overlap; Bonding in homonuclear molecules (H_2 to Ne) and heteronuclear molecules NO, CO, CN^+, CO^+, CN^-, HF, HCl, BeH_2, CO_2; Comparison of VB and MO theories.

BSCH113A GENERAL ORGANIC CHEMISTRY AND CHEMISTRY OF HYDROCARBONS (Credits4)

Overview:

This course inculcates the thought process of basic understanding of organic compounds and stereoisomers by giving the fundamental concepts of hybridization and variety of reactions. It also gives an overview on molecular orientation of atoms in three dimensional spaces. Students will get an idea how these small atoms could easily orient them in a molecule which results in various stereoisomers. The course also covers the chemistry of saturated and unsaturated hydrocarbons.

Objective and Expected Outcome:

The objective of the course is to enable students to learn classification and nomenclature of organic compounds. They will appreciate the concept of geometric and optical isomerism and acquire knowledge about the methods of synthesis and reactions of alkanes, alkenes, alkynes, cycloalkanes and aromatic hydrocarbons.

This course provides the hands-on experience of how these reaction mechanisms occur and we can relate these reactions with daily life experiences. Combustion of organic compounds such as fuel is a perfect example to notice this type of reaction. This course will enlighten the thoughts of the students regarding the mechanisms of reactions and structure of hydrocarbons. After completion of the course student will be able to critically analyze and relate the nature in

terms of reactions.

UNIT I

Basics of organic chemistry (Organic compounds): Classification and nomenclature; Hybridization and shapes of molecules; Influence of hybridization on bond properties. Electronic Displacements: Inductive, electrometric, resonance and mesmeric effects, hyper conjugation and its applications; Dipole moment; Organic acids and bases, and their relative strengths.

Homolytic and heterolytic fission with suitable examples; Curly arrow rules and formal charges; Electrophiles and nucleophiles; Nucleophlicity and basicity; Types, shape and the relative stability of carbocations, carbanions, free radicals and carbenes; Introduction to various types of organic reactions and their mechanism: Addition, elimination and substitution reactions.

UNIT II

Stereochemistry: Fischer projection, Newman and sawhorse projection formulae and their interconversions; Geometrical isomerism: cis-trans and syn-anti isomerism, E/Z notations with C.I.P rules.

Optical Isomerism: Optical activity, specific rotation, chirality/asymmetry and enantiomers; Molecules with two or more chiral-centers; Distereoisomers and meso structures; Racemic mixture and resolution, Relative and absolute configuration: D/L and R/S designations.

UNIT III

Chemistry of aliphatic hydrocarbons: Chemistry of alkanes: Formation of alkanes; Wurtz Reaction and Wurtz- Fitting reactions; Free radical substitutions: Halogenation - relative reactivity and selectivity.

Formation of alkenes and alkynes by elimination reactions; Mechanism of E1, E2, E1cb reactions; Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition); Mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation); 1, 2- and 1, 4- addition reactions in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Preparation, physical properties and reactions of alkynes: Acidity, electrophilic and nucleophilic additions; Hydration to form carbonyl compounds; Alkylation of terminal alkynes.

UNIT IV

Cycloalkanes and aromatic hydrocarbons: Cycloalkanes: Nomenclature, methods of synthesis and chemical reactions; Baeyer’s strain theory and its limitations; Ring strain in small rings (cyclopropane and cyclobutane); Sachse-Mohr concept of stainless rings.

Aromaticity: Hackle’s rule, aromatic character of arenas, cyclic carbocation’s/carbanions and heterocyclic compounds with suitable examples; Electrophilic aromatic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism and directing effects of the groups.

BSCH117A STATES OF MATTER (Credits 5)

Overview:

States of matter is a key to physical chemists. It is a physical property of matter and it has similar chemical composition and the same chemical properties, regardless of state. Normally every element and compounds form three physical states of matter: solid, liquid and gaseous state, though, other states are equally important. The content of this course provides an overview of various forms of matter. This course offers the formal introduction to the solid state, liquid state and gaseous state. It explains the presence of matter in different stets in terms of balance between intermolecular forces and particle energy. The existences of matter in gaseous state are so wide and strange, students will learn the various laws that govern the behavior of ideal gases and real gases. They will also get the knowledge of various properties of liquids and conditions required for liquefaction of gases.

Objective and expected Outcome:

The main objective of the course is to enable the students with the idea that various states of matter are the central science of any physical chemist because of the pivotal role these matters play in the biological and physical sciences, as well as in engineering, agriculture, medicine, and allied health disciplines as every compound is made of these matters only. They will also learn how and why deviations of real gases from ideal gas behavior occurs along with the getting the knowledge of Isotherms of real gases. In other section students will learn the physical properties of liquids, Cleansing action of detergents; Effect of temperature on viscosity of liquids and comparison with that of gases. Lastly the main objective of teaching solid state is to give students an overview of nature of the solid state, Miller indices, X-ray diffraction, Bragg's equation. This course will enlighten the thoughts of the students regarding basic concepts of kinetic molecular model of a gas and behavior of real gases.

The lab experiments empower students with understanding of physical parameters such as surface tension, density, viscosity of various compounds,surface tension, density, viscosity of various compounds.

UNIT I

Ideal gases : Kinetic molecular theory of gases: Postulates and derivation of the kinetic gas equation; Collision frequency, Collision diameter, Mean free path; Viscosity of gases and their dependence on temperature and pressure; Relation between mean free path and coefficient of viscosity. Maxwell distribution of molecular velocities and molecular energies; Types of molecular velocities (average, root mean square and most probable) and average kinetic energy; Degrees of freedom of a gaseous molecule; Principle of equipartition of energy.

UNIT II

Real gases : Deviations of real gases from ideal gas behavior; Explanation of deviation; Compressibility factor, Z and its variation with pressure for different gases; Van der Waals equation of state: Derivation and application in explaining real gas behavior; The Viral equation of state; Van der Waals equation expressed in viral form and calculation of Boyle temperature; Isotherms of real gases and their comparison with van der waals isotherms, Continuity of states; Critical state; Relation between critical constants and van der Waals constants; The principle of corresponding states.

UNIT III

Liquid state: The gaseous, liquid and solid states; Qualitative treatment of the structure of the liquid state; Radial distribution function; Physical properties of liquids: Vapour pressure, surface tension, coefficient of viscosity and their determination; Effect of addition of various solutes on surface tension and viscosity; Cleansing action of detergents; Effect of temperature on viscosity of liquids and comparison with that of gases;

UNIT IV

Solid state: Nature of the solid state; Law of constancy of interfacial angles; Law of rational indices; Miller indices; Symmetry elements and symmetry operations; Point groups and space groups; Space lattice and UNIT cell; Seven crystal systems and fourteen Bravais lattices; X-ray diffraction: The Bragg'sequation; A simple account of rotating crystal method and powder pattern method; structure factor and its relation to intensity and electron density.

LIST OF EXPERIMENTS

1. Determine the surface tension of given sample by drop number method
2. Determine the surface tension of given sample by drop weight method.
3. Determine the surface tension of methyl alcohol, ethyl alcohol and n-hexane and also calculate the atomic parachors of C, H and O.
4. Study the composition of a given mixture of two miscible liquids by viscosity measurement.
5. Viscosity measurement using Ostwald's viscometer.
6. Study the effect of the addition of solutes such as (i) polymer (ii) ethanol (iii) sodium chloride on the viscosity of water at room temperature.
7. Study the effect of variation of viscosity of an aqueous solution with the concentration of solute.
8. Measurement of pH of different solutions using pH-meter.
9. Preparation of buffer solutions and comparison of the pH values with the theoretical values.
10. To find the cell constant of the conductivity cell.
11. To find out the strength of strong/ weak acid conduct metrically.
12. To find out the strength of given acid pH-metrically.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH125A ENVIRONMENTAL STUDIES (Credits 3)

Overview:

Everything that surrounds and affects living organisms is environment. Environment includes all those things on which we are directly or indirectly dependent for our survival, whether it is living or biotic components like animals, plants or non-living or abiotic components like soil, air and water etc. It belongs to all, influences all and is important to all.

Environmental Protection Act (1986) defined "Environment as the sum total of water, air and land, their interrelationship among themselves and with the human beings, other living organisms and materials." Environmental studies are important since it deals with the most mundane problems of life like hygienic living conditions, safe and clean drinking water, fresh air, healthy food and sustainable development.

The syllabus for Environmental Studies includes conventional class room teaching as well as field work. In this course the teacher simply acts as a catalyst to infer what the student observes or discovers in his/her own environment. Involvement of students in project work is one of the most effective learning tools for environmental issues. This syllabus is beyond the scope of text book teaching and also the realm of real learning by observing the surroundings. The content of this course provides an overview of introduction to environment, concept of an ecosystem, various renewable and non-renewable resources, how are various biodiversity occur and different means to conserve these.

This course also includes various types of pollution and environmental policies & practices related with environs. Finally, it also highlights the relationship of human population with environment. The course further integrates to project work such as visit to an 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, and study of simple ecosystems. These studies are as imperative as it forms a unique synergistic tool for comprehensive learning process. This will help students to recognize and appreciate how the technological advancement at global level, exponential growth of human population and their unlimited demands has put the environment at stake and has contaminated the environment worldwide.

Objective and Expected Outcome:

The main objective of the course is to create consciousness among the students with the idea about healthy and safe environment. This course is aimed to explain students that the rapid industrialization, crazy consumerism and over-exploitation of natural resources have resulted in degradation of earth at all levels. These changes need the discussion, concern and recognition at national and international level with respect to formulate protection acts and sustainable developments policies. It can be possible only if every citizen of the nation is environmentally educated and gets involved into this matter at the grass root level to mitigate pollution.

After studying the course, the learners will be able to comprehend and become responsive regarding environmental issues. They will acquire the techniques to protect our mother earth, as without a clean, healthy, aesthetically beautiful, safe and secure environment no specie can survive and sustain. This is the only inheritance which every genera of specie passes to their future generation.

UNIT I

Introduction of Environmental Studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

Natural Resources: Renewable and Non-renewable Resources
Land resources: land use change; Land degradation, soil erosion and desertification.
Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
Energy resources: Renewable and non- renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

UNIT II

Ecosystems: Definition and Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.
Case studies of the following ecosystems:
a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biological Diversity: Levels of biological diversity; genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots ; India as a mega-biodiversity nation; Endangered and endemic species of India; Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UNIT III

Environmental Pollution: Types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks; Solid waste management: Control measures of urban and industrial waste; Pollution case studies.
Environmental Policies and practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. International agreements: Montreal & Koyoto protocol and convention on biological diversity. Nature reserves, tribal population and rights, human wild life conflicts in Indian context.

UNIT IV

Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Field work:

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
Study of common plants, insects, birds and basic principles of identification.
Study of simple ecosystems-pond, river, Delhi Ridge, etc.

BSCS102A INFORMATION TECHNOLOGY FUNDAMENTALS (Credits-4)

UNIT I

Basics of Computers and its evolution: Evolution of computers, Data, Instruction and Information, Block diagram of a computer, Characteristics of computers, Functions of different units of a computer, Generations of computers, Classification of computers: - Digital, Analog and Hybrid, Micro, Mini, mainframe and Super Computer, Single-board computer.

UNIT II

Introduction to Computer Software: Open source Software, Copylefted and Non-copylefted Software; System Software; Application Software; Utility Software; Shareware, Firmware, Freeware, Free Software. Compiler and Interpreter, Generations of languages: Machine Level, Assembly, High Level, 4GL.

Introduction to Operating System: Objectives and Function of OS, Structure of OS, Types of operating systems, Component and Services offered by OS, Layered approach of OS, Properties of OS, System boot, File Management.

UNIT III

Input and Output Devices: Keyboard, Mouse, Joystick, Digitizer, Scanner, MICR, OCR, OMR, Light Pen, Touch Screen, Bar Code and Quick Response Reader, Voice Input Device, Monitor and it's type, Printer and it's type, Plotter

Computer Memory: Memory hierarchy, Primary Memory (ROM and it's type - PROM, EPROM,EEPROM, RAM) Secondary memory- SASD, DASD Concept, Magnetic Disks - Hard disks, Optical disks - CD ROM and it's type (CD ROM, CD ROM-R, CD ROM-EO, DVD ROM), Flash Memory, Blu-ray Disk

UNIT IV

Concept of Data Communication and Networking: Networking Concepts, Types of networking (LAN, MAN AND WAN), Communication Media, Mode of Transmission (Simplex, Half Duplex, Full Duplex), Analog and Digital Transmission. Synchronous and Asynchronous Transmission, Network topologies.

Introduction to Internet: Terminology related to Internet: Protocols, TCP/IP, HTTP, Internet addressing, Domain Names, DNS, URL, World Wide Web. Overview of various services on Internet: Webservers, E-mail, FTP, Telnet.

OPEN ELECTIVE COURSE I: From the following courses choose only one course.

BSPH120A CONDENSED MATTER PHYSICS (Credits-4)

- UV-Visible spectroscopy, Basic principles of UV-Visible spectroscopy, IR spectroscopy, Basic principles of IR spectroscopy, Working principles and taking spectrum of IR spectroscopy device, NMR spectroscopy, Basic principles of NMR spectroscopy, Sample preparation procedure in NMR spectroscopy, Elemental analysis technique.

- Concepts of entropy, enthalpy and Ideal gas equation and various gas Laws: Gas Laws. Thermodynamic processes. Role of thermodynamic cycles, availability and irreversibility. Behavior Gas Power Cycles cycle. Concept of Availability. Concept of irreversibility and Second law efficiency.

- Fundamental concepts of solid-state physics, types of matter exist and the methods available to determine their structure and properties. Physical origins which govern the properties of matter in the solid state. Problems in solid state physics using relevant mathematical tools.

BSMA141A FUNDAMENTALS OF CALCULUS (Credits-4)

UNIT I

Recapitulation: Fundamentals. Mathematical functions, polynomial expressions, logarithmic and exponential function, Trigonometric functions, equation of a straight line, plotting graphs.

Mathematical series: Power series, Maclaurin, Taylor series.
Numerical Methods: Roots of quadratic equations analytically and iteratively. Numerical methods of finding roots (Bisection, Regular-Falsi, Secant, Newton-Raphson).

UNIT II

Differential calculus: limiting values of functions: L' Hôspital's rule, The tangent line and the derivative of a function, numerical differentiation, higher order derivatives, maximum-minimum problems, inflexion points.

UNIT III

Integral calculus: The process of integration, odd and even functions, indefinite integrals, methods of integration, numerical integration (Trapezoidal and Simpson's rule.

UNIT IV

Calculus with several independent variables: Functions of several independent variables, change of variables, relations between partial derivatives, total differentials, and chain rules for partial different ion, Euler's theorem.

Modeling of the following problems using Matlab / Mathematica / Maple etc.

1. Plotting graphs of Straight line.
2. Bisection method for finding the root
3. Regular-Falsi method for finding the root
4. Secant method for finding the root
5. Newton-Raphson method for finding the root
6. Numerical differentiation
7. Higher order derivatives
8. Maximum-minimum problems
9. Indefinite integrals
10. Various methods of integration
11. Trapezoidal rule
12. Simpson's rule

IIIT101A HARNESSING THE POWER OF THE WEB AS A KNOWLEDGE DEVICE (Credits-4)

Overview:

This course will give the learner an understanding of internet as a medium of learning. "Internet" is a gigantic library where information about almost any subject is available in depth and up to date. Through this program the student learns to appreciate the richness of the Web and the Internet, and gets an understanding to make clear what is reality and what is false propaganda and uses his/her own intelligence or mind to investigate further.
Internet has been incredibly useful as a learning medium as it facilitates both information and communication. The Internet has increased the accessibility of education at all levels and has turned out to be a giant repository of knowledge as it is not only a great place to gather and store information but also allows its easy retrieval whenever desired. In fact, it has turned out to be better than libraries when it comes to gathering information and doing research work.

The Internet expeditiously entered the life of the humankind in the 20th century. Less than a decade back we did not know much about the modern Internet and imagine its facilities and our life with it. In few years now it has become not only the hugest information resource in the world. Internet provides unique learning opportunities as the very idea behind invention of internet was education.

Today we live in an information society where knowledge has great value and knowledge can be manifested through qualification. All the countries are using high-end technology which needs highly qualified specialists. Web can be a very effective in promoting this process.

The most important thing is the ability to work with information because it demands a student's ability to use different kinds of intellectual skills. It means that a student should be able to analyze the information he deals with, to select the facts, data adequate to the problem he investigates.

The information the student comes across in the Internet is not always helpful. The Internet is a very democratic environment where every user can locate his/her information. A lot of educational materials do not undergo any examination. Besides, we should keep in mind that reading electronic texts in the net is not like reading printed texts.

For effective education a mere access to Internet information resources is not enough. It is necessary to prepare the students beforehand to work with information. The goal of this program is to develop critical thinking of student so that he or she can use internet for effective learning.

Objective and Expected Outcome:

The usage of the information resources located in the Internet is not such a simple affair. It requires not only the ability to search for it in the huge ocean of the Internet, but to process it, to use it effectively for the cognitive goals. Through this course the student will develop skills to use search engines effectively for learning and research.

The growth of the Internet has provided many opportunities people in different ways. Students consider the use of the Internet is mainly for information, social and entertainment purposes but the Internet provides huge academic and scientific information as well which makes it as a tool to learn. It provides asynchronous education to student, as they are passionate internet lovers and prefer to use web for information.

The course equips the student to find information on web and use critically and creatively, to become collaborative and cooperative workers and to solve problems.

Semester-II

BSCH112A PERIODIC PROPERTIES AND s-BLOCK ELEMENTS (Credits 5)

Overview:

Alkali and alkaline earth metals found wide application in daily life. This course deals with basic knowledge of s-block elements, different band theories which are helpful for

differentiating between conductors and insulators, solid defects, and types of chemical forces. It also describes the relationship between chemical periodicity and electronic structure of the atom. This course highlights the information about various elements present in the periodic table, their different properties like acids and bases, and variation along groups and periods.

Objective and expected outcome:

The main aim of the course is to give insight of long form of periodic table and its classification. The goal of the course is to aware students with the trends in the periodic table like ionic/ atomic radii, oxidation potential, ionization potential, electron enthalpy and electronegativity etc. which gives information about various forms of elements. This course also covers the production of alkali and alkaline earth metals, their uses, their trends in periodic table, and their various types of oxides and halides. After studying this course, students will be able to explain the unique position of hydrogen in the periodic table, its chemistry, industrial production and its bonding; and classification of acids and bases on the basis of Pearson's concept. Students will be able to explain why first element of alkali and alkaline earth metals shows anomalous behavior with respect to rest of elements and their diagonal relationships.

UNIT I

Metallic Bond and van der Waals forces: Qualitative idea of valence bond and band theories, Semiconductors and insulators, defects in solids.

Weak Chemical forces: van der Waals forces, Ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (Valence bond theory of hydrogen bonding); Effects of chemical forces on melting and boiling points, solubility energetics of dissolution process.

UNIT II

The periodic classification of elements and periodic properties :The relationship between chemical periodicity and electronic structure of the atom; The long form of the periodic table; Trends among representative elements; Atomic volume; Atomic and ionic radii; Periodic trends in atomic and ionic radii; Metallic/non-metallic character; standard electrode potential; Periodic trends in electrode potential; Ionization potential; Electron affinity and electronegativity; Electronegativity scale; Bond energies; Oxidation numbers and oxidation states; Periodicity in oxidation state of valence; Oxidizing or reducing behaviour; Acidic and basic character of oxides. Unique position of hydrogen in the periodic table; Isotopes of hydrogen; Industrial production; Hydrides and their chemistry; Heavy water; Hydrogen bonding; Hydrates.

UNIT III

Acids and bases: Various concepts of acids and bases; Relative strength of acids and bases; Amphiprotic substances; The solvent system concept of acid and bases; Lewis acid-base concept; Bond energies; Classification of lewis acids and bases; The Usanowich concept of

acid and bases and its applications; Pearson's hard and soft acid –base (HSAB) concept; Acid-base strength and hardness and softness; Symbiosis; Theoretical basis of hardness and softness; Electronegativity and hardness and softness.

UNIT IV

The s-block elements: Production and uses of metals; Chemical reactivity and trends in alkali and alkaline earth metals; Structure and properties of oxides, halides and hydroxides; Anomalous behavior of lithium and its similarity with magnesium; Anomalous behavior of beryllium; Diagonal relationship of beryllium and aluminium; Coordination complexes; Organometallic compounds of alkali metals; Crown and crypts; Behaviour of solutions in liquid ammonia.

LIST OF EXPERIMENTS

(a) Iodo / Iodimetric Titrations

(i) Estimation of Cu (II) and K2Cr2 O7 using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.

(b) Inorganic preparations

(i) Cuprous Chloride, Cu2Cl2
(ii) Preparation of Manganese (III) phosphate, MnPO4.H2O
(iii) Preparation of Aluminium Potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum.
(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

The lab experiments will help students to acquire the knowledge of Iodo / Iodimetric titrations, and inorganic preparations.

BSCH114A HALOGENATED HYDROCARBONS AND OXYGEN CONTAINING FUNCTIONAL GROUPS (Credits 5)

Overview:

This course content highlights the structure, stability, methods of synthesis and reactions of arenes and aryl halides. Alkyl halides are among the most versatile compounds in the chemical industry. Small haloalkanes are some of the most commonly used solvents in chemical laboratories; chlorofluorocarbons have seen widespread use as refrigerants and propellants; and compounds containing both Br and F are often used in fire retardants. Within synthetic organic chemistry, they are commonly used in alkylation reactions, radical cascades, and alkyl cross-coupling chemistry.

The course also entails with alcohols, phenols and their acidic strength and chemical properties. It also covers the nomenclature and reactions of ethers and epoxides and their systematic classification. The course will illustrate the method through which hydrolysis of amides and nitration of nitrobenzene can be carried out.

Objective and expected Outcome:

These classes of compounds find wide applications in industry as well as in day-to-day life. For instance, have you ever noticed that ordinary spirit used for polishing wooden furniture is chiefly a compound containing hydroxyl group, ethanol. The sugar we eat, the cotton used for fabrics, the paper we use for writing, are all made up of compounds containing –OH groups. Just think of life without paper; no note-books, books, newspapers, currency notes, cheques, certificates, etc. The magazines carrying beautiful photographs and interesting stories would disappear from our life. It would have been really a different world. The reactive nature of primary alkyl chlorides is sometimes exploited in medicinal chemistry and chemical biology.

Halogens containing organic compounds are relatively rare in terrestrial plants and animals. The ocean is the largest known source for atmospheric methyl bromide and methyl iodide. Furthermore, the ocean is also estimated to supply 10-20% of atmospheric methyl chloride, with other significant contributions coming from biomass burning, salt marshes and wood-rotting fungi. Many subsequent chemical and biological processes produce poly-halogenated methane.

It is expected that students will learn about the synthesis, importance, and the reactions of alkyl halide and aryl halides, phenols, alcohols and ethers.

Through this course students will be able to perform acetylation and benzoylation of amines and phenols, oxidation of aldehydes and alcohols etc.

UNIT I

Alkyl and Aryl halides : Nomenclature, methods of preparation and chemical reactions of alkyl halides; Mechanisms of nucleophilic substitution with stereochemical aspects, kinetics and effect of solvent etc.; nucleophilic substitution vs elimination; Preparation and properties of chloroform, carbon tetrachloride.

Nomenclature of benzene derivatives; the aryl group; Aromatic nucleus and side chain; Activating and deactivating substituents: Orientation and ortho/para ratio.
Side chain reactions of benezene derivatives: Birch reduction; Methods of formation and chemical reactions of alkylbenzenes.

Structure and methods of preparation of aryl halides; Nuclear and side chain reactions; The addition-elimination and the elimination-addition reactions; Mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides; Synthesis and uses of DDT and BHC.

UNIT II

Alcohols: Classification and nomenclature of alcohols; Nomenclature and methods of formation (reduction of carbonyl compounds, carboxylic acids and esters) of monohydric alcohols; Hydrogen bonding in alcohols; Acidic nature of alcohols and their reactions; Manufacture of ethyl alcohol from molasses.

Dihydric alcohols: Nomenclature, methods of preparation and chemical reactions of vicinal glycols; Pinacol-pinacolone rearrangement.

Trihydric alcohols: Nomenclature, methods of formation and chemical reactions of glycerol.

UNIT III

Phenols: Nomenclature, structure, and bonding; Preparative methods of phenols; Physical properties and acidic character; Comparison between acidic strengths of alcohols and phenols; Resonance stability of phenoxide ion. Electrophilic aromatic substitution, acylation and carboxylation reactions of phenols.

Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Ledrer-Manasse reaction and Reimer-Tiemann reaction.

UNIT IV

Ethers and epoxides: Nomenclature, isomerism, methods of synthesis, physical and chemical properties of ethers. Synthesis of epoxides; Acid and base-catalyzed ring opening of epoxides; Orientation of epoxide ring opening,

Organometallic compounds of Mg and Li and their use in synthesis of organic compounds. Reactions of Grignard and Organolithium reagents with epoxides.

LIST OF EXPERIMENTS

1. Purification of organic compounds by crystallization using different solvents (water and ethyl alcohol).
2. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus).
3. Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation method).
4. Preparation of derivatives (urea oxalate)
5. Preparation of urea-formaldehyde and phenol formaldehyde resins.
6. Determination of saponification number of oil.
7. Organic Preparations (m-Dinitrobenzene, Picric acid, Oxalic acid).
8. Acetylation of one of the following compounds: amines (aniline, o-,m- ,p- toluidines and o-,m-,p- anisidine) and phenols (β-naphthol, vanillin, salicylic acid)

9. Benzolyation of one of the following compounds: amines (aniline, o-,m-,p- toluidines and o-,m-,p- anisidine) and phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction
10. Hydrolysis of amides and esters to obtain benzoic acid.
11. Nitration of one the following compounds: nitrobenzene, chlorobenzene, bromobenzene.
12. Oxidation of the following compounds: benzaldehyde, benzyl alcohol acetophenone to benzoic acid (by iodoform reaction).

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH118A CHEMICAL THERMODYNAMICS (Credits 5)

Overview:

This course presents an introduction to Thermodynamics as a description of physical phenomena based on the concept of the state of a system and the changes that occur spontaneously or through interaction with other systems. The term system means any identifiable collection of matter that can be separated from everything else by a well-defined surface. From a thermal energy point of view therefore, thermodynamics is the science that dictates what happens in nature and what not and why?

Objective and expected Outcome:

Thermodynamics is the study of energy changes accompanying physical and chemical changes.

The term itself clearly suggests what is happening -- "thermo", from temperature, meaning energy, and "dynamics", which means the change over time. Thermodynamics can be roughly encapsulated with these topics: Heat and Work. Thermodynamics deals with things like energy, entropy, volume, heat, work, efficiency (ideal), free energy, chemical potential, pressure, temperature etc. The Laws of Thermodynamics are important because they control interactions of everything in the universe - regardless of scale. These rules stretch across every form of science known to humankind. Chemical processes were incorporated into the framework of thermodynamics by Gibbs, leading to an understanding of the spontaneity of, and energy exchanged during, chemical reactions and phase changes.

The development of statistical mechanics provided a microscopic basis for the theory, explaining how these bulk properties emerge from microscopic system properties (Boltzmann). In this course we shall explain why heat flows from hot to cold bodies, why the air becomes thinner and colder at higher altitudes, why the Sun appears yellow whereas colder stars appear red and hotter stars appear bluish-white, why it is impossible to measure a temperature below -273° C, why there is a maximum theoretical efficiency of a power

generation unit which can never be exceeded no matter what the design, why high mass stars must ultimately collapse to form black-holes, and much more.

There are two methods of describing the thermodynamic behavior of multi-component systems: one of them is based on excess functions and another on the equation of state. The excess function/property provides the deviation from ideal behavior of a liquid or gas mixture. It can also inform about the type molecular interactions, i.e., attraction or repulsion, related to the state of pure compounds before mixing.

Through the above-mentioned questions, students will understand the importance of thermodynamics and gain the knowledge of theories and concepts behind this.

The lab experiments are designed so as to acknowledge the students with the concept of enthalpy related to the various phenomenons observed in daily life such as neutralization, and sublimation etc.

UNIT I

Chemical thermodynamics-I Thermodynamic equilibrium; Intensive and extensive variables;; Zeroth law of thermodynamics.

Statement of first law and its limitations; Relation between heat capacities; Calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data; Effect of temperature (Kirchoff's equations) and pressure on enthalpy of reactions; Adiabatic flame temperature and explosion temperature.

UNIT II

Chemical thermodynamics-II: Carnot cycle; Statement of the second law of thermodynamics; Concept of entropy and its physical significance; Calculation of entropy change for reversible and irreversible processes.

Third law of thermodynamics; Determination of absolute entropy of molecules; residual entropy; variation of S, G, A with T, V, P; Free energy change and spontaneity; Relation between Joule-Thomson coefficient and other thermodynamic parameters; Inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; Thermodynamic equation of state.

UNIT III

Systems of variable composition : Partial molar quantities; Dependence of thermodynamic parameters on composition; Gibbs- Duhem equation; Variation of chemical potential with temperature and pressure; chemical potential in a system of ideal gases; Concept of fugacity and activity; .

UNIT IV

Excess thermodynamic functions: Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

LIST OF EXPERIMENTS

1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of the enthalpy of ionization of ethanoic acid.
4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
5. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
6. Determination of enthalpy of hydration of copper sulphate.
7. Study of the solubility of benzoic acid in water and determination of enthalpy change.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSEL101A COMMUNICATION SKILLS (Credits-5)

Overview

The world is shrinking into a global village and therefore, communication skills in English have emerged as a major means of empowerment and human resource development. Many professionals fail to make an impact on the global market as they lack the required communicative competence. The course with its practice-based learning tasks will facilitate the learners to enhance their communication skills in a modern and globalized context. It will enhance the linguistic and communicative competence of the learners and hone their interpersonal skills. This course will augment comprehension skills, enhance vocabulary, acquire impressive writing skills, correspond with others effectively, understand the non-verbal cues and enhance skills in spoken English through a variety of teaching techniques. The course will be instrumental in acquiring proficiency both in spoken and oral language.

Objective and Expected Outcome

The course will help the learners to focus on communication activities in functional and situational contexts as well as enhance the four language skills of reading, writing, listening and speaking through real-life and professional situations. It will build confidence among the students and encourage them to speak fluently. Through practical learning and delivery, the learners will be able to identify their areas of strengths and weaknesses and improvise their personality and soft skills. The learners will be able to strengthen and broaden their communication skills through various insightful ways.

UNIT I

Introduction to Communication: Meaning, Forms & Types of Communication; Process of Communication; Principles of Effective Communication/7Cs, Barriers in Communication

UNIT II

Essentials of Grammar: Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection; Using tenses; Articles; Reported Speech; Punctuation

UNIT III

Building Vocabulary: Word Formation (by adding suffixes and prefixes); Common Errors; Words Often Confused; Homonyms and Homophones; Antonyms/Synonyms, Phrasal Verbs

UNIT IV

Personality Development: Public Speaking; Body Language: Posture, Gesture, Eye Contact, Facial Expressions; Presentation Skills/ Techniques

Communication Skills Lab Activity

Activity 1: Self- introduction: Informal introduction & formal introduction; A detailed write up on formal 'Self Introduction'; Formal Introduction of oneself in front of the group.

Activity 2: News Reading: Introduction to 'online News papers'; Browsing and selecting the preferred Newspaper; Browsing through the News Headlines; Selecting interested News items; Comprehending the content, writing down the essence and reading the News in front of the Group. Discuss 5 to 8 new words or terms, 4 to 5 important personalities of that day's news etc.

Activity 3: JAM: Introduction to 'Just A Minute speech' and the 'Extempore speech'; Preparation of speech on given topic(different topic for each student); delivery of the speech; Feed back(on content, time management, body language etc. highlighting the positive aspects first.)

Activity 4: News Discussions: Selecting News of the day, Discussing among the group, prepare the news content and prepare the group opinion about the issue and present it in front of the class by the group involving each member; select 5 new words & new usages from the selected news item

Activity 5: Conversation ability: Characteristics ofeffective conversation; Listening to a few sample conversations; preparing conversation based on the given situation; enacting the situation through effective delivery of the script; feedback & suggestions for improvement.

Activity 6: Role Play: Characteristics of Role Play; assigning roles; developing the content to deliver; enacting the role with effective delivery; feedback & suggestions for improvement.

Activity 7: Public Speaking: Characteristics of effective Public speaking; possible barriers; watching demo online; topic assignment, information gathering & recording; delivery in front of the class; feedback & suggestions for improvement. . (Different topic for each student)

Activity 8: Group Discussion: Importance and characteristics; Dos & Don'ts in GD; Demo display; assign topic for the group, Preparation & performance; feedback & suggestions for improvement.

Activity 9: Debate: Difference between Group Discussion & Debating; Watching demo of Debating; Topic for the group of 2 or 4; preparation and performance; feedback &

suggestions for improvement.

Activity 10: .Interview: Importance & purpose of Job Interview; Interview etiquettes; Watch demo interview; Appear for formal mock interview; feedback & suggestions for improvement.

OPEN ELECTIVE COURSE II: From the following courses choose only one course.

BSPH217A APPLICATIONS OF MATERIALS (Credits-4)

Overview:

Both physics and chemistry are concerned with matter and its interaction with energy, the two disciplines differs in approach. In physics, it is typical to abstract from the specific type of matter, and to focus on the common properties of many different materials. In optics, for example, materials are characterized by their index of refraction, and materials with the same index of refraction will have identical properties. Chemistry, on the other hand, focuses on what compounds are present in a sample, and explores how changing the structure of molecules will change their reactivity and their physical properties. Chemistry and physics are interrelated, chemists and physicists work in teams to explore the following topics in this current course related with Material Science, Nuclear physics, and Nanomaterials.

Objective and Expected Outcome:

The use of fundamental sciences and their principles relevant to materials that include the relationships between nano/microstructure, characterization, properties, processing, performance and design of materials. The study of nuclear physics is the understanding of the "Structure of Nuclei". A most basic property of a nucleus is its binding energy. This is brought about by the specific nuclear forces, counteracted partially by the Coulomb repulsion between the protons. An understanding of the structure-property relationships in nano-materials as well as the concepts, not applicable at larger length scales, that need to be taken into consideration for nano-science and nanotechnology. To make quantitative predictions about whether, equilibrium will favour products or reactants in a redox reaction. Imagine each of the above as a competition to gain electrons.

After completion of the course the student should be able to:

- Describe the basic structure of materials at the molecular, microscopic, and macroscopic scales, and will be able to describe modern methods of characterizing materials at each of these length scales. Students will understand diffusion and electrochemical processes in materials.
- Explain the ground state properties of the nucleus for study of the nuclear structure

behavior. They can explain the deuteron behavior at ground and excited states. They can apply deuteron physics and the Nucleon-Nucleon scattering for explaining the nuclear forces. They can able to demonstration of the shell model and collective model descriptions. They can apply various aspects of nuclear reactions in view of compound nuclear dynamics.

- Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.
- Describe several synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nanoporous materials, and nanostructured bulk materials, and also could describe how different lithography methods can be used for making nanostructures. The student should have a theoretical background within synthesis/fabrication of nanomaterials which makes he/she prepared for later literature studies and laboratory work within the field.
- Perform simple geometric calculations of surface energy, coordination number, and volume fraction related to nanoscale properties and synthesis, and also simple chemical calculations related to synthesis.
- Use the acquired knowledge to evaluate which synthesis methods that can be best suited for fabricating nanostructured materials of various inorganic compounds (metals, semiconductors, oxides, fullerenes) and constructions of these.
- Basic structure of materials at the molecular, microscopic, and macroscopic scales, Modern methods of characterizing materials at each of these length scales. Diffusion and electrochemical processes in materials.
- Ground state properties of the nucleus for study of the nuclear structure behavior. Deuteron behavior at ground and excited states. Nucleon-Nucleon scattering for explaining the nuclear forces. Shell model and collective model descriptions. Various aspects of nuclear reactions in view of compound nuclear dynamics.
- How the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.
- Synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nanoporous materials, and nanostructured bulk materials, Different lithography methods can be used for making nanostructures. Theoretical background within synthesis/fabrication of nanomaterials.
- Geometric calculations of surface energy, coordination number, and volume fraction related to nanoscale properties and synthesis, and also simple chemical calculations related to synthesis.
- Fabricating nanostructured materials of various inorganic compounds (metals, semiconductors, oxides, fullerenes) and its constructions.

BSMA142A ESSENTIALS OF MATHEMATICS (Credits-4)

Overview:

The course deals with fundamental concepts of differential equations, and the

interrelationship between differential equations and linear algebra and the concept of existence and uniqueness of solutions of a differential equation, concept of a general solution, a particular solution and initial conditions, solve first order differential equation (both nonlinear and linear) using various techniques: integrating factor, separable differential equation, substitution method, exact differential equation and describes the basic notions of linear algebra such as vector, matrix, determinant, and eigenvalue.

Objective and Expected Outcome:

The objectives of this course are to introduce students with both exact and numerical procedures for finding solutions to problems of differential equations. They will be given exposure to problems related to linear algebra. The course highlights the applications of linear algebra, complex logical arguments.

The primary learning outcome for this course is Quantitative Reasoning, which is to understand and apply mathematical concepts and reasoning, and analyze and interpret various types of data.

After the completion of the course, students will become competent in solving linear equations, performing matrix algebra, calculating determinants, and finding eigenvalues and eigenvectors. Students will be able to understand a matrix as linear transformations and they will differentiate between complex number and real number.

UNIT I

Exact differential equation, equations reducible to exact differential equations, application of differential equation to Newton's law of cooling and orthogonal trajectories. Linear differential equations of second and higher order. Complete solution, complementary function and particular integral, method of variation of parameter to find particular integral, Cauchy's and Legendre's linear equation , simultaneous linear equations with constant coefficients.

UNIT II

Complex number, geometrical representation of imaginary numbers, argand diagram, Equal complex number, addition of complex numbers, Subtraction, Power of iota, Multiplication, Iota as an operator, Conjugate of complex number, Division, Modulus and argument, Polar form, Type of complex number, Square root of complex number, Exponential and circular functions of complex variables, De-moivre's theorem, Roots of complex number, circular function of complex numbers, Sepration of real and imaginary parts of circular functions.

UNIT III

Double integration, Evaluation of double integral, evaluation of double integrals in polar co-ordinates, Change of order of integration, area by double integration, Volume by double integration, Tripple integration,Beta and gamma functions and their relation.

UNIT IV

Determinants. Matrix algebra, Simultaneous equations: method of substitution and elimination, consistency and independence. Homogeneous linear equations. Simultaneous equations with more than two unknowns (e.g. spectrophotometry), Cramer's rule, matrix inversion, orthogonal and UNITary matrices, matrix eigenvalues and eigenvectors, diagonalization of a matrix.

Modeling of the following problems using Matlab / Mathematica / Maple etc.

1. Exact differential equation
2. Linear differential equations of second and higher order
3. Simultaneous linear equations with constant coefficients
4. Double integration
5. Area by double integration
6. Volume by double integration
7. Triple integration
8. Beta and gamma functions and their relation
9. Matrix algebra
10. Simultaneous equations
11. Homogeneous linear equations
12. Simultaneous equations with more than two unknowns
13. Cramer's rule
14. Matrix inversion method

IIIT104A UNDERSTANDING THE POWER OF DATA (Credits-4)

Overview:

This course is designed to provide students with hands-on experience for gaining an understanding of numbers and data for building models.

Why data is so important in our life? Many of us are knowingly or unknowingly using it but are unknown about the fact. Such as “I sleep for about 8 hours a day.”, “I usually drive at 50 km/hr.”, “If I start early then the chances that I will pass in the exam are higher.” or “Which political party will win next assembly elections?” These are nothing but statistical in nature.

We are constantly gathering, organizing and analyzing information, and using it to make judgments and decisions that affect our actions.

This course aims to enable students to figure out and solve problems on their own and use technology efficiently. The activities are designed to encourage students to take accountability for their own learning. The skills the students acquire during the course are necessary for the needs and challenges of the country.

Objective and Expected Outcome:

This course encourages students to blend theoretical and practical knowledge, and transfer it into practice. The themes on which the course is based are - • Interesting properties of prime numbers without proofs • Analysis of data for simple quantitative inference • Correlate real-world observations with theoretical knowledge • Compute and validate probabilities • Use of spreadsheets and R for practical work • Statistical analysis of the stock market, weather, and daily life data.

Data can be used to describe situations or events. For instance, a manufacturer might want to know something about the consumers who will be purchasing his product so he can plan an effective marketing strategy. In another situation, a buyer might survey before purchasing a product. For example, when we purchase a cell phone we look at various features and specifications provided by different companies. Further, trends in the market can be analyzed, enabling prospective buyers to make more intelligent decisions. These examples illustrate a few situations where collecting and analyzing data will help students make better decisions.

The course is about exercising the brain and learning new ideas, not to just mimic steps, procedures, and formulas. The students are expected to acquire the ability to overcome obstacles and keep trying until they reach a goal.

Semester-III

BSCH211A CHEMISTRY OF P–BLOCK ELEMENTS AND HALOGENS (Credits-4)

Overview:

This course gives the basic information about p-block elements from group III to VII. There are 35 p-block elements and they are an exceptionally differing group of elements with an extensive variety of properties. The variation in properties of the p-block elements due to the influence of d and f electrons in the inner core of the heavier elements which makes their chemistry interesting. It is fascinating to note that the non-metals and metalloids exist only in the p-block of the periodic table. This course gives an overview of basic chemistry of boron, carbon, nitrogen, oxygen and fluorine family; their anomalous behavior with respect to other elements of their groups. It also gives information about the organometallic compounds of aluminium, tin and lead. The most common type of heavy duty rechargeable cell is the familiar lead accumulator (car battery) found in most combustion - engine vehicles.

Objective and expected outcomes:

The various topics covered in the present course acquaints students with p block elements, their various physical and chemical properties, anomalous behavior of first elements like B, C etc. with respect to other elements. Along with the basic insight of p block elements this course also provides explanation regarding the chemistry of halogen family including inter halogen compounds, polyhalides and polyhalonium ions. After the thorough understanding of this course the students will be able to learn some basic ideas about allotropes of carbon, (diamond and graphite), phosphorous (white, red black and blue phosphorous) and sulphur (α, β and γ sulphur) and their use in daily life.

The lab course inculcates the knowledge about complexometric, iodometric and argentometric titrations.

UNIT I

The p-block elements group III (B, Al, Ga, In, Tl family): Chemical reactivity and trends; Structures of crystalline boron; borides, boranes and carboranes; Metallocarboranes and their chemistry; Boron halides; Boric acid; Borates; Boron-nitrogen compounds; $LiAlH_4$ – its uses as a reducing and hydrogenating reagent. Alumina and aluminates; Manufacture of portland cement; Organometallic compounds of Aluminium.

The p-block elements group IV (C, Si, Ge, Sn, Pb family): Chemical reactivity and group trends; Carbon: Allotropic forms, compounds; Graphite intercalation compounds; Carbides. Silicon carbides, silicides and silanes; Structures of silicate mineral; Organosilicon compounds; Oxides and halides of tin and lead; Pb accumulators; Organometallic compounds of Sn and Pb.

UNIT II

The p-block elements group V (N, P, As, Sb and Bi family): Chemical reactivity and group trends; Anomalous behavior of nitrogen; Types of covalence in nitrogen and stereochemistry; Chemical reactivity; Dinitrogen complexes; Hydrides of nitrogen; Nitrogen halides; Oxides and oxyacids of nitrogen; Liquid NH3 as a solvent; Elemental P and its allotropic forms; Hydrides, halides, oxides and oxy-acids of phosphorous; Phosphorus-nitrogen compounds.

UNIT III

The p-block elements group VI (O, S, Se and Te family): Chemical Reactivity, group trends and stereochemistry; Dioxygen as a ligand (basic idea only); Structure of O3 and H2O2; Clathrate hydrates; Allotropic forms of S and Se; Structures of halides, oxides and oxyacids of S, Se and Te; Liquid SO2 and sulphuric acid; S-N compounds (neutral) ; Polyatomic cations of S, Se and Te.

UNIT IV

The halogen family group VII (F, Cl, Br and I): Chemical reactivity and group trends; Chemistry of preparation of fluorine; Hydrogen halides; HF as a solvent; Preparation and structures of inter-halogen compounds; Polyhalide and polyhalonium ions; polyatomic cations of halogens; Oxides and oxyacids of halogens.

BSCH261A INORGANIC CHEMISTRY-III LAB (Credits-2)

LIST OF EXPERIMENTS

(1) Complexometric Titrations:
(i) Complexometric estimation of (i) Mg^{2+} (ii) Zn^{2+} using EDTA
(ii) Estimation of total hardness of water samples
(iii) Estimation of Ca^{2+} in solution by (substitution method) using Erio-chrome black-T as indicator.
(iv) Estimation of Ca/Mg in drugs and Biological samples.
(2) Iodometic Titrations:
(i) Determination of Cu^{2+} (using standard hypo solution).
(3) Argentometry: Estimation of Cl^- (i) By Mohr's method, (ii) By Vohlard's method, (iii) By Fajan's method.
(4) Paper Chromatographic separation of Ni (II) and Co (II); Cu (II) and Cd (II)
(5) To verify Beer - Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4/K_2Cr_2O_7$ solution.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH 213A CHEMISTRY OF CARBONYL COMPOUNDS (Credits-4)

Overview:

This course deals primarily with the basic principles to understand the structure and reactivity of organic molecules containing carbonyl moiety. A "carbonyl group" consists of a sp2 hybridized carbon atom that is joined to an oxygen atom by a double bond. These compounds can be divided into two broad categories: aldehydes and ketones, and carboxylic acids and their derivatives (acid chlorides, acid anhydrides, esters and amides).

The variety of carbonyl compounds is so wide, and their chemistry is so extensive, that syllabus is divided so that this large amount of factual material can be studied in small, readily digestible blocks. The purpose is to provide a general outline about the nature of the carbonyl group, their synthesis and the four most common mechanisms by which carbonyl groups react. Emphasis is on substitution and elimination reactions and chemistry of carbonyl compounds. Methods of preparation and important reactions of fat and oils like saponification etc. will also be discussed through laboratory experiments.

Objective and expected Outcome:

The main objective of this course is to provide the knowledge of various carbonyl compounds containing carbonyl groups: aldehydes, ketones, carboxylic acids, acid chlorides, acid anhydrides, esters, lactones and amides.

After the completion of this course the students will be able to differentiate between aldehydes and ketones, and the other types of compounds, learn the nomenclature of these compounds, their method of synthesis, their physical characteristics and mechanism of each of the four general types of reactions that dominate the chemistry of carbonyl compounds. Student will be able to learn examples of the wide variety of biologically important, pharmaceutical and industrial compounds that contain one or more carbonyl groups.

Through this course students will be able carry out benzoin condensation, Diels alder reaction, Photo reduction, preparation of derivatives of carbonyl compounds in the laboratory.

UNIT I

Aldehydes and ketones : Nomenclature and structure of the carbonyl group; Methods of preparation: Direct oxidation of alcohols and catalytic dehydrogenation of alcohols, Oxidation of alkenes; Hydration of alkynes; Hydrolysis of gem-Dihalides; Pyrolysis of calcium salts of acids; Synthesis of aldehydes from acid chlorides, Synthesis of aldehydes and ketones using 1,3-dithianes, Synthesis of ketones from nitriles and from carboxylic acids; Physical properties; Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, perkin and knoevenagel condensations; Condensation with ammonia and its derivatives; Wittig reaction; Mannich reaction; Oxidation of aldehydes; Baeyer-Villiger oxidation of ketones; Canizzaro reaction; Clemmensen; Wolff-Kishner; Haloform reaction; Reformatsky reaction; LiAIH4 and NaBH4 reductions.

UNIT II

Monocarboxylic acids: Nomenclature, structure and bonding of carboxylic compounds; Physical properties and acidity of carboxylic acids; Effects of substituents on acid strength; Preparation and reactions of aliphatic and aromatic carboxylic acids; Hell-Volhard-Zelinsky reaction; Reduction of carboxylic acids; Mechanism of decarboxylation.

Dicarboxylic acids: Nomenclature, physical properties and methods of formation; Chemical properties: Reactions of -COOH group, effect of heat and dehydrating agents, reactions of oxalic, malonic, succinic and adipic acid.

UNIT III

Halo carboxylic acids: Methods of preparation and properties.

Hydroxy carboxylic acids: Nomenclature, methods of preparation and properties.

Polyhydroxy carboxylic acids: Preparation and properties of malic, tartaric and citric acids.

Methods of synthesis and chemical reactions of unsaturated monocarboxylic acids.

UNIT IV

Acyl derivatives: Orbital structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides; Relative stability of acyl derivatives; Synthesis of acid chlorides, esters and amides; Physical properties; Chemical reactions; Mechanisms of esterification and hydrolysis (acidic and basic).

Fats and oils: Distinction between fats and oils; Extraction; Physical and chemical properties; Analysis of fat and oils; Manufacture of soap; Synthetic detergents.

BSCH263A ORGANIC CHEMISTRY-III LAB (Credits-2)

LIST OF EXPERIMENTS

Organic Preparations

1. Derivatives of the carbonyl compounds:

I. 2,4-DNP of one the following compounds- acetone, ethyl methyl ketone, di-ethyl ketone, cyclohexanone.

II. Semicarbazone of one the following compounds- acetone, ethyl methyl ketone, di- ethyl ketone, cyclohexanone.

III. oxime of one the following compounds- di-ethyl ketone, cyclohexanone.

2. Diels-Alder reaction between anthracene and maleic anhydride.

3. Reduction of nitrobenzene to azobenzene (TLC of the mixture), m-dinitrobenzene to m-nitroaniline.

4. Photochemical reduction of benzophenone to benzopinacol.

5. Benzoin condensation of benzaldehyde (using thiamine hydrochloride).

6. Condensation of p-toluidine with benzaldehyde /salicylaldehyde /2-hydroxy-3-methoxy benzadehyde to get schiff's base (solventless condensation).

7. Estimation of Phenol and aniline by bromination with potassium bromate-potassium bromide method.
8. Estimation of glycine by formylation method

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH 215A IONIC IQULLIBIA, ELECTROCHEMICAL EQUILIBRIA AND ELECTRICAL CONDUCTANCE (Credits-4)

Overview:

The content of this course deals with concepts of Ionic equilibrium and electrochemical equilibria along with applications of electrochemistry. A general study of the concept of ionization is applicable to the solvation of various soluble and partially soluble salts. Their solubility is based on their extent of hydrolysis, their pH and buffer action.

Electrochemical equilibrium reactions are responsible for the various types of cells used in day to day life, which also includes the reversible and non-reversible batteries. The concept of Le-Chatelier is applied to the solubility of various compounds based on the nature of heat evolved. This course includes conductivity, equivalent and molar conductivity, transport numbers and their relation to ionic mobilities. It also includes the various laws such as Kohlrausch law and rules for electrolytic conductance.

Objective and expected Outcome:

The aim of studying the electrolytic conductance course is that the students will get equipped with basic knowledge of conductance and how the ions flow from one electrode to other under electric field. It also aims to fortify the students in determining the transport numbers and applications of conductance measurement. This study will lay the necessary foundation to engage them in scientific research in the future.

The main objective of the course is to enable students to calculate the new equilibrium position, describing the van't Hoff equation. It also helps to understand the interplay between the rate of reaction and the magnitude of the equilibrium constant for reversible chemical reactions, The subject describes the Henderson-Hazel equation and its applications, describe the effect of a catalyst on the equilibrium position for a reversible chemical reaction

In electrochemistry, the Nernst equation is an equation that relates the reduction potential of an electrochemical reaction (half-cell or full cell reaction) to the standard electrode potential, temperature, and activities (often approximated by concentrations) of the chemical species undergoing reduction and oxidation.

Linear free energy relationships as Le Chatelier principle, Hammett equation as LFER, reaction mechanism, Taft equation are attempts to develop quantitative relationships between structure

and activity.

The lab experiments are designed so as to acknowledge the students with the concept of distribution coefficient, CSTand Melting point of solutions.

UNIT I

Ionic equilibrium I:

Ionization of weak acids and bases, pH scale, common ion effect, Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson-Hazel equation and its applications; buffer capacity, buffer range, buffer action and applications.

UNIT II

Ionic equilibrium II : Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid – base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems .

UNIT III

Electrochemical equilibria Electrical transport: Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/ reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation, Chemical Equilibria: Le Chatelier principle, Hammett equation: Hammett equation as LFER, reaction mechanism, Taft equation.

Applications of electrochemistry: Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. potentiometric titrations.

UNIT IV

Electrolytic Conductance Conductivity: Equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes; Molar conductivity at infinite dilution; Kohlrausch law; Debye-Huckel-Onsager equation; Wien effect; Debye-Falkenhagen effect; Walden’s rules.

BSCH265A PHYSICAL CHEMISTRY-III LAB (Credits-2)

LIST OF EXPERIMENTS

1. Study the equilibrium of at least one of the following reactions by the distribution method:
(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$
(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)n^{2+}$
2. Perform the following potentiometric titrations (at least two):
(i) Strong acid with strong base
(ii) weak acid with strong base and
(iii) dibasic acid with strong base
3. Potentiometric titration of Mohr's salt with potassium dichromate.
4. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
5. Phase equilibria: Construction of the phase diagram of (i) simple eutectic and (ii) congruently melting systems, using cooling curves and ignition tube methods.
6. To determine the melting point by using melting point apparatus.
7. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
8. To determine the solubility of benzoic acid at various temperatures and to determine the ΔH of the dissolution process.
9. To study the distribution of iodine between water and CCl_4.
(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

SKILL ENHANCEMENT COURSE-II

BSCH217A INTELLECTUAL PROPERTY RIGHTS (Credits-4)

Objectives:

The course aims to give insights into the basics of the Intellectual Property (IP) and in its wider purview it encompasses intricacies relating to IP. This course is designed to introduce a learning platform to those who may be involved in the making and creation of various forms of IP, besides the effective management of IPR of other creators. The course may also provide cursory understanding of the overall IP ecosystem in the country.

Learning Outcomes:

At the end of this course, students will be able to:
- Learn theoretical concepts of evolution of Intellectual Property Laws, and to differentiate between the different kinds of IP.
- Know the existing legal framework relating to IP in India.

- Comprehend the value of IP and its importance in their respective domains.
- This course may motivate the students to make their career in multifaceted field of intellectual property rights.

Unit I

Introduction

Basic concept of Intellectual Property, Rationale behind Intellectual Property, Justifications for protection of IP, IPR and Economic Development, Major International Instruments relating to the protection of IP. The World Intellectual Property Organization (WIPO), WTO and TRIPS Agreement.

Copyright and Related rights

Introduction to copyright and its relevance, subject matter and conditions of protection, ownership and term of copyright, rights under copyright law, infringement of copyright and remedies, exceptions to infringement/ public rights.

Unit II

Patents Introduction, Criteria for obtaining patents, Patentable subject matter, Non patentable inventions, Procedure for registration, Term of patent and Rights of patentee, Patent Cooperation Treaty & International registration, Basic concept of Compulsory license and Government use of patent, Infringement of patents and remedies, Software patents and importance for India, Utility model & patent, Trade secrets and know-how agreement, Traditional Knowledge and efforts of Indian Govt. for its protection.

Unit III

Trade Marks Meaning of mark and Trademark, Categories of Trademark: Service Mark, Certification Mark, Collective Mark, Well known Mark and Non-conventional Mark, Criteria for registrability of trademark: Distinctiveness & non- deceptiveness, A good Trade Mark & its functions, Procedure for registration and Term of protection, Grounds for refusal of trademark registration, Assignment and licensing of marks (Character merchandising), Infringement and Passing Off, Salient Features of Indian Trade Mark Act,1999.

Unit IV

Designs, GI and Plant Varieties Protection

Designs: Meaning of design protection, Concept of original design, Registration &Term of protection, Copyright in Designs.

Geographical Indication: Meaning of GI, Difference between GI and Trade Marks, Registration of GI, Term & implications of registration, Concept of Authorized user, Homonymous GI

Plant Variety Protection and Farmer's Right: Meaning, Criteria of protection, Procedure for registration, effect of registration and term of Protection, Benefit Sharing and Farmer's rights

Enforcement and Protection

Enforcement of Intellectual Property Rights: Counterfeiting and Piracy, Understanding Enforcement of IP and Enforcing IPRs, Enforcement under TRIPS Agreement, Role of Customs and Police in IPR Protection

References books:

1. Pandey, N.; Dhami, K. (2014),Intellectual Property Rights, PHI Learning Pvt. Ltd.
2. Acharya, N.K.(2001),Text Book of Intellectual Property Rights, Asia Law House.
3. Ganguli, P. (2001),Intellectual Property Rights: unleashing the knowledge economy. Tata McGraw Hill.

BSDM301A DISASTER MANAGEMENT (Credits-3)

COURSE OBJECTIVE: The objective of the course is to create awareness about various types of disasters and to educate the learners about basic disaster management strategies. The course examines disaster profile of our country and illustrates the role played by various governmental and non- governmental organizations in its effective management. It also acquaints learners with the existing legal frame work for disaster management.

LEARNING OUTCOME: The course will -

1. Provide students an exposure to disasters, their significance and types.
2. Ensure that the students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
3. Provide the students a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
4. Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

UNIT I Introduction to Disasters: Concept and definitions- Disaster, Hazard, vulnerability, resilience, risks.

Different Types of Disaster: Causes, effects and practical examples for all disasters.

- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc
- Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc.

UNIT- II Disaster Preparedness and Response Preparedness

- Disaster Preparedness: Concept and Nature
- Disaster Preparedness Plan
- Prediction, Early Warnings and Safety Measures of Disaster.
- Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.
- Role of IT in Disaster Preparedness
- Role of Engineers on Disaster Management.
- Relief and Recovery
- Medical Health Response to Different Disasters

UNIT III Rehabilitation, Reconstruction and Recovery

- Reconstruction and Rehabilitation as a Means of Development.
- Damage Assessment
- Post Disaster effects and Remedial Measures.
- Creation of Long-term Job Opportunities and Livelihood Options,
- Disaster Resistant House Construction
- Sanitation and Hygiene
- Education and Awareness,
- Dealing with Victims' Psychology,
- Long-term Counter Disaster Planning
- Role of Educational Institute.

UNIT IV Disaster Management in India

- Disaster Management Act, 2005:
- Disaster management framework in India before and after Disaster Management Act, 2005, National Level Nodal Agencies, National Disaster Management Authority
- Liability for Mass Disaster
- Statutory liability
- Contractual liability
- Tortious liability
- Criminal liability
- Measure of damages
- Epidemics Diseases Act, 1897: Main provisions, loopholes.

Project Work: The project/ field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived based on the geographic location and hazard profile of the region where the institute is located.

Reference Books:

1. Government of India, Department of Environment, Management of Hazardous Substances Control
2. Act and Structure and Functions of Authority Created Thereunder.
3. Indian Chemical Manufacturers' Association & Loss Prevention Society of India, Proceedings of the National Seminar on Safety in Road Transportation of Hazardous Materials: (1986).
4. Author Title Publication Dr. Mrinalini Pandey Disaster Management Wiley India Pvt. Ltd.
5. Tushar Bhattacharya Disaster Science and Management McGraw Hill Education (India) Pvt. Ltd.
6. Jagbir Singh Disaster Management: Future Challenges and Opportunities K W Publishers Pvt. Ltd.

7. J. P. Singhal Disaster Management Laxmi Publications.
8. Shailesh Shukla, Shamna Hussain Biodiversity, Environment and Disaster Management Unique Publications
9. C. K. Rajan, Navale Pandharinath Earth and Atmospheric Disaster Management: Nature and Manmade B S Publication
10. Indian law Institute (Upendra Baxi and Thomas Paul (ed.), Mass Disasters and Multinational Liability: The Bhopal Case (1986)
11. Indian Law Institute, Upendra Baxi (ed.), Environment Protection Act: An Agenda for Implementation (1987)
12. Asian Regional Exchange for Prof. Baxi., Nothing to Lose But our Lives: Empowerment to Oppose
13. Industrial Hazards in a Transnational world (1989)
14. Gurudip Singh, Environmental Law: International and National Perspectives (1995), Lawman (India) Pvt. Ltd.
15. Leela Krishnan, P, The Environmental Law in India, Chapters VIII, IX and X (1999), Butterworths, New Delhi.

SEMESTER- IV

BSCH 212A CRYSTAL DEFECTS AND COORDINATION COMPOUNDS

(Credits-4)

Overview:

The present course highlights about inert gases, occurrence in nature, and their admirable properties. This course deals with the defects occurring in the crystal structure, their effects on properties of metals and also clears some basic concept about insulator and conductor. This course also covers the coordination compounds, their stability, bonding in the coordination compounds and the transitions due to which coordination compounds are colored.

Objective and expected outcomes:

The objective of the present course is to enable the students to know about the noble gases and some of their basic use in daily life. They will appreciate the concepts of defects, insulator and semiconductors, p – n junction which is used in solar cell and LED lights. After completion of course, students will be able to analyse that how semiconductors and p – n junction helps in producing the light in cameras, televisions etc. Various topics covered in the coordination complexes acquaint the students with their chemistry, stability and bonding. After studying the coordination chemistry, students will get information about various transitions of electrons in coordination chemistry responsible for coloration, magnetic properties of coordination complexes.

Lab experiments constitute with qualitative analysis of inorganic cations and anions such as Pb^{2+}, Bi^{3+} Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+} and CO_3^{2-}, SO_3^{2-} , CO_2^{3-}, SO_2^{-3}, S^{2-}, NO_2^{-} etc.

UNIT I

Noble gases: Occurrence & uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2 and XeF4, XeF6; Nature of bonding in noble gas

compounds (Valence bond treatment and M.O. treatment for XeF2 and XeF4). Molecular shapes of noble gas compounds (VSEPR theory).

UNIT II

Defects in solids: Intrinsic and extrinsic defects: Point, line and plane defects; Vacancies: Schottky and Frenkel defects; Thermodynamics of Schottky and Frenkel defect formation; The colourcentres; Imperfactions due to transient atomic displacements; Band structure of metals; Insulators and semiconductors; Intrinsic and extrinsic semiconductors; Doping semiconductors; P-N junctions; High temperature super conductors.

UNIT III

Coordination compounds: Various definitions; Classical and non-classical ligands; The Chelate and microcyclic effect; Multidentate ligands; Conformation of chelate rings; Stereochemistry of various coordination numbers; Isomerism in coordination compounds: Nomenclature and stability of coordination compounds: Thermodynamic and kinetic stability; Stability constants and factors affecting the stability constant; Experimental and statistical ratios of stability constants.

UNIT IV

Bonding in Coordination compounds: Valence bond theory for bonding in coordination compounds; Concept of multiple bonding and back bonding: Strength and weakness of valence bond approach.

Crystal field theory: Splitting of d-orbitals in different fields; Consequences of orbital splitting; Crystal field stabilization energy; Magnetic properties; Factors affecting extent of splitting and spectrochemical series; Colours of transition metal complexes; Structural effect of crystal field splitting; Ionic radii; Jahn Teller effect in octahedral and tetrahedral complexes; Molecular orbital treatment of octahedral, tetrahedral and square planar complexes. Molecular orbital diagrams for complexes.

BSCH262A INORGANIC CHEMISTRY-IV LAB (Credits-2)

LIST OF EXPERIMENTS

(a) Qualitative analysis:

Using H_2S /PTC/ Thioacetamide or any other reagent. Identification of cations and simple anions in a mixture of salts containing not more than six ions (Three cations and three anions)

(i) Cation :Pb^{2+}, Bi^{3+} Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+} or Sn^{4+}, Fe^{2+} OR $Fe^{3+,}$ Al^{3+}, Cr^{3+},Co2+, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH^{4+}, K^{+}

(ii) Anion : CO_3^{2-}, SO_3^{2-}, CO_2^{3-}, SO_2^{-3}, S^{2-}, NO^{-2}, CH_3COO^{-}, NO^{-3}, Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, PO_4^{3-} ,BO_3^{3-},F^{-}, $C_2O_2^{-4}$

(b) Analysis of interfering anions using semi micro scheme of analysis.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment

may be added.)

BSCH 214A AMINES AND HETEROCYCLIC COMPOUNDS (Credits-4)

Overview

Amines constitute an important class of organic compounds derived by replacing one or more hydrogen atoms of ammonia molecule by alkyl/aryl group(s). In nature, they occur among proteins, vitamins, alkaloids and hormones. Synthetic examples include polymers, dyestuffs and drugs. Two biologically active compounds, namely adrenaline and ephedrine, both containing secondary amino group, are used to increase blood pressure. Novocain, a synthetic amino compound, is used as an anaesthetic in dentistry. Benadryl, a well-known antihistaminic drug also contains tertiary amino group.

Heterocycles are another important class of compounds, which are used in a wide variety of drugs, most vitamins, many natural products, biomolecules, and biologically active compounds, including antitumor, antibiotic, anti-inflammatory, antidepressant, antimalarial, anti-HIV, antimicrobial, antibacterial, antifungal, antiviral, antidiabetic, herbicidal, fungicidal, and insecticidal agents.

Heterocycles are also of considerable interest because of their synthetic utility as synthetic intermediates, protecting groups, chiral auxiliaries, organ catalysts, and metal ligands in asymmetric catalysts inorganic synthesis. Therefore, substantial attention has been paid to develop efficient new methods to synthesize heterocycles.

This course content provides knowledge about the chemistry of preparation and reactions of aliphatic and aromatic amines which are used as a starting material for the manufacture of azo dyes.

Objective and expected Outcome:

In this course student will learn about structure, stability, methods of synthesis and reactions of amine and their derivatives. The course will apprise students about the synthesis, reactions and mechanism of substitution reactions of five membered and six membered heterocycles like furan, pyrrole, pyridine, thiophene and indole etc. Modern theory of colors and chemistry of dyes like azo dyes, phthalein dyes etc. will also be discussed.

After the course students will be able to know the chemistry of amines, polynuclear aromatic hydrocarbons and heterocyclic compounds which have been frequently found as a key structural unit in synthetic pharmaceuticals and agrochemicals.

After the completion of course students will be able to perform qualitative analysis of organic compounds.

UNIT I

Organo-sulphur compounds: Preparation and reactions of thiols, thioethers and aromatic sulphonic acids.

Organo-phosphorous compounds: Methods of formation, physical and chemical reactions of phosphines and phosphine oxides.

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 10, 20 and 30 amines with Hinsberg reagent and nitrous acid; Preparation and important reactions of nitro alkanes and alkyl nitrites and isonitriles.

Diazoalkanes and Azides: Preparation and their synthetic applications.

UNIT II

Polynuclear Hydrocarbons: Synthesis and reactions of naphthalene, phenanthrene and anthracene; Structure, methods of preparation, structure elucidation and important derivatives of naphthalene and anthracene.

UNIT III

Heterocyclic Compounds: Classification and nomenclature, Structure and aromaticity in 5-membered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and furoic acid.

UNIT IV

Colours dyes and pigments: Wit's theory of color; Modern theory of color; Dyes and their classification according to chemical structure; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes - Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein.

Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Classification according to their methods of application; Food dyes.

BSCH264A ORGANIC CHEMISTRY-IV LAB (Credits-2)

LIST OF EXPERIMENTS

1. Systematic analysis of (N, S etc.) elements in the given unknown compounds and tests for unsaturation in the following compounds.
2. Qualitative analysis of the following types of unknown organic compounds

a. Carboxylic acids
b. Phenols
c. Alcohols
d. Aldehydes
e. Ketones
f. Esters

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH216A CHEMICAL KINETICS AND PHASE EQUILLIBRIUM (Credits-4)

Overview:

The content of this course provides an overview of chemical kinetics of various reactions. It describes the rate at which chemical structure change. This course offers the formal introduction to the chemical kinetics terms including Order, Molecularity, and Rate Laws. Since simple-minded methodologies for determining rate constants of the reactions are susceptible to incorrectness in determining final state of the system, it is important to understand the concept of steady state approximation for multiple reactions. The kinetics of the complex reactions is so wide and strange that in other part of the syllabus students will learn the various types of reactions such as opposing, reverse, consecutive and parallel reactions. They will also get the knowledge of their differential rate equations. The course further integrates types and characteristics of catalyst in catalysis reactions, Mechanism of acid-base catalysis, and Michelis- Menten's equation for enzyme catalysis.

It also includes the phase diagram which shows the graphical representations of metal alloys after heating and cooling process. These graphical maps are primary tools in metallurgy for predicting the changes in the internal structure of a material. The course includes the Gibbs phase rule and construction of phase equilibria for single, two and three component systems. This course also examine the relationship between thermodynamic and phase diagram of materials

Objective and expected Outcome:

The main objective of the course is to enable the students with the idea about the speed at which a reaction occurs and kinetics also sheds light on the mechanism of the reaction. They will also learn the role of catalyst in enhancing the rate of reaction. After completion of the course, students will be able to identify and differentiate the chemical kinetics of various reactions. This course will enlighten the thoughts of the students regarding the chemical kinetics, colloidal and surface chemistry. Group working of students provides them not only hands-on experience but it will help them to do minds-on approach to learning physical science. The main objective of teaching phase equilibria is that students would be able extract information about phase equilbria from phase diagrams which is relevant in production and application of materials with focus on metals, alloys and inorganic materials. Through the study of this course, students will gain the proper understanding and basic theory of phases; master the new development of the phase diagram analysis method. They will be able to perform simple calculations of binary phase diagrams by the use of ideal and regular solution models.

The lab experimentation includes the application of Beer-Lambert's law along with preparation of various sols. The lab experiments help the students to gain practical knowledge about integrated rate equations and determining order of reactions.

UNIT I

Chemical kinetics-I: Order and molecularity of a reaction; Rate laws, Differential and integrated form of rate expressions up to second order reactions; Experimental methods of the determination of rate laws; Effect of temperature on reaction rates; Arrhenius equation; Activation energy; Collision theory of bimolecular gaseous reactions; The Lindemann theory of unimolecular gaseous reactions.

UNIT II

Chemical kinetics-II:

a) Kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing or reverse reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions

b) Catalysis: Types and characteristics of catalyst; Mechanism of acid-base catalysis; The Michelis- Menten's equation for enzyme catalysis; Mechanisms of catalyzed reactions at solid surfaces.

UNIT III

Surface chemistry: Physical and chemical adsorptions; Applications of adsorption; Factors influencing adsorption; Adsorption isotherms; Modern techniques for investigating surfaces, Perrin's method of determination of the Avogadro's number.

UNIT IV

Phase equilibria-I: Concept of phases, components and degrees of freedom; Derivation of Gibbs phase rule for non-reactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria; Phase diagram for one component systems (H2O and CO2); Phase diagrams for two component systems involving eutectic (Pb-Ag), congruent (Zn-Mg), cooling curves,

Phase equilibriaII: Phase diagrams for two component systems involving incongruent melting points (Na-K and Na2SO4- H2O,); Three component systems; Water-chloroform-acetic acid system. Applications of phase rule equation.

Liquid crystals: Classification of liquid crystals, polymorphism

BSCH266A PHYSICAL CHEMISTRY-IV LAB (Credits-2)

LIST OF EXPERIMENTS

(a) Study the kinetics of the following reactions: -

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:

(i) Acid hydrolysis of methyl acetate with hydrochloric acid, volumetrically or conductometrically.

(ii) Iodide-persulphate reaction

(iii) Saponification of ethyl acetate.

(b) To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically

(c) To determine the strength of given acid solution (mono and dibasic acid)/KMnO4 – Mohr salt potentiometrically.

(d) To determine the molecular weight of a non-volatile solute by Rast method.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

SEMESTER-V

BSCH311A BIOMOLECULES (Credits-4)

Objectives:

This core course aims to introduce the learner to the fascinating chemistry of some biomolecules,i.e., amino acids, peptides, proteins, carbohydrates, lipids andnucleic acidsthat work within biological systems. It aims to build the concept of metabolism by the study of chemistry and energetics of biological system.

Learning Outcomes:

On completion of this course, the students will be able to:

- Understand and demonstrate how structure of biomolecules determines their reactivity and biological functions.
- Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation.
- Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.

Unit I

Nucleic Acids: Structure of components of nucleic acids: Bases, Sugars, Nucleosides and Nucleotides. Nomenclature of nucleosides and nucleotides, structure of polynucleotides (DNA and RNA), concept of DNA duplex formation and its characterization. Biological roles of DNA and RNA. Concept of heredity:Genetic Code, Replication, Transcription and Translation.

Unit II

Amino Acids, Peptides and Proteins: Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structure-end group analysis. Synthesis of peptides using N-protecting, C-protecting and C- activating groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Denaturation of proteins.
Enzymes: Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking chymotrypsin as an example), factors affecting enzyme action, coenzymes and cofactors (NAD,FAD), specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance.

Unit III

Carbohydrates and lipids: Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projection and conformational structures; Interconversion of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen. Introduction to oils and fats: common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Unit IV

Concept of Energy in Biosystems: Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+, FAD. Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle. Caloric value of food, standard caloric content of food types.

Reference Books:

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006),Biochemistry. W.H. Freeman and Co.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L.(2009),Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W.(2009),Harper's Illustrated Biochemistry.Lange Medical Books/McGraw-Hill.
4. Brown,T.A. (2018) Biochemistry, (First Indian addition 2018) Viva Books.

BSCH361A BIOMOLECULES LABS (Credits-2)

LIST OF EXPERIMENTS

1. Estimation of glucose by Fehling's solution.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch under optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Isolation and estimation of DNA using cauliflower/onion.
7. Saponification value of the given oil.
8. Determination of Iodine number of the given oil.

References books:

1. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
2. Kumar, A.; Garg, S.; Garg, N. (2012), Biochemical Tests: Principles and Protocols.Viva Books.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH313A QUANTUM CHEMISTRY AND SPECTROSCOPY (Credits-4)

Objectives:

The aim of this course is to make students understand the limitations of classical mechanics and the need of quantum chemistry, familiarize them with postulates of quantum chemistry and apply the same to derive equations for various models and hydrogen atoms. Understand the basis of molecular spectroscopy and its applications.

Learning Outcomes:

By the end of this course, students will be able to:

- Learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.
- Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.
- Interpret various types of spectra and know about their application in structure elucidation

Unit I

Quantum Chemistry: Postulates of quantum mechanics, quantum mechanical operators and commutation rules, Schrödinger equation and its application to free particle and particle in a box (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation in Cartesian and spherical polar coordinates (derivation not required). Separation of variables. Spherical harmonics. Discussion of solution (Qualitative).

Unit II

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part and quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many- electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Unit III

Molecular Spectroscopy: Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation

energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales (δ and T), spin-spin coupling and high resolution spectra, interpretation of PMR spectra of simple organic molecules like methanol, ethanol, acetaldehyde, acetic acid and aromatic proton.

Reference books:

1. Banwell, C.N.; McCash, E.M.(2006), Fundamentals of Molecular Spectroscopy, Tata McGraw- Hill.
2. Kapoor, K.L.(2015),A Textbook of Physical Chemistry, McGraw Hill Education, ,Vol 4, 5th Edition, McGraw Hill Education.
3. House, J.E.(2004), Fundamentals of Quantum Chemistry, 2nd Edition, Elsevier.
4. McQuarrie, D.A.(2016),Quantum Chemistry, Viva Books.
5. Chandra, A. K.(2001),Introductory Quantum Chemistry, Tata McGraw-Hill.
6. Kakkar, R. (2015),Atomic & Molecular Spectroscopy, Cambridge University Press.

BSCH363A QUANTUM CHEMISTRY AND SPECTROSCOPY LAB (Credits-2)

LIST OF EXPERIMENTS

Colorimetry:

1. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration.
2. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.
3. Study the kinetics of iodination of propanone in acidic medium.
4. Determine the amount of iron present in a sample using 1, 10-phenanthroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

Spectrophotometry:

2. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different units (kJ molecule-1, kJ mol-1, cm-1, eV).
3. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.
4. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.
5. Analysis of the given vibration-rotation spectrum of HCl (g)

Reference books:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
2. Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003),Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

DISCIPLINE SPECIFIC COURSE-I

BSCH315A NOVEL INORGANIC SOLIDS (Credits-4)

Objectives:

Solid-state chemistry also referred as material chemistry currently has emerged with great focus on novel inorganic solids. It has found enormous applications in both industrial and research arenas and has helped to shape modern day recyclable adsorbents and catalysts. Novel inorganic-organic hybrid nanocomposites have received a lot of attention because of their abundance and cost-effective nature they can be utilized as catalysts, as a nano reactor to host reactants for synthesis and for the controlled release of biomolecules. Materials such as semiconductors, metals, composites, nanomaterials, carbon or high-tech ceramics make life easier in this era and are great sources of industrial growth and technological changes. Therefore, its exposure to the undergraduates with science backgrounds can groom them for future researches.

Learning Outcomes:

By the end of the course, the student will be able to:

- Understand the mechanism of solid-state synthesis.
- Explain about the different characterization techniques and their principle.
- Understand the concept of nanomaterials, their synthesis and properties.
- Explain the mechanism of growth of self-assembled nanostructures.
- Appreciate the existence of bioinorganic nanomaterials.
- Explain the importance of composites, conducting polymers and their applications.
- Understand the usage of solid materials in various instruments, batteries, etc. which would Help them to appreciate the real-life importance of these materials

Unit I

Basic introduction to solid-state chemistry: Semiconductors, different types of semiconductors and their applications.
Synthesis of inorganic solids: Conventional heat and beat method, Co-precipitation method, Sol-gel method, Hydrothermal method, Chemical vapor deposition (CVD), Ion-exchange and Intercalation method.

Unit II

Characterization techniques of inorganic solids: Powder X-ray Diffraction, UV-visible spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Fourier-Transform Infrared (FTIR) spectroscopy, Brunauer–Emmett–Teller (BET) surface area analyser, Dynamic Light Scattering (DLS)

Unit III

Cationic, anionic and mixed solid electrolytes and their applications. Inorganic pigments – coloured, white and black pigments. One-dimensional metals, molecular magnets, inorganic liquid crystals.

Unit IV

Nanomaterials: Overview of nanostructures and nanomaterials, classification, preparation and optical properties of gold and silver metallic nanoparticles, concept of surface plasmon resonance, carbon nanotubes, inorganic nanowires, Bioinorganic nanomaterials, DNA and its nanomaterials, natural and artificial nanomaterials, self-assembled nanostructures, control of nanoarchitecture, one dimensional control.

Unit V

Composite materials: Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, bio-nanocomposites, environmental effects on composites, applications of composites.

Speciality polymers: Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene, polyanilineand polypyrrole, applications of conducting polymers, ion-exchange resins and their applications.

Ceramic & Refractory:Introduction, classification, properties, manufacturing and applications of ceramics, refractory and superalloys as examples.

References books:

1. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley.
2. Smart, L. E.; Moore, E. A., (2012),Solid State Chemistry: An Introduction CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J. (1997),New Direction in Solid State Chemistry, Cambridge University Press.
4. Poole Jr.; Charles P.; Owens, Frank J. (2003), Introduction to Nanotechnology, John Wiley and Sons.

BSCH365A NOVEL INORGANIC SOLIDS LAB (Credits-2)

LIST OF EXPERIMENTS

1. Synthesis of silver nanoparticles by chemical methods and characterization using UV-visible spectrophotometer.
2. Synthesis of silver nanoparticles by green approach methods and characterization using UV-visible spectrophotometer.
3. Preparation of polyaniline and its characterization using UV-visible spectrophotometer.
4. Synthesis of metal sulphide nanoparticles (MnS, CdS, ZnS, CuS, NiO) and characterization using UV- visible spectrophotometer.
5. Intercalation of hydrogen in tungsten trioxide and its conductivity measurement using conductometer.
6. Synthesis of inorganic pigments (PbCrO4, ZnCrO4, Prussian Blue, Malachite).
7. Synthesis of pure ZnO and Cu doped ZnO nanoparticles.
8. Preparation of zeolite A and removal of Mg and Ca ions from water samples quantitatively using zeolite.

References books:

1. Orbaek, W.; McHale, M.M.; Barron, A. R.; Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory,J. Chem. Educ. 2015, 92, 339−344.
2. MacDiarmid, G.; Chiang, J.C.; Richter, A.F.; Somasiri, N.L.D.(1987), Polyaniline: Synthesis and Characterization of the Emeraldine Oxidation State by Elemental Analysis, L. Alcaeer (ed.), Conducting Polymers, 105-120, D. Reidel Publishing.
3. Cheng, K.H.; Jacobson, A.J.; Whittingham, M.S. (1981),Hexagonal Tungsten Trioxide and Its Intercalation Chemistry, Solid State Ionics, 5, 1981, 355-358.
4. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; Synthesis of ZnO Nanoparticles by Precipitation Method, Orient J Chem 2015, 31(2).

(Note: A candidate must perform at least eight experiments in the lab. Any suitable experiment may be added.)

DISCIPLINE SPECIFIC COURSE-II

BSCH317A GREEN METHODS OF CHEMISTRY (Credits-4)

Objectives

Today's society is moving towards becoming more and more environmentally conscious. There is rising concern of environmental pollution, depleting resources,climate change, ozone depletion, heaps and heaps of landfills piling up, legislation which is getting stringent with strict environmental laws,,rising cost of waste deposits and so on. We are faced with a challenge to work towards sustainable practices.Green chemistry has arisen from these concerns.It is not a new branch of chemistry but the way chemistry should be practiced. Innovations and applications of green chemistry in education has helped companies not only gainenvironmental benefits but at the same time achieve economic and societal goals also. This is possible because these undergraduate students are ultimate scientific community of tomorrow.

Learning Outcomes

By the end of this course, students will be able to:
•Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances.

•Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it is different from percentage yield.

•Learn to design safer chemical ,products and processes that are less toxic, than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you"

•Understand benefits of use of catalyst and bio catalyst ,use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, importance led reactions in various green solvents.

•Appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus the students are able to realise that chemistry can be used to solve rather than cause environmental problems.

•Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real world cases also motivate them to practice green chemistry.These days customers are demanding to know about a product: Is it green? Does it contribute to global warming? Was it made from non depletable resources? Students have many career opportunities as " green" is the path to success.

Unit I

Introduction to Green Chemistry

What is Green Chemistry? Some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Unit II

Principles of Green Chemistry and Designing a Chemical synthesis Twelve principles of Green Chemistry and their explanation with examples Special emphasis on the following:

•Prevention of Waste/ by products; maximum incorporation of the materials used in the process into the final products , Environmental impact factor, waste or pollution prevention hierarchy

•Green metrics to assess greenness of a reaction, e.g. Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

•Prevention/ minimization of hazardous/ toxic products reducing toxicity

•Risk = (function) hazard x exposure

•Designing safer chemicals with minimum toxicity yet has the ability to perform the desired functions

•Green solvents: super critical fluids with special reference to carbon dioxide, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, solvents obtained from renewable resources and how to compare greenness of solvents

•Energy requirements for reactions – alternative sources of energy: use of microwaves , ultrasonic energy and photochemical energy

•Selection of starting materials; should be renewable rather than depleting, Illustrate with few examples such as biodiesel and polymers from renewable resources (such as green plastic)

•Avoidance of unnecessary derivatization – careful use of blocking/protecting groups

•Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

•Design for degradation: A product should not persist after the commercial function is over e.g. soaps and detergents, pesticides and polymers

•Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.
•Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy

(safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

Unit III

Examples of Green Synthesis/ Reactions

- Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis).
- Green Reagents: Non-phosgene Isocyanate Synthesis, Selective Methylation using dimethylcarbonate.
- Microwave assisted solvent free synthesis of copper phthalocyanine
- Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction
- Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)

Unit IV

Real world case studies based on the Presidential green chemistry awards of EPA

- Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.
- A new generation of environmentally advanced wood preservatives: Getting the chromium and Arsenic out of pressure treated wood.
- An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.
- Healthier Fats and oils by Green Chemistry: Enzymatic Inter esterification for production of No Trans-Fats and Oils.
- Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting.
- Using a naturally occurring protein to stimulate plant growth, improve crop quality, increase yields, and suppress disease.

Future Trends in Green Chemistry Oxidation reagents and catalysts; Biomimcry and green chemistry, Biomimetic, Multifunctional Reagents; mechanochemical and solvent free synthesis of inorganic complexes; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

References books:

1.Anastas, P.T.; Warner, J.C.(1998),Green Chemistry, Theory and Practice, Oxford University Press.
2.Lancaster, M.(2016),Green Chemistry An Introductory Text.2nd Edition, RSC Publishing.
3.Cann, M. C. ;Connely,M. E.(2000), Real-World cases in Green Chemistry, American Chemical Society, Washington.
4.Matlack, A.S.(2001),Introduction to Green Chemistry, Marcel Dekker.
5.Alhuwalia, V. K.; Kidwai, M.R.(2005),New Trends in Green chemistry, Anamalaya Publishers.

BSCH367A GREEN METHODS OF CHEMISTRY LAB (Credits-2)

LIST OF EXPERIMENTS

Characterization by m. pt., U.V.-Visible spectroscopy, IR spectroscopy, and any other specific method should be done (wherever applicable).
Safer starting materials
1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
Using renewable resources
2. Preparation of biodiesel from waste cooking oiland characterization (TLC, pH, Solubility, Combustion Test, Density, Viscosity, Gel Formation at Low Temperature and IR can be provided).
Use of enzymes as catalysts
3. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
Alternative green solvents
4. Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.
5. Mechanochemical solvent free, solid–solid synthesis of azomethine using p- toluidine and o-vanillin/p- vanillin (various other combinations of primary amine and aldehyde can also be tried).
Alternative sources of energy
6. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
Reducing waste
8. Designing and conducting an experiment by utilizing the products and by products obtained in above preparations which become waste otherwise if not used. This is done by critical thinking and literature survey.

Some representative examples:

- Use of nanoparticles as catalyst for a reaction
- Benzoin converted into Benzil and Benzil into Benzilic acid by a green method
- Use of azomethine for complex formation
- Rearrangement reaction from Benzopinacol to Benzopinacolone
- Conversion of byproduct of biodiesel to a useful product
- Students should be taught to do spot tests for qualitative inorganic analysis for cations and anions, and qualitative organic analysis for preliminary test and functional group analysis.

References books:

1. Kirchoff, M.; Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia,D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),Introduction to organic Laboratory Technique- A Microscale approach,4th Edition, Brrooks-Cole Laboratory Series for Organic chemistry.
4. Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. Indu Tucker Sidhwani et al. University of Delhi, Journal of Undergraduate Research and Innovation, Volume 1, Issue 1,February 2015, ISSN: 2395-2334.
5. Sidhwani, Tucker I.; Chowdhury, S. Greener alternatives to Qualitative Analysis for Cations without H2S and other sulfur containing compounds, J. Chem. Educ. 2008, 85, 1099.
6. Sidhwani, Tucker I.; Chowdhury, S. et al., DU Journal of Undergraduate Research and Innovation, 2016, Volume 2, Issue 2, 70-79.
7. Dhingra, S., ;Angrish, C. Qualitative organic analysis: An efficient, safer, and economical approach to preliminary tests and functional group analysis. Journal of Chemical Education, 2011, 88(5), 649-651.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

SEMESTER-VI

BSCH312A ORGANOMETALLICS CHEMISTRY (Credits-4)

Objectives:

The course introduces some important topics of Inorganic Chemistry in a compact way. Unit 1 of the course introduces students to the basic principles of qualitative inorganic analysis. The influence of solubility products and the common ion effect on the separation of cations is made clear. Interfering anions are identified and their removal is studied. Unit 2, an introduction to the very important area of organometallic chemistry including classification of organometallic compounds, the concept of hapticity and the 18-electron rule governing the stability of a wide variety of organometallic species. Specific organometallic compounds are studied in detail to further understand the basic concepts: metal carbonyls, metal alkyls, Zeise's salt and ferrocene. Unit 4 takes this a step further by covering catalysis, an important application of organometallic compounds. Under Unit 3, bioinorganic chemistry, the student learns the importance of inorganic chemical species, especially metals, in biological systems, through discussions on metal-containing enzymes, the sodium-potassium pump and the applications of iron in physiology, including iron transport and storage system.

Learning Outcomes:

By the end of the course, the students will be able to:

- Understand and explain the basic principles of qualitative inorganic analysis
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
- Identify important structural features of the metal alkyls tetrameric methyl lithium and dimeric trialkyl aluminium and explain the concept of multicenter bonding in these compounds
- Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it and understand and describe the active sites and action cycles of the metalloenzymes carbonic anhydrase and carboxypeptidase
- Explain the sources and consequences of excess and deficiency of trace metals and learn about the toxicity of certain metal ions, the reasons for toxicity and antidotes
- Explain the use of chelating agents in medicine and, specifically, the role of cisplatin in cancer therapy and explain the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin
- Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.

Unit I

Theoretical Principles in Qualitative Analysis (H2S Scheme)

Basic principles involved in analysis of cations and anions. Solubility products, common ioneffect. Principles involved in separation of cations into groups and choice of group reagents.Interfering anions (fluoride, borate, oxalate and phosphate), need to remove them afterGroup II and methods of removal. Analysis of insoluble substances.

Unit II

Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.

Ferrocene: Preparation, physical properties and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Unit III

Bioinorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin, Myoglobin; Storage and transfer of iron.

Unit IV

Catalysis by Organometallic Compounds

General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis (catalytic steps, examples and industrial applications), deactivation and regeneration of catalysts, catalytic poison, promoter.

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Synthetic gasoline (Fischer Tropsch reaction)
3. Polymerization of ethene using Ziegler-Natta catalyst

BSCH362A ORGANOMETALLICS CHEMISTRY LAB (Credits-2)

LIST OF EXPERIMENTS

1. Qualitative semi-micro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-} , S^{2-}, SO_3^{2-}, NO^{2-} SO^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br-, I-, NO^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

2. Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO^{2-} and NO^{3-}, Cl^- and Br^- , Cl^- and I^-, Br^- and I^-, NO^{3-} and Br-, NO^{3-} and I^-. Spot tests should be done whenever possible.

References books:

1. Svehla, G. (1996),Vogel's Qualitative Inorganic Analysis,7th Edition,Prentice Hall.
2. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K.(2009),Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.
3. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994),Inorganic Chemistry 2nd Ed., Oxford University Press.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010),Shriver and Atkins Inorganic Chemistry, 5th Edition, W. H. Freeman and Company.
5. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. Basic Inorganic Chemistry, 3rd Edition,Wiley India.
6. Greenwood, N.N.; Earnshaw, A.(1997), Chemistry of the Elements, 2nd Edition, Elsevier (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
7. Powell, P.(1988), Principles of Organometallic Chemistry, Chapman and Hall.

References books:

1. Vogel, A.I,(1972),Qualitative Inorganic Analysis, Longman.
2. Svehla, G. (1996),Vogel's Qualitative Inorganic Analysis, Prentice Hall.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

BSCH314A SPECTROSCOPY AND APPLIED ORGANIC CHEMISTRY (Credits-4)

Objectives:

The course introduces the learner to various tools and techniques for identifying and characterizing the organic compounds through their interactions with electromagnetic radiation viz. UV-Visible, IR and NMR spectroscopy. This course also deals with some classes of organic compounds finding applications in everyday life namely; polymers, dyes, and pharmaceutical compounds. The chemistry of these compounds in general will be explained through naturally occurring and synthetic compounds.

Learning Outcomes:

On completion of this course, the students will be able to:

- Gain insight into the basic principles of UV, IR and NMR spectroscopic techniques.
- Use spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds.
- Develop a sound understanding of the structure of Pharmaceutical Compounds. They will also understand the importance of different classes of drugs and their applications for treatment of various diseases.
- Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- Learn about the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.

Unit I

Organic Spectroscopy General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes);distinction between cis and trans isomers by UV.

UNIT II

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorptionpositions of O, N and S containing functional groups; Effect of H-bonding, conjugation,resonance and ring size on IR absorptions; Fingerprint region and its significance; application of IR in functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Equivalent and non-equivalent protons, Spin – Spin coupling and coupling constant;

Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules.

Unit III

Pharmaceutical Compounds

Classification, structure and therapeutic uses of antipyretics - Paracetamol (with synthesis);Analgesics- Ibuprofen (with synthesis); Antimalarials - Chloroquine (with synthesis); Antitubercular drugs - Isoniazid. An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Unit IV

Polymers

Introduction and classification including di-block, tri-block and amphiphilic polymers; weight average molecular weight, number average molecular weight, glass transition temperature (Tg) of polymers;Polymerisation reactions -Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes. Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamide, polyester). Rubbers – natural and synthetic, Buna-S, Chloroprene and Neoprene. Vulcanization - Polymer additives; Introduction to Biodegradable and conducting polymers with examples.

References books:

1. Pavia, D.L. Introduction to Spectroscopy, Cengage learning (India) Pvt. Ltd.
2. Morrison, R. T.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Solomons, T.W.G. (2017),Organic Chemistry, John Wiley & Sons.
4. Kemp, W. (1991), Organic Spectroscopy, PalgraveMacmillan.
5. Silverstein, R.M.; Webster, F.X.; Kiemle, D.J.; Bryce, D.L. (2014),Spectrometric Identification of Organic Compounds,Wiley.

(We deleted dyes from this syllabus because students will learn this in IV semester)

BSCH364A SPECTROSCOPY AND APPLIED ORGANIC CHEMISTRY LAB

(**Credits-2)**

LIST OF EXPERIMENTS

1. Qualitative analysis of unknown organic compounds containing monofunctional groups: aromatic hydrocarbons, aryl halides, carbohydrates, nitro compounds, amines, amides and simple compounds containing bifunctional groups, e.g. salicylic acid, cinnamic acid, nitrophenols.
2. Identification of simple organic compounds by IR and NMR spectroscopy(Spectra to be provided).

References books:

1. Vogel, A.I. (2012),Quantitative Organic Analysis, Part 3, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009),Practical Organic Chemistry, Pearson Education.
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),Vogel's Textbook ofPractical Organic Chemistry, 5th Edition,Pearson.
4. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: QualitativeAnalysis, University Press.

(Note: A candidate must perform at least eight experiments in the lab. Any suitable experiment may be added.)

DISCIPLINE SPECIFIC COURSE-III

BSCH316A ANALYTICAL METHODS IN CHEMISTRY (Credits-4)

Objectives:

The objective of this course is to make student aware of the concept of sampling, Accuracy, Precision, Statistical test data-F, Q and t test. The course exposes students to the laws of spectroscopy and selection rules governing the possible transitions in the different regions of the electromagnetic spectra. Thermal and electroanalytical methods of analysis are also dealt with. Students are exposed to important separation methods like solvent extraction and chromatography. The practicals expose students to latest instrumentation and they learn to detect analytes in a mixture.

Learning Outcomes:

By the end of this course, students will be able to:

- Perform experiment with accuracy and precision.
- Develop methods of analysis for different samples independently.
- Test contaminated water samples.
- Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer.
- Learn separation of analytes by chromatography.
- Apply knowledge of geometrical isomers and keto-enol tautomers to analysis.
- Determine composition of soil.
- Estimate macronutrients using Flame photometry.

Unit I

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression. Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit II

Optical methods of analysis

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Transmittance.

Absorbance and Beer-Lambert law

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs). Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal, Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit III

Thermal methods of analysis:

Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations.Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit IV

Separation techniques
Solvent extraction: Classification, principle and efficiency of the technique.
Mechanism of extraction: extraction by solvation and chelation, Technique of extraction: batch, continuous and counter current extractions, Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media.
Chromatography: Classification, principle and efficiency of the technique, Mechanism of separation: adsorption, partition & ion-exchange, Development of chromatograms: frontal, elution and displacement methods.

References books:

1. Willard, H.H.(1988),Instrumental Methods of Analysis, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C.(2007),Quantitative Chemical Analysis,6th Edition, Freeman.
4. Khopkar, S.M. (2008), Basic Concepts of Analytical Chemistry, New Age International Publisher.
5. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd.

BSCH366A ANALYTICAL METHODS IN CHEMISTRY LAB (Credits-2)

LIST OF EXPERIMENTS

1. Separation of mixtures by paper chromatography and reporting the Rf values:
(i) Co^{2+} and $Ni^{2+.}$
(ii) Amino acids present in the given mixture.
2. Solvent Extractions
(i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} DMG complex in chloroform, and determine its concentration by spectrophotometry.
3. Analysis of soil:
(i) Determination of pH of soil.
(ii) Total soluble salt
(iii) Estimation of calcium and magnesium
(iv) Qualitative detection of nitrate and phosphate
4. Ion exchange:
(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of amino acids from organic acids by ion exchange chromatography.

5. Spectrophotometry

(i) Verification of Lambert-Beer's law and determination of concentration of a coloured species ($CuSO_4$, $KMnO_4$, $CoCl_2$, $CoSO_4$)
(ii) Determination of concentration of coloured species via following methods;
(a) Graphical method, (b) Epsilon method, (c) Ratio method, (iv) Standard addition method

References books:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989),Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

(Note: A candidate must perform at least eight experiments in the lab. Any suitable experiment may be added.)

DISCIPLINE SPECIFIC COURSE-IV

BSCH358A RESEARCH PROJECT (Credits-6)

Guidelines:

1. Students will be divided among faculty members of the Department for the supervision of the research work.
2. In the first week of Semester V, each faculty member will assign a suitable research topic to the students from the selected topics in the areas of chemical sciences.
3. The student will work on the assigned research topic during semesters V and VI in regular consultation with his/her assigned teacher.
4. The student will write a dissertation based on the research work carried out during Semesters V and VI and prepare two copies to be submitted to the office of the Head of the Department duly signed by the student and the supervisor in the sixth week of VI semester or a date decided by the HOD of the department.
5. Before preparing power point presentation and submission of dissertation, each student has to deliver a seminar talk on his/ her research project work on a date fixed by HOD, necessary suggestions have to be incorporated in the final draft of dissertation.
6. The student will make a power point presentation based on the work carried out and mentioned in the dissertation to the board of examiners appointed by the University.

ANNEXURE I

B.Sc. (H) Chem.	**Year 2019-2022** **Scheme of Studies as per Choice Based Credit System (CBCS)**	**SBAS**

YEAR	**ODD SEMESTER**				**EVEN SEMESTER**			
	S.No.	**COURSE CODE**	**COURSE TITLE**	**Credits**	**S.No**	**COURSE CODE**	**COURSE TITLE**	**Credits**
FIRST	1	BSCH111 A	ATOMIC STRUCTURE AND CHEMICAL BONDING	5	1	BSCH112A	PERIODIC PROPERTIES AND s-BLOCKS ELEMENTS	5
	2	BSCH113A	GENERAL ORGANIC CHEM-ISTRY AND CHEMISTRY OF HYDROCARBONS	4	2	BSCH114A	HALOGENATED HYDROCAR- BONS AND OXYGEN CONTAIN- ING FUNCTIONAL GROUPS	5
	3	BSCH117A	STATES OF MATTER	5	3	BSCH118A	CHEMICAL THERMODYNAMICS	5
	4	BSCH125A	ENVIRONMENTAL STUDIES	3	4	BSEL101A	COMMUNICATION SKILLS	5
	5	BSCS102A	INFORMATION TECHNOLO-GY FUNDAMENTALS	4	5		OPEN ELECTIVE -II	4
	6		OPEN ELECTIVE -I	4				
	TOTAL			**25**			**TOTAL**	**24**
SEC- OND	1	BSCH211A	CHEMISTRY OF p-BLOCK ELEMENTS AND HALOGENS	4	1	BSCH212A	CRYSTAL DEFECTS AND COOR- DINATION COMPOUNDS	4
	2	BSCH261A	INORGANIC CHEMISTRY-III LAB	2	2	BSCH262A	INORGANIC CHEMISTRY-IV LAB	2
	3	BSCH213A	CHEMISTRY OF CARBONYL COMPOUNDS	4	3	BSCH214A	AMINES AND HETEROCYCLIC COMPOUNDS	4
	4	BSCH263A	ORGANIC CHEMISTRY-III LAB	4	4	BSCH264 A	ORGANIC CHEMISTRY-IV LAB	2
	5	BSCH215A	IONIC AND ELECTROCHEMI-CAL EQUILIBRIA	2	5	BSCH216 A	CHEMICAL KINETICS AND PHASE EQUILLIBRIUM	4
	6	BSCH265A	PHYSICAL CHEMISTRY-III LAB	2	6	BSCH266A	PHYSICAL CHEMISTRY-III LAB	2
	7	BSCH217A	INTELLECTUAL PROPERTY RIGHTS	4	7	BSPH120A	CONDENSED MATTER PHYSICS	4
	8	BSDM301A	DISASTER MANAGEMENT	3	8			
	TOTAL			**25**	**TOTAL**			**22**

THIRD	1	BSCH311A	BIOMOLECULES	4	1	BSCH312A	ORGANOMETALLICS CHEMISTRY	4
	2	BSCH361A	BIOMOLECULES LAB	2	2	BSCH362A	ORGANOMETALLICS CHEMISTRY LAB	2
	3	BSCH313A	QUANTUM CHEMISTRY AND SPECTROSCOPY	4	3	BSCH314A	SPECTROSCOPY AND APPLIED ORGANIC CHEMISTRY	4
	4	BSCH363A	QUANTUM CHEMISTRY AND SPECTROSCOPY LAB	2	4	BSCH364A	SPECTROSCOPY AND APPLIED ORGANIC CHEMISTRY LAB	2
	5	BSCH315A	NOVEL INORGANIC SOLIDS	4	5	BSCH316A	ANALYTICAL METHODS IN CHEMISTRY	4
	6	BSCH365A	NOVEL INORGANIC SOLIDS LAB	2	6	BSCH366A	ANALYTICAL METHODS IN CHEMISTRY	2
	7	BSCH317A	GREEN METHODS OF CHEMISTRY	4	7	BSCH358A	RESEARCH PROJECT	6
	8	BSCH367A	GREEN METHODS OF CHEMISTRY LAB	2	8	BSPH217A	APPLICATION OF MATERIALS	4
					9		VALUE ADDED COURSE	0
	TOTAL			**24**	**TOTAL**			**28**
		Electives (Choose any one from each)						
		DISCIPLINE ELECTIVE- I				OPEN ELECTIVE-I		
		BSCH239A	FERTILIZER CHEMISTRY	2		BSPH120A	CONDENSED MATTER PHYSICS	4
		BSCH241A	INORGANIC MATERIALS FOR INDUSTRIAL USE	2		BSMA141A	FUNDAMENTALS OF CALCULUS	4
		DISCIPLINE ELECTIVE -II				IIT101A	HARNESSING THE POWER OF WEB AS A KNOWLEDGE DEVICE	4
		BSCH240A	CHEMISTRY OF FUELS	2				
		BSCH242A	PESTICIDES	2		OPEN ELECTIVE- II		
		DISCIPLINE ELECTIVE- III				BSPH217A	APPLICATIONS OF MATERIALS	4
		BSCH339A	NUCLEAR CHEMISTRY	2		BSMA142A	ESSENTIALS OF MATHEMATICS	4
		BSCH341A	COSMETICS AND PER-FUMES	2		IIT104A	UNDERSTANDGING THE POWER OF DATA	4
		Total Cred- its [C] =	**148**					

Student can choose two non-credit courses (2 hours per week), one in odd semester and one in even semester during the entire duration of Programme from the pool of courses provided by the university.