
جَامِعَةٌ عَالِيَةٌ

# ALIAH UNIVERSITY

21, Haji Md. Mohsin Square
Kolkata-700 016

SYLLABI

FOR

FIVE-YEAR INTEGRATED & SUBSIDIARY

COURSES OF STUDIES
IN
**CHEMISTRY**

# CONTENTS

# ALIAH UNIVERSITY

## PROPOSED SYLLABUS FOR CHEMISTRY (MEDICINAL CHEMISTRY)

## COURSE DESCRIPTION AND AIM

Life is composed of lifeless molecules. These molecules obey all the laws of Physics and Chemistry. The Chemistry by which nature interconverts the molecule of life follows the same essential principles as followed by the reactions occurring in the laboratory. An understanding of these common principles allows chemists to examine life processes in molecular details. In biophysical and medicinal chemistry as well as in biochemistry, chemists explore the fundamental concepts of chemistry using case studies from biochemical and biomedicinal research.

Through the lens of chemistry--inorganic, organic, physical—chemists gather an insight about the assembly, structure and interactions of biological molecules, both small and large. Here they study how biological catalysts increase the rate of the reactions that enable a continuation and maintenance of life process and how drug molecules metabolize and heal the diseases.

Enchasing the concepts in biophysical and biochemistry one can experience how medicinal chemists discover and finally develop therapeutic chemicals into medicines. Consequently one can use the knowledge gathered from research in medicinal chemistry to study the interaction of small “molecules of mercy” (*i.e.* molecules of medicines) with their biological targets.

In this way chemists develop ingenious techniques to relive the pain and ailment of people and improve the quality of human life.

**COURSE MODULES**

| **SEMESTER- 1** | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **Topic** | **Contact hrs / wk** | | | | **Credit** |
| | | **L** | **T** | **P** | **TOTAL** | |
| MA 131 | Mathematic-I | 3 | 1 | 0 | 4 | 4 |
| CH 101 | Chemistry-I | 2 | 0 | 0 | 2 | 2 |
| PH 131 | Physics-I | 2 | 0 | 0 | 2 | 2 |
| | Com.English -I | 3 | 1 | 0 | 4 | 4 |
| | Basic Electrical Sc.-I | 3 | 0 | 3 | 6 | 5 |
| | Mechanics-I | 3 | 1 | 0 | 4 | 4 |
| CH 103 | Engg. Drawing & Graphics / Chemistry-II | 0 | 0 | 3 | 3 | 2 |
| | Ele. Arabic | 2 | 1 | 0 | 3 | 3 |
| | | | | | | 28 |
| **PRACTICAL** | | | | | | |
| CH 191 | Chemistry | 0 | 0 | 3 | 3 | 2 |

| **SEMESTER- 2** | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **Topic** | **Contact hrs / wk** | | | | **Credit** |
| | | **L** | **T** | **P** | **TOTAL** | |
| MA 132 | Mathematics-I | 3 | 1 | 0 | 4 | 4 |
| CH 102 | Chemistry-II | 2 | 0 | 0 | 2 | 2 |
| PH 132 | Physics-II | 2 | 0 | 0 | 2 | 2 |
| | Com.English -II | 3 | 1 | 0 | 4 | 4 |
| | Basic Electrical Sc.-II | 3 | 0 | 3 | 6 | 5 |
| | Mechanics-II | 3 | 1 | 0 | 4 | 4 |
| CH 104 | Engg. Drawing & Graphics / Chemistry-II | 0 | 0 | 3 | 3 | 2 |
| | Ele. Arabic | 2 | 1 | 0 | 3 | 3 |
| | | | | | | |
| **PRACTICAL** | | | | | | |
| CH 192 | Chemistry-II | 0 | 0 | 3 | 3 | 2 |

| **SEMESTER 3** | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS /WK | | | | **CREDIT** |
| | | **L** | **T** | **P** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 201 | INORGANIC | 3 | 0 | 0 | 3 | 3 |
| CH 203 | ORGANIC | 3 | 0 | 0 | 3 | 3 |
| CH 205 | PHYSICAL | 3 | 0 | 0 | 3 | 3 |
| CH 207 | Environment and ecology | 3 | 0 | 0 | 3 | 3 |
| | Islamic studies | 2 | 0 | 0 | 2 | 2 |
| **PRACTICAL** | | | | | | |
| CH 291 | INORGANIC | 0 | 0 | 3 | 3 | 2 |
| | ORGANIC | 0 | 0 | 3 | 3 | 2 |
| | PHYSICAL | 0 | 0 | 3 | 3 | 2 |

| **SEMESTER 3 (Subsidiary)** | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS /WK | | | | CREDIT |
| | | **L** | **T** | **P** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 231 | CHEMISTRY SUB | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | |
| CH 261 | Practical | 0 | 0 | 3 | 3 | 2 |

| **SEMESTER 4** | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS / WK | | | | CREDIT |
| | | L | T | O | TOTAL | |
| **THEORY** | | | | | | |
| CH 202 | INORGANIC | 3 | 1 | 0 | 4 | 4 |
| CH 204 | ORGANIC | 3 | 1 | 0 | 4 | 4 |
| CH 206 | PHYSICAL | 3 | 1 | 0 | 4 | 4 |
| **PRACTICAL** | | | | | | |
| CH 292 | INORGANIC | 0 | 0 | 3 | 3 | 2 |
| | PHYSICAL | 0 | 0 | 3 | 3 | 2 |
| | ORGANIC | 0 | 0 | 3 | 3 | 2 |

| SEMESTER 4 (Subsidiary) | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS /WK | | | | CREDIT |
| | | **L** | **T** | **P** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 232 | CHEMISTRY SUB | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | |
| CH 262 | PRACTICAL | 0 | 0 | 3 | 3 | 2 |

| **SEMESTER 5** | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS / WK | | | | CREDIT |
| | | L | T | O | TOTAL | |
| **THEORY** | | | | | | |
| CH 301 | INORGANIC | 3 | 1 | 0 | 4 | 4 |
| CH 303 | ORGANIC | 3 | 1 | 0 | 4 | 4 |
| CH 305 | PHYSICAL | 3 | 1 | 0 | 4 | 4 |
| **PRACTICAL** | | | | | | |
| CH 391 | INORGANIC | 0 | 0 | 3 | 3 | 2 |
| | PHYSICAL | 0 | 0 | 3 | 3 | 2 |
| | ORGANIC | 0 | 0 | 3 | 3 | 2 |

| **SEMESTER 6** | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS / WK | | | | CREDIT |
| | | **L** | **T** | **O** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 302 | INORGANIC | 3 | 1 | 0 | 4 | 4 |
| CH 304 | ORGANIC | 3 | 1 | 0 | 4 | 4 |
| CH 306 | PHYSICAL | 3 | 1 | 0 | 4 | 4 |
| **PRACTICAL** | | | | | | |
| CH 392 | INORGANIC | 0 | 0 | 3 | 3 | 2 |
| | PHYSICAL | 0 | 0 | 3 | 3 | 2 |
| | ORGANIC | 0 | 0 | 3 | 3 | 2 |

| SEMESTER 7 | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS / WK | | | | CREDIT |
| | | **L** | **T** | **O** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 401 | PHARMACOGNOSY-1 | 3 | 0 | 0 | 3 | 3 |
| CH 403 | BIOCHEMISTTY 1 | 3 | 0 | 0 | 3 | 3 |
| CH 405 | MEDICINAL CHEMISTRY-I | 3 | 0 | 0 | 3 | 3 |
| CH 407 | ANALYTICAL CHEMISTRY AND INSTRUMENTAL ANALYSIS | 3 | 0 | 0 | 3 | 3 |
| CH 409 | PHARMACEUTICAL STATISTICS | 3 | 0 | 0 | 3 | 3 |
| CH 411 | BIOTECHNOLOGY AND GENETIC ENGINEERING | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | |
| CH 491 | PHARMACOGNOSY-1 | 0 | 0 | 3 | 3 | 2 |
| CH 493 | BIOCHEMISTRY | 0 | 0 | 3 | 3 | 2 |
| CH 495 | BIOTECHNOLOGY | 0 | 0 | 3 | 3 | 2 |

| SEMESTER 8 | | | | | | |
|---|---|---|---|---|---|---|
| COURSE CODE | COURSE NAME | TOTAL CLASS HRS / WK | | | | CREDIT |
| | | **L** | **T** | **O** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 402 | PHARMACOGNOSY-2 | 3 | 0 | 0 | 3 | 3 |
| CH 404 | TOXICOLOGY | 3 | 0 | 0 | 3 | 3 |
| CH 406 | MEDICINAL CHEMISTRY- II | 3 | 0 | 0 | 3 | 3 |
| CH 408 | MEDICINAL COMPOUNDS AND QUALITY CONTROL | 3 | 0 | 0 | 3 | 3 |
| CH 412 | DRUG DELIVERY SYSTEM | 3 | 0 | 0 | 3 | 3 |
| CH 414 | BIOCHEMISTRY 2 | 3 | 0 | 0 | 3 | 3 |
| PRACTICAL | | | | | | |
| CH 492 | MEDICINAL CHEMISTRY (LAB) | 0 | 0 | 3 | 3 | 2 |
| CH 494 | TOXICOLOGY | 0 | 0 | 3 | 3 | 2 |
| CH 496 | ANALYTICAL MEDICINAL CHEMISTRY | 0 | 0 | 3 | 3 | 2 |
| | | | | | | 24 |

| **SEMESTER 9** | | | | | | |
|---|---|---|---|---|---|---|
| ***COURSE CODE*** | ***COURSE NAME*** | ***TOTAL CLASS HRS / WK*** | | | | ***CREDIT*** |
| | | **L** | **T** | **O** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 501 | PHARMACOGNOSY-3 | 3 | 0 | 0 | 3 | 3 |
| CH 503 | MICROBIOLOGY-1 | 3 | 0 | 0 | 3 | 3 |
| CH 505 | IMMUNOLOGY | 3 | 0 | 0 | 3 | 3 |
| CH 507 | PHARMACOLOGY-1 | 3 | 0 | 0 | 3 | 3 |
| CH 509 | PHARMACOKINETICS AND PHARMACODYNAMICS | 3 | 0 | 0 | 3 | 3 |
| CH 511 | MATHEMATICS APPLIED IN MEDECINAL CHEMISTRY | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | |
| CH 591 | PHARMACOGNOSY | 0 | 0 | 3 | 3 | 2 |
| CH 593 | MICROBIOLOGY | 0 | 0 | 3 | 3 | 2 |
| CH 595 | PHARMACOLOGY | 0 | 0 | 3 | 3 | 2 |
| TOTAL | | | | | | |

| **SEMESTER 10** | | | | | | |
|---|---|---|---|---|---|---|
| ***COURSE CODE*** | ***COURSE NAME*** | ***TOTAL CLASS HRS / WK*** | | | | ***CREDIT*** |
| | | **L** | **T** | **P** | **TOTAL** | |
| **THEORY** | | | | | | |
| CH 502 | COMPUTER APPLICATION IN MEDICINAL CHEMISTRY | 3 | 1 | 0 | 3 | 3 |
| CH 504 | INDUSTRIAL MANGEMENT | 3 | 0 | 0 | 3 | 3 |
| CH 506 | QUANTITATIVE STRUCTURE ACTIVITY RELATION AND DRUG DESIGN | 3 | 1 | 0 | 3 | 3 |
| CH 508 | PHARMACOLOGY2 | 3 | 0 | 0 | 3 | 3 |
| CH 512 | FUNCTIONAL ENGLISH | 3 | 0 | 0 | 3 | 3 |
| CH 514 | SEMINAR ON ASSIGNED TOPIC AND FACTORY VISIT | 3 | 0 | 0 | 3 | 3 |
| CH 582 | PROJECT AND LITERATURE SURVEY | | | | | 6 |

# SEMESTER- 1

COURSE CODE: CH 101 CREDITS: 2

## INORGANIC CHEMISTRY

### *1. Radioactivity and Atomic Structure-I*

Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory. Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.

Bohr's theory to hydrogen-like atoms and ions; spectrum of hydrogen atom. Quantum numbers. Introduction to the concept of atomic orbitals; shapes, radial and angular probability diagrams of s, p and d orbitals (qualitative idea). Many electron atoms and ions: Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation.

### *2. Chemical periodicity I*

Periodic table, group trends and periodic trends in physical properties. Classification of elements on the basis of electronic configuration. Modern IUPAC Periodic table. General characteristic of s, p, d and f block elements. Position of hydrogen and noble gases in the periodic table.

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## ORGAINC

### *1. Acyclic stereochemistry-I*

Representation of molecules in saw horse, Fischer, flying-wedge and Newman formulae and their inter translations, symmetry elements, molecular chirality.

Optical activity of chiral compounds: specific rotation, optical purity (enantiomeric excess), racemic

### *2. Bonding and physical properties-I*

Valence bond theory: concept of hybridisation, resonance (including hyperconjugation), orbital pictures of bonding ($sp^3$, $sp^2$, sp: C-C, C-N & C-O system). Inductive effect, bond polarization and bond polarizability, steric effect, steric inhibition of resonance.

Physical properties: bond distance, bond angles, mp/bp & dipole moment in terms of structure and bonding (covalent & non covalent). Heat of hydrogenation and heat of combustion.

## PHYSICAL

### 1. *Kinetic theory and the gaseous state*

Concept of pressure and temperature. Nature of distribution of velocities in one, two and three dimensions. Maxwell's distribution of speeds. Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; calculation of number of molecules having energy $\geq \varepsilon$, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Collision of gas molecules; collision diameter; collision number and mean free path; frequency of binary collisions (similar and different molecules); wall collision and rate of effusion.

Deviation of gases from ideal behaviour; compressibility factor; Andrew's and Amagot's plots; van der Waals equation and its characteristic features. Existence of critical state. Critical constants in terms of van der Waals constants. Law of corresponding state and significance of second virial coefficient. Boyle temperature. Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential, elementary idea).

### 2. *Thermodynamics – I*

Importance and scope, definitions of system and surroundings; type of systems (isolated, closed and open). Extensive and intensive properties. Steady state and equilibrium state. Concept of thermal equilibrium and the zeroth-law of thermodynamics. Thermodynamic coordinates, state of a system, equation of state, state functions and path functions. Partial derivatives and cyclic rule. Concept of heat and work (IUPAC convention). Graphical explanation of work done during expansion and compression of an ideal gas. Reversible and irreversible processes and work done.

First law of thermodynamics, internal energy (U) as a state function. Enthalpy as a state function. Heat changes at constant volume and constant pressure; relation between $C_P$ and $C_V$ using ideal gas and van der Waals equations. Joule's experiment and its consequence. Explanation of term $(\delta U/\delta V)_T$. Isothermal and adiabatic processes.

Thermochemistry: heat changes during physicochemical processes at constant pressure/volume. Kirchoff's relations. Bond dissociation energies. Changes of thermodynamic properties in different chemical changes.

COURSE CODE: CH 103 CREDITS: 2

## INORGANIC CHEMISTRY

### 1. *Radioactivity and Atomic Structure-II*

Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. Separation and uses of isotopes.
Electronic energy level diagram and electronic configurations of hydrogen-like and polyelectronic atoms and ions. Term symbols of atoms and ions for atomic numbers < 30.

### 2. *Chemical periodicity II*

Effective nuclear charges, screening effects, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties. Inert pair effect. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements

## ORGAINC

### 1. *Acyclic stereochemistry-II*

Molecular chirality.Configuration: stereogenic units i) stereocentres: systems involving 1, 2, 3 centres, stereogenicity, chirotopicity. pseudoasymmetric (D/L and R/S descriptor, threo/erythro and syn/anti nomenclatures (for aldols) ii) stereoaxis: chiral axis in allenes & biphenyls, R/S descriptor; cis/trans, syn/anti, E/Z descriptors (for C=C, C=N). racemisation (through cationic and anionic and radical intermediates), resolution of acids, bases and alcohols via diastereomeric salt formation. Topicity of ligands and faces (elementary idea): Pro-R, Pro-S and Re /Si descriptors.

Conformation: Conformational nomenclature, eclipsed, staggered, gauche and anti; dihedral angle, torsion angle, energy barrier of rotation, relative stability of conformers on the basis of steric effect, dipole-dipole interaction, H-bonding; conformational analysis of ethane, propane, n-butane, haloethane, 1,2-haloethane, 1,2- glycol, 1,2-halohydrin; invertomerism of trialkylamines.

### 2. *Bonding and physical properties-II*

Orbital pictures of bonding ($sp^3$, $sp^2$, sp: C-C, C-N & C-O system). Inductive effect, bond polarization and bond polarizability, steric effect, steric inhibition of resonance.

MO theory: sketch and energy levels of MOs of i) acyclic p orbital system (C=C, conjugated diene and allyl systems) ii) cyclic p orbital system (neutral system: [4], [6] annulenes; charged system: 3,4,5-ring system); Frost diagram, Huckel's rules for aromaticity & antiaromaticity; homoaromaticity.

COURSE CODE: CH 191 CREDITS: 2

## PRACTICAL

1. ***Volumetric estimation***

   Preparation of standard solution, Acid-base titration, Carbonate and Biocarbonate mixture, NaOH and Oxalic acid,

2. ***Experiment -1. Qualitative analysis of single solid organic compounds***
   A. Detection of special elements (N, Cl, S) by Lassaigne's test
   B. Solubility and Classification (solvents: H2O, 5% HCl, 5% NaHCO3, 5% NaOH)

# SEMESTER- 2

COURSE CODE: CH 102 CREDITS:3

## INORGANIC CHEMISTRY

### 1. *General concept of chemical bonding*

Ionic bonding: Lattice energy, Covalent bonding:. Valence Bond Theory, hybridizations, Partial ionic Character of covalent bonds, bond moment, dipole moment and electronegativity differences. Concept of resonance, resonance energy, resonance structures

### 2. *Acid-Base reactions*

Acid-Base concept: Arrhenius concept, theory of solvent system (in $H_2O$, $NH_3$, $SO_2$ and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling rules. Amphoterism. Lux-Flood concept, Lewis concept. Superacids, HSAB principle. Acidbase equilibria in aqueous solution and pH. Acid-base neutralisation curves; indicator, choice of indicators.

## ORGAINC

### 1. *General concept of organic reaction*

Mechanistic classification: ionic, radical and pericyclic; heterolytic bond cleavage and heterogenic bond formation, homolytic bond cleavage and homogenic bond formation; representation of mechanistic steps using arrow formalism.

Reactive intermediates: carbocations (cabenium and carbonium ions), carbanions,carbon radicals, carbenes –Concept of acids and bases: effect of structure, substituent and solvent on acidityand basicity.

### 2. *Nucleophilic substitution reactions*

Sustitution at sp3 centre - Mechanism: SN1, SN2, SN2', SNi mechanisms, effect ofsolvent, substrate structure, leaving group, nucleophiles including ambident nucleophiles(cyanide & nitrite) substitution involving NGP; relative rate & stereochemical features[systems: alkyl halides, allyl halides, alcohols, ethers, epoxides].

Halogenation of alkanes and carbonyls.

Substitution at $sp^2$ carbon (carbonyl system) - Mechanism: BAC2, AAC2, AAC1, AAL1 (inconnection to acid and ester). Systems: amides, anhydrides & acyl halides [formation andhydrolysis]

## PHYSICAL

### *1. Thermodynamics – II*

Second law of thermodynamics – need for a Second law. Concept of heat reservoirs and heat engines. Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation. Carnot cycle and refrigerator. Carnot's theorem; thermodynamic scale of temperature.

Physical concept of entropy. Entropy as a measure of the microscopic but not macroscopic disorder. Values of §dQ/T and Clausius inequality. Entropy change of systems and surroundings for various processes and transformations. Entropy change during the isothermal mixing of ideal gases. Entropy and unavailable work. Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.

### *1. Liquid State and Viscosity of Fluids*

Nature of the liquid state, (short range order and long range disorder). Vapor pressure. Surface tension, surface energy, excess pressure, capillary rise and measurement of surface tension. Work of cohesion and adhesion, spreading of liquid over other surface. Vapour pressure over curved surface. Temperature dependence of surface tension.

General features of fluid flow (streamline flow and turbulent flow). Reynold number, nature of viscous drag for streamline motion, Newton' equation, viscosity coefficient. Poiseuille's equation (with derivation), temperature dependence of viscosity, principle of determination of viscosity coefficient of liquids by falling sphere method. Viscosity of gases vs. liquids and kinetic theory of gas viscosity.

COURSE CODE: CH 104 CREDITS: 2

## INORGANIC CHEMISTRY

### *1. Chemical Bonding and structure*

Ionic bonding: Size effects, radius ratio rules and their limitations. Packing of ions in crystals, lattice energy, Born-lande equation and its applications, Born-Haber cycle and its applications. Solvation energy, polarizing power and polarizability, ionic potential, Fazan’s rules. Defects in solids (elememtary idea).

Covalent bonding: Lewis structures, formal charge. Valence Bond Theory, directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent’s rule, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry), Partial ionic

Character of covalent bonds, bond moment, dipole moment and electronegativity differences. Concept of resonance, resonance energy, resonance structures

**ORGAINC**

***1. General treatment of reaction mechanism***

structure using orbital picture, electrophilic/nucleophilic behaviour, stability, generation and fate (elementary idea)5

Reaction thermodynamics: free energy and equilibrium, enthalpy and entropyfactor, intermolecular & intramolecular reactions. Application of thermodynamicprinciples in tautomeric equilibria [keto-enol tautomerism, composition of theequilibrium in different systems (simple carbonyl, 1,3 and 1,2- dicarbonyl systems,phenols and related system), substituent and solvent effect]. Hammet equation.

**PRACTICAL**

COURSE CODE: CH 192 CREDITS: 2

***1. Complexometric titration***

Determination of Hardness of water, Determination of Calcium and Magnesium in mixture Complexometric titration , Ca in chalk, iron-calcium mixture, Zinc-Magnesium mixture

***2. Redox titration***

Estimation of Mohr salt solution by permanganate and dichromate.

# SEMESTER – 3

## INORGANIC

COURSE CODE: CH 201 CREDITS: 3

### *1. Chemical Periodicity II*

General trends of variation of electronic configuration, elemental forms, metallic nature, magnetic properties (if any), catenation and catalytic properties (if any), oxidation states, inert pair effect (if any), aqueous and redox chemistry in common oxidation states, properties and reactions of important compounds such hydrides, halides, oxides, oxyacids (if any), complex chemistry (if any) in respect of the following elements:

(i) s-block elements: Li-Na-K, Be-Mg-Ca-Sr-Ba.

(ii) p-block elements: B-Al-Ga-In-Tl, C-Si-Ge-Sn-Pb, N-P-As-Sb-Bi, O-S-Se-Te,

F-Cl-Br-I, He-Ne-Ar-Kr-Xe

### *2. Other Types of Bonding*

Molecular orbital concept of bonding (elementary pictorial approach):sigma and pi-bonds, multiple bonding, MO diagrams of $H_2$, $F_2$, $O_2$, $C_2$, $B_2$, CO, NO, CN-, HF, and $H_2O$; bond orders, bond lengths, Walsh Diagram. Coordinate bonding: Lewis acid-base adducts (examples), double salts and complex salts, Werner theory of coordination compounds. Ambidentate and polydentate ligands, chelate complexes. IUPAC nomenclature of coordination compounds (up to two metal centers). Coordination numbers, constitutional isomerism. Stereoisomerism in square planar and octahedral complexes.

Hydrogen bonding and its effects on the physical properties of compounds of the main group elements.

Metallic bonding: qualitative idea of band theory, conducting, semi conducting and insulating properties with examples from main group elements.

## ORGANIC

COURSE CODE: CH 203 CREDITS: 3

### *1. Addition reactions*

Electrophilic addition to C=C: Mechanism, reactivity, regioselectivity and stereoselectivity. Reactions: halogenations, hydrohalogenation, hydration, hydrogenation, epoxidation, hydroxylation, ozonolysis, electrophiilic addition to diene (conjugated dienes and allenes). Radical addition: HBr addition. Dissolving metal

reduction of alkynes and bezenoid aromatics (Birch). Pericyclic addition: Diels-Alder reaction. Addition of singlet and triplet carbenes.

Nucleophilic addition to C=O: Mechanism, reactivity, equilibrium and kinetic control. Reactions with alcohols, amines, thiols, HCN, bisulfate, Wittig reaction.Carbonyl Reduction: hydride addition, Wolff-Kishner reduction, dissolving metal (Bouveault-Blanc reduction, Clemmensen Reduction), Cannizzaro reaction, Tischenko reaction, aldol condensation, benzoin condensation. Hydrolysis of nitriles and isonitriles. Nucleophilic addition to α,β-unsaturated carbonyl system (general principles).

***2. Elimination and aromatic substitution***

Elimination - Mechanisms: E1, E2 and E1cB; reactivity, orientation (Saytzeff/ Hofmann) and stereoselectivity; substitution vs elimination,

Electrophilic aromatic substitution: Mechanisms, orientation and reactivity. Reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reactions, onecarbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Hoesch, Vilsmeier-Haack reaction, Reimer-Tiemann, Kolbe-SCH idt).

Nucleophilic aromatic substitution: Addition-elimination mechanism, SN1 mechanism, benzyne mechanism.

## PHYSICAL

COURSE CODE: CH 205 CREDITS: 3

***21. Thermodynamics and Equilibrium***

Thermodynamic relations: Maxwell's relations, thermodynamic equation of state. Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature. Joule-Thomson coefficient for a van der Waals gas. General heat capacity relations.

Open system, chemical potential and activity, partial molar quantities, chemical potential in terms of Gibb's free energy and other thermodynamic state functions and its variation with temperature and pressure. Gibbs-Duhem equation; fugacity of gases and fugacity coefficient.

Thermodynamic conditions for equilibrium, degree of advancement. van't Hoff's reaction isotherm (deduction from chemical potential). Explanation of the free energy versus degree of advancement plot . Equilibrium constant and standard Gibbs free energy change. Definitions of $K_P$, $K_C$ and $K_x$ ; van't Hoff's reaction isobar and isochore

from different standard states. Shifting of equilibrium due to change in external parameters e.g. temperature and pressure. Le Chatelier's principle and degree of advancement.

Activity and activity coefficients of electrolyte / ion in solution. Debye-Huckel limiting law (statement and applications only). Solubility equilibrium and influence of common ions and indifferent ions thereon. pH, buffer solution, buffer capacity, salt hydrolysis (detailed treatment).

***2. Chemical kinetics***

Introduction of reaction rate in terms of extent of reaction; rate constants, order and molecularity of reactions. Reactions of zero order, first order, second order and fractional order. Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate). Determination of order of a reaction by half-life and differential method. Rate-determining and steady-state approximation – explanation with suitable examples.

Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order).

Temperature dependence of rate constant: Arrhenius equation, energy of activation. Homogeneous catalysis with reference to acid-base catalysis. Enzyme catalysis: Michaelis-Menten equation, turn-over number.

## PRACTICAL

## INORGANIC

COURSE CODE: CH 291 CREDITS: 6

***1. Systematic qualitative analysis of the following metals and non metals***

Hg(ous), Hg (ic), Pb, Ag, Cu, Bi, Cd, As, Sb, Sn, Al, Fe, Cr, Co, Ni, Zn, Ca, Sr, Ba, Mg, Na, K, $NH_4$,

sulpjide, suiphate, sulphite, hiosulphate, nitrite, nitrate, orthoborate, metaborate, fluoride, chloride, bromide, iodide, Phosphate, Arsenate, arsenite, silicate, ferocyanide, fericyanide, thiocyanate,

Semi micro and spot analysis method should be encourage

## ORGANIC

1. ***Detection of the following functional groups by systematic chemical tests***:
   Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), Aimdo ($-CONH_2$, including imide), Phenolic –OH, Carboxylic acid (-COOH), Carbonyl (>C=O); only one test for each functional group is to be reported. Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown (at least 5) organic compounds.

## PHYSICAL

1. Determination of surface tension of a given solution by drop weight method using a stalagmometer, considering aqueous solutions of NaCl, acetic acid, ethanol etc, as systems.

2. Determination of viscosity coefficient of a given solution with Ostwald's viscometer considering aqueous solutions of cane-sugar, glycerol, ethanol, etc.

3. Determination of solubility of sparingly soluble salts in water and various Electrolyte medium by titrimetric method. KHTa as sparingly soluble salt in water, KCl, $NaNO_3$ may be used.

A separate laboratory workbook should be maintained for these experiments.

# SEMESTER – 4

## INORGANIC

COURSE CODE: CH 202 CREDITS: 4

***1. Chemistry of s- and p-block Elements***

(i) Structure, bonding and reactivity of $B_2H_6$; $(SN)_x$ with x = 2, 4; phosphazines; interhalogens. (ii) Structure of borates, silicates, polyphosphates, borazole, boron nitride, silicones, thionic acids. (iii) Reactivity of polyhalides, pseudo halides, fluorocarbons, freons and $NO_x$ with environmental effects. (iv) Chemistry of hydrazine, hydroxylamine, $N_3^-$, thio- and per-sulphates.

Noble gases from air; oxides, fluorides and oxofluorides of xenon; chemical and photochemical reactions of ozone.

***2. Precipitation and Redox Reactions***

Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides. Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples).

## ORGANIC

COURSE CODE: CH 204 CREDITS: 4

***1. Nitrogen compounds and Organometallics***

Nitrogen compounds: amines (aliphatic & aromatic) [preparation, separation and identification of primary, secondary and tertiary amines], E. Clarke reaction, enamines, Mannich reaction, diazomethane, diazoacetic ester, aromatic nitro compounds, aromatic diazonium salts, nitrile and isonitrile.

Organometallics: preparation of Grignard reagent and organo lithium. Reactions: addition of Grignard and organo lithium to carbonyl compounds, substitution on -COX, conjugate addition by Gilman cuprates, Reformatsky reaction.

***2. Reactions: Rearrangements***

1,2-shift: Rearrangement to electron-deficient carbon (Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement).

Electron-deficient nitrogen (Beckmann rearrangement, SCH idt rearrangement, Hofmann rearrangement, Lossen rearrangement, Curtius rearrangement).

Electron-deficient oxygen (Baeyer-Villiger oxidation, hydroperoxide rearrangement (cumene hydroperoxide-phenol rearrangement), Dakin reaction.

Aromatic rearrangements [migration from oxygen to ring carbon (Fries rearrangement, Claisen rearrangement); migration from nitrogen to ring carbon (Hofmann-Martius rearrangement**,** Fischer-Hepp rearrangement, N-azo to C-azo rearrangement, Bamberger rearrangement, Orton rearrangement, benzidine rearrangement.

## PHYSICAL

COURSE CODE: CH 206 CREDITS: 4

***1. Quantum Chemistry I***

Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis.

Elementary concepts of operators, eigenfunctions and eigenvalues. Linear operators. Commutation of operators, fundamental commutator and uncertainty relation (without proof). Expectation value. Hermitian operator. Schrodinger time-independent equation: nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function.

Particle in a box: setting up of Schrodinger equation for one-dimensional box and its solution. Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution). Expectation values of x, $x^2$, px and $px^2$ and their significance in relation to the uncertainty principle. Extension of the problem to two and three dimensions and the concept of degenerate energy levels.

***2. Electrochemistry***

Conductance and measurement of conductance, cell constant, specific conductance and molar conductance. Variation of specific and equivalent conductance with dilution for strong and weak electrolytes. Kohlrausch's law of independent migration of ions, ion conductance and ionic mobility. Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes. Ostwald's dilution law. Debye-Huckel model (physical idea only). Application of conductance measurement (determination of solubility product and ionic product of water).

Conductometric titrations. Determination of transport number by moving boundary method. Types of electrochemical cells and examples , cell reactions, emf and change in free energy, $\Delta H$ and $\Delta S$ of cell reactions from emf measurements. Thermodynamic derivation of Nernst equation. Standard cells. Half-cells / electrodes, different types of electrodes (with examples). Standard electrode potential (IUPAC convention) and principles of its determination. Types of concentration cells. Liquid junction potential and its minimisation. Glass electrode and determination of pH of a solution. Potentiometric titrations: acid-base and redox

## PRACTICAL

### ORGANIC

COURSE CODE: CH 292 CREDITS:6

1. Estimation of the following compounds (at least four)
   Aniline, Formalin, Acetone, Vitamine C,

### PHYSICAL

1. Determination of partition coefficient of Iodine or Acetic acid in water and an immiscible organic solvent.

2. Determination of the rate constant for the first order acid catalyzed hydrolysis of an ester ($V_0$ and $V_\infty$ be supplied).

3. Determination of rate constant of decomposition of $H_2O_2$ by acidified KI solution using clock reactions.

A separate laboratory workbook should be maintained for these experiments.

### INORGANIC

1. Redox titration
   Estimation of
   $Fe^{+2}$/ $Fe^{3+}$ by permanganometry and dichromometry, iron-copper mixture, iron chromium mixture, power of hydrogen peroxide, available chorine in bleaching powder, Estimation of Manganese.

# SEMESTER 5

## INORGANIC

COURSE CODE: CH 301 CREDITS: 4

### *1. Chemistry of coordination compounds*

Isomerism, reactivity and stability: Determination of configuration of cis- and trans-isomers by chemical methods. Labile and inert complexes, substitution reaction on square planer complexes, trans effect (example and applications). Stability constants of coordination compounds and their importance in inorganic analysis.

Structure and bonding: VB description and its limitations. Elementary Crystal Field Theory: splitting of dn configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy in weak and strong fields; pairing energy. Jahn-Teller distortion. Metal-ligand bonding (MO concept, elementary idea), sigma- and pibonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples).

Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of dn ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for 3d1-3d9 ions and their spectroscopic ground states; selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea).

### *2. Chemistry of d- and f- block elements*

General comparison of 3d, 4d and 5d elements in term of electronic configuration, elemental forms, metallic nature, atomization energy, oxidation states, redox properties, coordination chemistry, spectral and magnetic properties.

f-block elements: electronic configuration, ionization energies, oxidation states, variation in atomic and ionic (3+) radii, magnetic and spectral properties of lanthanides, comparison between lanthanide and actinides, separation of lanthanides (by ion-exchange method).

Chemistry of some representative compounds: $K_2Cr_2O_7$, $KMnO_4$, $K_22[Fe(CN)_6]$, $K_2[Ni(CN)_4]$, $H_2PtCl_6$, $Na_2[Fe(CN)_5NO]$.

### *3. Organometallic Compounds*

18-electron rule and its applications to carbonyls (including carbonyl hydrides and carbonylates), nitrosyls, cyanides, and nature of bonding involved therein. Simple

examples of metal-metal bonded compounds and metal clusters. Metal-olefin complexes: zeises salt (preparation, structure and bonding), Ferrocene (preparation, structure and reactions). Hapticity(η) of organometallic ligands, examples of mono tri and penta-hapto cyclopentadienyl complexes. Simple examples of fluxional molecules. Coordinative unsaturation: oxidative addition and insertion reactions. Homogeneous catalysis by organometallic compounds: hydrogenation, hydroformylation and polymerization of alkenes (Ziegler-Natta catalysis).

***4. Bioinorganic Chemistry***

Elements of life: essential major, trace and ultratrace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially $Na^{+}$, $K^{+}$, $Mg^{2+}$, $Ca^{2+}$, $Fe^{3+/2+}$, $Cu^{2+/+}$, and $Zn^{2+}$). Metal ion transport across biological membrane Na+-ion pump, ionophores. Biological functions of hemoglobin and myoglobin, cytochromes and ferredoxins, carbonate bicarbonate buffering system and carbonicanhydrase. Biological nitrogen fixation, Photosynthesis: Photosystem-I and Photosystem-II. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases.

## ORGANIC

COURSE CODE: CH 303 CREDITS: 4

***1. Carbanion chemistry and cyclic stereochemistry***

Carbanions: formation of enols and enolates (metal), alkylation of enolates, reactions of enolates with carbonyls (aldehydes, ketones and esters), conjugate addition of enolates.

Cyclic Stereochemistry: Baeyer strain theory. Conformational analysis: cyclohexane, mono and disubstituted cyclohexane, symmetry properties and optical activity.

Conformation & reactivity in cyclohexane system: elimination (E2), rearrangement, nucleophilic substitution (SN1, SN2, NGP), oxidation of cyclohexanol, esterification, saponification, lactonisation.

***2. Spectroscopy UV, IR, NMR (elementary)***

UV Spectra*:* Electronic transition (σ-σ*, n-σ*, π-π* and n-π*), relative positions of $\lambda_{max}$ considering conjugative effect, steric effect, solvent effect, red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples).

IR Spectra: Modes of molecular vibrations, application of Hooke's law, characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; factors effecting stretching frequencies (H-bonding, mass effect, electronic factors, bond multiplicity, ring size).

PMR Spectra: Nuclear spin, NMR active nuclei, principle of proton magnetic resonance, equivalent and non-equivalent protons, chemical shift δ), shielding / deshielding of protons, up-field and down-field shifts. NMR peak area (integration), diamagnetic anisotropy, relative peak positions of different kinds of protons (alkyl halides, olefins, alkynes, aldehyde H), substituted benzenes (toluene, anisole, nitrobenzene, halobenzene, dinitrobenzenes, chloronitrobenzene), first order coupling (splitting of the signals: ordinary ethanol, bromoehane, dibromoehanes), coupling

***3. Carbohydrate chemistry***

Monosaccharides: Aldoses upto 6 carbons, structure of D-glucose & D-fructose (configuration & conformation), anomeric effect, mutarotation. reactions: osazone formation, bromine – water oxidation, stepping–up (Kiliani method) and stepping–down (Ruff's & Wohl's method)of aldoses.

Disaccharides: glycosidic linkages, structure of sucrose.

## PHYSICAL

COURSE CODE: CH 305 CREDITS: 4

***1. Properties of solids, interfaces and dielectrics***

Crystal, crystal planes, law of rational indices, Calculation of fraction occupied for simple cubic, bcc, and fcc. Miller indices. Bragg's law and its applications for the determination of crystal structure for cubic system single crystal. Crystal structures of NaCl and KCl.

Special features of interfaces compared to bulk. Surface dynamics: Physical and chemical adsorption. Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required). Gibbs adsorption isotherm and surface excess. Heterogeneous catalysis (single reactant).

Colloids: lyophobic and lyophilic sols. Origin of charge and stability of lyophobic colloids. Coagulation and Schultz-Hardy rule. Zeta potential and Stern double layer (qualitative idea). Tyndall effect. Electrokinetic phenomenon (qualitative idea only).

Electrical properties of molecules: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules. Clausius-Mosotti equation and Debye equation (both with derivation) and their application. Determination of dipole moments.

***2. Quantum Chemistry – II***

Simple Harmonic Oscillator: setting up of the Schrodinger stationary equation, energy expression (without derivation), expression of wave function for n = 0 and n = 1 (without derivation) and their characteristic features.

Stationary Schrodinger equation for the H-atom in polar coordinates, separation of radial and angular (θ, φ) parts. Solution of φ-part and emergence of quantum number 'm'; energy expression (without derivation), degeneracy. Hydrogenic wave functions up to n = 2 (expression only); real wave function. Concept of orbitals and shapes of s and p orbitals.

***3. Statistical thermodynamics and the third law***

Macrostates and microstates, thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation). Applications to barometric distribution. Partition function and Einstein's theory of heat capacity of solids. Limitations of Einstein's theory and Debye's modification (qualitative).

Nernst heat theorem. Approach to zero kelvin, adiabatic demagnetisation. Planck's formulation of third law and absolute entropies.

## PRACTICAL

COURSE CODE: CH 391 CREDITS: 6

### INORGANIC

Spectro photometric analysis of
Mn, Fe, $PO_4$, As

### PHYSICAL

1. To study the kinetics of inversion of sucrose using polarimeter.

2. To study the phase diagram of a binary system (Phenol + water) and the effect of impurities (e.g. NaCl).

3. Determination of ionization constant of a weak acid by conductometric method.

4. To study the kinetics of saponification of ester by conductometric method.

## ORGANIC

Organic preparations

A. The following reactions are to be performed, noting the yield of the crude product:

1. Nitration of aromatic compounds

2. Condesation reactions

3. Hydrolysis of amides/ imides/ esters

4. Acetylation of phenols / aromatic amines

5. Benzoylation of phenols / aromatic amines

6. Side chain oxidation of aromatic compounds

7. Diazo coupling reactions of aromatic amines

8. Bromination of anilides

9. Redox reaction

10. Green ‘multi-component –coupling’ reaction

B. Purification of the crude product is to be made by crystallisation (water/alcohol, crystallisation after charcoal treatment, or sublimation, whichever is applicable).

C. MP of the purified product is to be noted. Note: Each student is required to perform ALL the experiments cited above (in A, B and C) in classes.

# SEMESTER 6

## INORGANIC

COURSE CODE: CH 302 CREDITS: 4

***1. Electrochemical and spectral analysis, and analytical separation***

Electrochemical methods: Conductometry, Potentiometry, pH-metry. Electrogravimetry, Coulometry. Spectrophotometry: Lambert-Beer law, Limits to Beer's law, Principle of spectrophotometric estimation of iron, manganese and phosphorous. Principles and instrumentations of atomic absorption and atomic emission spectrometry; estimation of sodium and potassium in water samples.

Ion exchange resins and their exchange capacities, principle and simple applications of ion exchange separation. Chromatographic separations: General description and classification of chromatographic methods, thin layer, paper and column chromatographic techniques and their simple applications, $R_f$-values and their significance, elution in column chromatography, migration rates of solutes, band broadening and column efficiency, column resolution.

***2. Statistical methods in chemical analysis and environmental analysis***

Errors in chemical analysis: Accuracy and precision of measurements, determinate indeterminate, systematic and random errors in chemical analysis with examples, absolute and relative errors; source, effect and detection of systematic errors; distribution of random errors, normal error curve, standard deviations, standard deviation of calculated results- sum or difference, product or quotient, significant figures, rounding and expressing results of chemical computations.

Principles for determination of BOD, COD, DO, TDS, in water samples. Detection and estimation of As, Hg, Cd, Pb, $NH_4^+$, and $F^-$, $NO_3^-$, $NO_2^-$ in water sample. Detection, collection and principles of estimation of CO, $NO_x$, $SO_2$, $H_2S$ and SPM in air samples.

***3. Gravimetric and tritimetric methods of analysis***

Requirements of gravimetry: properties of precipitates and precipitating regents, particle size and filterability of precipitates, colloidal and crystalline precipitates coprecipitation and post-precipitation drying and ignition of precipitates, principles of gravimetric estimation of chloride, phosphate, zinc, iron, aluminum and magnesium singly.

Primary and secondary standard substances in acid-base, redox, complexometric (EDTA) and argentometric titrations. Principle and application of redox tritimetric estimation based on the use of the following reagents: $KMNO_4$, $K_2Cr_2O_7$, $I_2$,

$Na_2S_2O_3.5H_2O$, $KH(IO_3)_2$ and $KBrO_3$. Principle of argentimetric estimation of chloride using adsorption indicators.

Principle of complexometric EDTA titration, metal ion indicators (examples), masking and demasking reactions, estimation of Cu-Zn, Fe-Al and Ca-Mg mixture by EDTA titration methods.

Dissolution, scheme of analysis and principles of estimation of the constituents of the following materials: dolomite, pyrolusite, chalchopyrites, Portland cement, basic slag, brass, steel and type metal.

***4. Thermodynamics of dissolution***

Acidities of cations, factors influencing acidities (effects of charge and size); basicities of anions, factors influencing basicities (size and charge effects). Hydration energies of ions, Born-equation, enthalpy change associated with dissolution, solubility rules, thermodynamic interpretations of the rules; application of the rules for precipitation reactions, uses of the rules in quantitative and qualitative analysis, complexation reactions and their roles in dissolution processes

## ORGANIC

COURSE CODE: CH 304 CREDITS: 4

***1. Carbocycles and Heterocycles***

Polynuclear hydrocarbons: syntheses and reactions of naphthalene, anthracene and phenanthrene.

Heterocyclic compounds: reactivity, orientation and important reactions of furan, pyrrole, pyridine, indole, synthesis (including retrosynthetic approach) pyrrole: Knorr pyrrole synthesis and Hantzsch synthesis. Hantzsch pyridine synthesis. Indole: Fischer, Madelung and Reissert synthesis, Skaurp quinoline and Bischler-Napieralski Synthesis of isoquinoline.

2. ***Pericyclic and photochemistry***

***3. Amino acids, peptides and nucleic acids***

Amino acids: Synthesis: (Strecker, Gabriel, acetamido malonic ester, azlactone); isoelectric point, ninhydrin reaction.

Peptides: peptide linkage, syntheses of peptides using N-protection & Cprotection, solid phase synthesis; peptide sequence: C–terminal and N–terminal unit determination (Edmann, Sanger & dansyl chloride).

Nucleic acids: pyrimidine & purine bases (only structure & nomenclature), nucleosides and nucleotides, DNA: Watson-Crick model, complimentary base –pairing in DNA.

***4. Synthetic strategies and Asymmetric synthesis***

Retrosynthetic analysis: disconnections, synthons, donor and acceptor synthons, functional group interconversion, C-C disconnections and synthesis [one group and twogroup (1,2 to 1,6-dioxygenated], reconnection (1,6-di carbonyl), natural reactivity and umpolung, protection-deprotection strategy [alcohol, amine, carbonyl, acid]

Strategy of ring synthesis: thermodynamic factor, synthesis through enolate anion chemistry and carbonyl condensation reactions (including acetoaceticester & malonic ester synthesis) ,synthesis through rearrangement (including pinacol, Favorski), synthesis of large rings, high dilution technique and acyloin reaction, Stobbe condensation.

Asymmetric synthesis: stereoselective and stereospecific reactions, diastereoselectivity and enantioselectivity (only definition), diastereoselectivity: addition of nucleophiles to C=O, adjacent to a stereogenic centre (Felkin-Anh model).

## PHYSICAL

COURSE CODE: CH 306 CREDITS: 4

***1. Phase equilibrium and colligative properties***

Definitions of phase, component and degrees of freedom. Phase rule and its derivations. Definition of phase diagram. Phase equilibria for one component system – water, $CO_2$. First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use.

Liquid vapour equilibrium for two component systems. Ideal solution at fixed temperature and pressure. Principle of fractional distillation. Duhem-Margules equation. Henry's law. Konowaloff's rule. Positive and negative deviations from ideal behaviour. Azeotropic solution. Liquid-liquid phase diagram using phenol-water system. Solidliquid phase diagram. Eutectic mixture. Nernst distribution law. Solvent extraction.

$\Delta G$, $\Delta S$ $\Delta H$ and $\Delta V$ of mixing for binary solutions. Vapour pressure of solution. Ideal solutions, ideally diluted solutions and colligative properties. Raoult's law. Thermodynamic derivation of colligative properties of solution (using chemical potentials) and their inter-relationships. Abnormal colligative properties.

***2. Kinetics and photochemistry***

Collision theory (detailed treatment); outline of Transition State theory. Primary kinetic salt effect. Lindemann theory of unimolecular reaction.

Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra. Bond dissociation and principle of determination of dissociation energy (ground state). Decay of excited states by radiative and non-radiative paths. Fluorescence and phosphorescence, Jablonsky diagram.

Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law; quantum yield and its measurement for a photochemical process, actinometry. Photostationary state. Photosensitized reactions. Kinetics of HI decomposition, $H_2$-$Br_2$ reaction, dimerisation of anthracene.

***3. Spectroscopy***

Rotational spectroscopy of diatomic molecules: rigid rotor model, selection rules, spectrum, characteristic features of spectral lines (spacing and intensity). Determination of bond length, effect of isotopic substitution.

Vibrational spectroscopy of diatomic molecules: SHO model, selection rules, spectra; anharmonicity and its consequences on energy levels, overtones, hot bands.

Raman Effect. Characteristic features and conditions of Raman activity with suitable illustrations. Rotational and vibrational Raman spectra. Rule of mutual exclusion with examples.

## INORGANIC

COURSE CODE: CH 352 CREDITS: 2

1. Conductometry: HCl-AcOH mixture; dibasic acid.
2. Potentiometry: Halide ion.
3. pH-metry: HCl-AcOH mixture; dibasic acid.
4. Ion-exchanger: Cation content of a sample by cation exchanger

## PHYSICAL

COURSE CODE: CH 354 CREDITS: 2

1. Determination of the equilibrium constant of the reaction $KI + I_2 = KI_3$ by partition method (partition coefficient to be supplied).

2. Determination of $E_0$ of $Fe^{+3}/Fe^{2+}$ couple in the hydrogen scale by potentiometric titration of ferrous ammonium sulfate solution using $KMnO_4$, or, $K_2Cr_2O_7$ as standard.

3. Determination of concentration of (i) $AgNO_3$ solution and (ii) solubility product of AgCl by potentiometic titration of standard KCl solution against $AgNO_3$ solution.

4. Determination of pK values of weak monobasic, dibasic and polybasic acid by pH metric method (e.g. using, acetic acid, succinic acid, oxalic acid, phosphoric acid, etc.).

5. Study of the kinetics of the reaction $I^- + S_2O_3^{2-}$ by colorimetric method.

## ORGANIC

COURSE CODE: CH 356 CREDITS: 2

Spectroscopic Analysis of Organic Compounds

A. Assignment of labelled peaks in the $^1H$ NMR spectrum of the known organic compounds explaining the relative $\partial$ values and splitting pattern.

B. Assignment of labeled peaks in the IR spectrum of the same compound. (C-H, O-H, N-H, C=C, C=O, $NO_2$ stretching frequencies)

At least 10-15 compounds from among the list given below are to be chosen:

(i) p-Bromoacetanilide (ii) p-Methyl-α-bromoacetophenone (iii) Vanillin (iv) Cinnamic acid (v) p-Aminobenzoic acid (vi) Salicylamide (vii) o-Hydroxy acetophenone (viii) 4-keto pentanoic acid (ix) Benzylacetate (x) Diethylmaleate (xi) Diethylfumarate (xii) p-Nirtobenzaldehyde (xiv) Mesityl oxide (xv) o-Hydroxybenzaldehyde (xvi) p-Nitroaniline

A separate laboratory workbook should be maintained for these experiments.

# SEMESTER 7

## PHARMACOGNOSY-1

COURSE CODE: CH 401 CREDITS: 3

1. Definition, history and scope of pharmacology including indigenous system of medicine.

2. Various system of classification of drugs of natural origin.

3. Adulteration, distribution, organoleptic evaluation, microscopical evaluation, chemical constituents including tests whenever applicable and their therapeutic efficacy of the following categories of drugs:

**(a) Laxatives:** Aloes, Rhubarb, Castor oil, Isopgul, Senna.

**(b) Cardiotonics:** Digitalis, Arjuna.

**(c) Carminatives and G.I. regulators:** Umbelliferous fruits, Coriander, Fennel, Ajowan, Cardamom, Ginger, Black pepper, Asafoetida, Nutmeg, Cinnamon, Clove.

**(d) Astringents:** Catechu.

4. Occurrence, distribution, organoleptic evaluation, microscopical evaluation, chemical constituents including tests wherever applicable and therapeutic efficacy of the following categories drugs.

**(a) Drugs acting on nervous system:** Hyoscyamus, Belladona, Aconite, Ashwagandha, Ephedra, Opium, Cannabis, Nuxvomica.

**(b) Antihypertensives:** Rauwolfia.

**(c) Antitussives:** Vasaka, Tolu balsam, Tulsi.

**(d) Antirheumatics:** Guggul, Colchicum.

**(e) Antitumor:** Vinca.

**(f) Antileprotics:** Chaulmoogra oil.

**(g) Antidysentric:** Ipecacuanha.

**(h) Anriseptic and disinfectants:** Benzoin, Myrrh, Neem, Curcuma.

**(i) Antimalarial:** Cinchona.

**(j) Oxytocic:** Ergot.

**(k) Vitamins:** Shark oil, Liver oil and Amla.

**(l) Enzymes:** Papya, Diastase yeast.

5. Gross anatomical studies of : Senna, Cinchona, Fennel, Clove, Ginger, Nuxvomica.

6. Brief outline of occurrence, distribtution outline of isolation, identification tests, therapeutic effects and pharmacological application of alkaloids, terpenoids, glycosides, volatile oils, tannins and resins.

## PRACTICAL (PHARMACOGNOSY -1)

COURSE CODE: CH 451 CREDITS: 2

1. Identificaion of crude drugs (Containing carbohydrates, lipid, glycosides, volatile oil, alkaloids etc.)

2. Physical and chemical tests for evaluation of crude drugs whenever applicable.

3. Microscopic studies of senna leaf, Rauwolfia root, Cinnamon bark, Datura flower and stem.

4. Identification of fibers, surgical dressings and pharmaceutical aids.

5. Preparation of Herberium Sheet.

## BIOCHEMISTRY-1

COURSE CODE: CH 403 CREDITS: 3

1. Biochemical organization of cell and transport process across cell membrane.

2. The concept of free energy, determination in free energy change from equilibrium constant and reduction potential, Bioenergetics, production of ATP and its biological significance.

3. Introduction to 3-D structure of protein, stability and denaturation of protein, allosteric proteins.

4. ***Enzymes***- Nomenclature, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis.

5. ***Co-enzymes-*** Vitamins as coenzyme and their significance. Metals as coenzyme and their significance.

6. ***Carbohydrate metabolism:*** Conversion of polysaccharides to glucose-1-phosphate, glycolysis and fermentation and their regulation, gluconeogenesis, and glycogenolysis, metabolism of galactose and galactosamine, role of sugar nucleotides in biosynthesis, pentose phosphate path way.

7. ***The citric acid cycle***.
   Significance, reactions and energetic of the cycle, amphibolic role of the cycle, glyoxalic acid cycle.

***8. Lipid metabolism***

A) Oxidation of fatty acids, χ-oxidation and energetics, O-oxidation and ν oxidation, biosynthesis of ketone bodies and their utilization.

B) Biosynthesis of unsaturated and saturated fatty acids, control of lipid metabolism.

C) Essential fatty acids eicosanoids (prostaglandins, thromboxenes and leukotrienes), Phopholipids and sphingolipids.

***9. Biological oxidation***
Redox potential, enzymes and co-enzymes involved in and its control; energetic of oxidative phosphorylation, inhibitors of respiratory chain and oxidative phosphorylation, mechanism of oxidative phosphorylation.

## PRACTICAL BIOCHEMISTRY

COURSE CODE: CH 453 CREDITS: 2

1. Experiments on sugar-
   Test for reducing sugar, Calorimetric estimation of sugar, Chromatographic separation of sugar.

2. Titration curve for amino acids.

3. Separation of amino acids by 2D chromatography and gel electrophoresis.

4. Experiments on lipids
   Saponification numbers, Iodine number, Separation of lipids by TLC.

5. Quantitative estimation of amino acids and proteins.

6. Experiments on clinical biochemistry
   Blood sugar estimation, cholesterol in blood

Separation of blood plasma protein by electrophoresis.
Non-protein nitrogen in blood (Urea).
Estimation SGPT, SGOT and ALP in serum.

7. Estimation on enzyme
   Effect of pH, effect of temperature and use of inhibitors

## MEDICINAL CHEMISTRY-I

COURSE CODE: CH 405 CREDITS: 3

To study the following with special reference to pharmaceutical applications

1. Introduction to medicinal Chemistry-its role in society and commerce
2. Classification of drugs on the basis of sources, site of action and mode of action.
3. Preparations and properties of medicinally important heterocyclic compounds such as pyrrole, furan, Pyridine, Pyrimidine and Pyrazines.
4. Preparation and properties of medicinally important heterocyclic compounds in which benzene ring is fused with five or six membered ring containing one heteroatom-indole, Quinoline, isoquinoline
5. General properties, Chemistry, Biological action and therapeutic applications of the following

a) alicyclic compounds : cyclopropane, Terpenes, camphor, Menthol, Carotenes

b) Alkaloids-Atropine, Morphin, Codeine, Thebine, Ergotamines, Reserpine

c) Vitamines-(Water and Fat soluble) B1, B2, B6, B12, Nicotinic acid, Biotin, Pentothenic acid, Ascorbic acid, Vitamine K

d) Hormones-(Steroidal and Proteinious), Testosteron, Progesteron, Estrogen, aldosteron, Cortison, Insulin, Glucagon, Oxitossin, Vasopressin, Seratonin.

## BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: CH 455 CREDITS:2

1. Protein separation by gel electrophoresis

   (a) Setting of electrophoretic apparatus.

   (b) Stacking of gel and well preparation.

(c) Sample preparation and loading of gel and gel running.

(d) Staining

(e) Estimatnion of total protein contain of sample and preparation of standard curve

2. Quanitaive estimation of specific antigen / antibody in human serum by ELISA.

3. DNA separation and isolation.

## ANALYTICAL CHEMISTRY AND INSTRUMENTAL ANALYSIS

COURSE CODE: CH 407 CREDITS: 3

To study the principles and application of the following methods and techniques in pharmaceutical analysis and drug development.

1. UV and IR spectroscopy.

***2. Nuclear magnetic resonance spectroscopy (NMR)***

a) Principles and advanced techniques and application of NMR.

b) $^{1}H$ and $^{13}C$ NMR spectroscopy-principles, instrumentation, principles of decoupling.

c) Gated decoupling difference spectroscopy; Relaxation process, Population transfer, Selective polarization transfer.

d) INEPT, basic two-dimensional sequence, Homonuclear shift correlation.

e) Application of DEPT, $^{1}H$-$^{1}H$ COSY, HMBC, HOHAHA (TOCSY).

f) NOE in structure elucidation of organic compounds.

g) NMR in drug screening.

h) Application of NMR in medical science.

***3. Mass spectroscopy***

Theory, Instrumentation and Ionization methods (FAB, ESI, MALDI, FD etc.), Application of HRIEMS, MS-MS, GC-MS, LC-MS.

Mass spectrometers (MALDI, TOF, ES) in structure elucidation of small and macromolecules.

***4. Electron spin resonance spectroscopy(ESR).***

Introduction, Principles, Instrumentation and application in detection of free radicals in chemical and biological systems.

***5. High Performance Liquid Chromatography (HPLC)***

Normal phase, reverse phase, Ion exchange and Ion pairing techniques, chiral HPLC. Application of HPLC in analysis of drugs in pharmaceutical preparations and biological fluids.

***6. Gas chromatography.***

Introduction, Principles, Instrumentation, application of gas chromatography in the Identification and estimation of components in chemical and biological mixtures.

## PHARMACEUTICAL STATISTICS

COURSE CODE: CH 409 CREDITS: 3

**1. Stastical Analysis using standard package:**

**(a)** Introductory Statistical Concepts, Basic Definations.

**(b)** Introduction to probability-Binomial distribution, Normal distribution, t-distribution, chi-distribution, and F-distribution.

**(c)** Statistical inference, Confidence intervals, Hypothesis testing.

**(d)** Estimation of parameters using computers.

**2. Analysis of variance and experimental design:**

One way analysis of variance, Multiple comparison, Two way analysis of variance.

**3. Linear Regression and Correlation:**

Introduction, Fitting lines, Confidence level, Analysis of residuals.

**4.** Principal Component Analysis.

**5.** Cluster Analysis.

## BIOTECHNOLOGY AND GENETIC ENGINEERING

COURSE CODE: 411 CREDITS: 3

1. Enzyme immobilization:

2. Techniques of immobilization of enzymes; factors affecting enzyme kinetics.

3. Study of enzymes such as hyaluronidase, Peniclinase, Streptokinase, Streptodernase, Amylase and Protease etc.

4. Introduction and historical background,

   (a) Scientific and technological foundations.

   ***(b) Micro and nanotechnology for medicine.***

   History, Implications Applications Regulation Organizations Popular culture List of topics, Fullerene,, Carbon Nanotubes , Nanoparticles, Nanotoxicology Nanosensor Self-assembled monolayer Supramolecular assembly DNA nanotechnology Molecular electronics Nanolithography, Scanning probe microscopy Atomic force microscope Scanning tunneling microscope Molecular nanotechnology, Molecular assembler Nanorobotics Mechanosynthesis

5. Biotechnology and medicine:
   Vitamins
   Steroids
   Amino acid
   Proteins
   Antibiotics
   Natural compounds

6. \Gene farming – (a) Plants, (b) animals

7. Recombinant DNA technology:
   Concept, (b) Cutting and rejoining of DNA, (c) DNA segregation, (d) PCR in gene amplification, (e) Isolation and amplification of genes.

# SEMESTER8

## PHARMACOGNOSY-2

COURSE CODE: CH 402 CREDITS:3

1. ***Study of the following drugs containing:*** Resins and resin combinations like Colophony, Podophyllum, Jalap, Cannabis, Capsicum, Myrrh, Asafoetida.

2. Balsam-of Peru, Benzoin and Tannins containing drugs like Gambir, Gall and Myrabolan.

3. **Volatile oils:** General methods for obtaining oils from plants. Study of volatile oils of Mentha, Cassia, Lemon peel, Orange peel, Lemon grass Citronella, Caraway, Dile, Spearmint, Enclyptus, Chenopodium, Valerian, Musk, Gaultheria, Sandalwood.

4. **Fibres:** Study of fibres used in pharmacy such as Cotton, Silk, Wool, Nylon, Glasswool, Plyesters and asbestors.

5. **Pharmaceutical aids:**

   -Study of pharmaceutical aids like Talc, Diatomile, Kaolin, Bentonite, Gelatine and Natural colours.

6. **Chemotaxonomy of**

**(b)** Medicinal plants.

**(c)** Health and health practical food.

**(d)** Herbal cosmetics.

**(e)** Marine pharmacognosy.

7. **Study of the traditional drugs:**

   Common vernacular name, Botanical sources, Morphology, Chemical nature of chief constituents, Pharmacology, Categories and common uses of and marketed formulations of the following indigenous drugs:

   Amla, Kantikari, Satavari, Tylophora, Bilwa, Kalijeera, Bach, Rasna, Punarnova, Chilrack, Apamarg, Gokhur, Shankhapuspi, Brahmi, Adusa, Arjuna, Methi, Lahrun, Palash, Gagul, Gyumnema, Shilajit, Nagamotha and Neem.

8. The holistic concept of drug administration in traditional system of medicine Introduction of ayurbedic preparation like Aristha, Agvas, Gutikas, Tailas, Churnas, Lehyas, Bhasmas.

## TOXICOLOGY

COURSE CODE: CH 404 CREDITS:3

**1.** Basic concept of Toxicology and subdivision in Toxicology.

**2.** Routes and sites of exposure, Duration and Frequency of exposure, Dose-Response Relationship.

**3.** Mechanism and Action of toxicants.

**4.** Biotransformation of toxicants-sites, enzymes involved.

**5.** Biotransformation reactions:

Phase I, Phase II

**6.** Toxicity test and Safety Evaluation of Chemicals-Predictive.

**7.** Toxicology.

**8.** Antioxidants and Natural Body Antioxidants: Superoxide Theory and Oxygen Toxicity, Lipid peroxydation, Antioxidant defence system, Free radical chein reaction, Toxicity of Free Radicals and Prevention of Free Radicals damage by Antioxidant.

## MEDICINAL CHEMISTRY- II

COURSE CODE: CH 406 CREDITS:3

To study the chemistry, structure, mechanism, structure-activity relationship and therapeutic application of the followings:

1. **Analgesic and Antipyretics:** Paracetamol, Salicylic acid analoges, Quinolones, Pyrazolones and Pyrazolodine, N-aryl Anthranilic acid and Hereroaryl Acetic Acid derivatives.

2. **Local Anesthetics:** Benzoic acid derivatives, Lido Caine derivatives, Amino Benzoic Acid, Procaine, Lignocaine, Eucaine, Cocaine.

**3. Central Nervous System Depressants:**

**(a)** General anesthetics, Inhalation anesthetics, Barbiturates, Nitrous Oxide, Chloroform, Methohexital, Thioamylal sodium.

**(b)** Anxiolytic sedatives, Hypnotics such as Benzo-Barbiturates, Paraldehyde Glutethimide, Cholral hydrates, Alcohols.

**(c)** Anticonvulsants such as Barbirurates, Oxazolidinediones, Succinimides, Benzodiazepines.

4. **Central Nervous System Stimulants:** Analepties, Picrotoxins, Methylxanthines, Monoamine inhibitors, Tricyclic Compounds.

5. **Diuretics:** Carbonic anhydrase inhibitors, Thiazides and the derivatives, High ceiling and looping diuretics, Potassium diuretics, Marcaptomerin, Meralluride, Thiazides, Furosimide, Aceta zolamide.

6. **Anti-Neoplastic agents:** Alkylating agents, Antimetabolites, Antibiotics, Hormones, Methotrexate, Fluorouracil, Actinomycenes, Vincristine, Tamoxifen.

7. **Antihistamines:** $H_1$ antagonistic, $H_2$ antagonistic, Aminoalkylethenediamines, Propylamine derivatives, Piperazine derivatives, Promethazine, Cyclizine, Terfenadine, Cimetidine, Rantidine, Omeprazole.

8. **Cardiovascular agents:** Antianalginal agents, Vasodialators, Antiarrhythmic and Antihypertensive agents, Angiotensin-converting inhibitors, Antihyperlipidemic agents, Anticoagulants.

9. **Antitubercular agents:** Ethambutol, iso-Nicotinic acid, Hydrazides, Thioguanine, Cytarbine, 5-Fluoracil, Dicarbazine, Streptomycine.

10. Drug-Receptor Interaction.

11. To study the chemistry, structure, structure-activity relationship and therapeutic application of the following:

**(a) Sulphonamides**-such as Sulfamethoxazole, Sulfafurazole.

**(b) Hypoglycimic agents**-Sulfonylureaschloropropamide, Acetohexamide Glipizide.

**(c) Antibiotics**-Penicillines, Cephalosorpins, Chloramphenicol, Tetracyclines, Kanamycin.

**(d) Antimalarial agents**- 4-amioquinine, Aminoquinolines, Biguanides, 9-Amino acridines, Mefloquine, Cincona alkaloids.

**(e) Antihelminthics**-Piperzine derivatives, Mendendazole, Pyrantal

**(f) Antiviral agents-**Acyclovir, Ribavirin.

***12. To study the biosynthesis and drug designing of the following:***

Autocoids such as Prostaglandins, Lector cicosanoids, Adrenenergic receptors, Agonists and antagonists.

## MEDICINAL CHEMISTRY (LAB)

COURSE CODE: CH 452 CREDITS: 2

1. Separation, Identification and Quantification of active principles extracted from plants by chromatographic methods. (Paper chromatography and TLC)

2. Assay of bioactive principles isolated from plants by spectroscopic methods (visible and UV)

## TOXICOLOGY (PRACTICAL)

COURSE CODE: 454 CREDITS: 2

**1.** Study of enzyme poisoning with heavy metal (*e.g.* Hg etc) and its recovery with EDTA.
**2.** Lipid peroxidase study for toxicity
**3.** a) Acute toxicity test
b) Chronic toxicity test
4. Computation of $LD_{50}$ or $LC_{50}$
5. determination of minimal acceptable toxic concentration.

## MEDICINAL COMPOUNDS AND QUALITY CONTROL

COURSE CODE: 408 CREDITS: 3

1. Norms of quality control
2. Raw materials for drug.
3. Source of impurities in pharmaceuticals.
4. Purity and its control.
5. Test and determination of walls.
6. Sampling techniques, Validation and statistical analysis of data.
7. Pharmacopeial tests and specification.
8. Standardization of pharmaceuticals.
9. Total quality management.

## DRUG DELIVERY (I)

COURSE CODE: CH 412 CREDITS: 3

1. Modified release Drug products, Biopharmaceutics factors.
2. Dosage form selection
3. Drug release from Matrix
4. Advantages and Disadvantages of extended release products
5. Kinetics of control release dosage factors
6. Pharmakokinetics simulation of extended release products consideration in the eavaluation of modified release products.

II. **Novel Drug Delivery System:**
Introduction to novel drug delivery systems like microcapsule and micro pellet parenteral and implantable therapeutic system,
Trans dermal therapeutic system.
Microparticulate drug carrier system.
Microencapsulation.

## BIOCHEMISTRY 2

COURSE CODE: CH 414 CREDITS: 3

4. **Nitrogen and sulfur cycle:**Nitrogen fixation, Ammonia assimilation, Nitrification and Nitrate assimilation,Sulfate activation, Sulfate reduction, Incorporation of sulfur in organic compounds; Release of sulfur from organic compounds.

5. **Metabolism of Nitrogen and Sulfur Containing Monomers:** Nitrogen balance; Biosynthesis of Amino acids, Catabolism of Amino acids; Conversion of Amino acids to specialized products, Assimilation of ammonia, Urea Cycle; Metabolic disorder of Urea Cycle; Metabolism of sulfur containing amino acids.Porphyrin biosynthesis; Formation of bile pigments; Hyperbilirubinemia, Purine biosysnthesis, Purine nucleotide interconversion, Pyrimidine biosynthesis and Formation of Deoxyribonucletides.

6. **Biosynthesis of Nucleic acids:** Brief introduction of genetic organization of the mammalian genome, Alteration and arrangements of genetic materials. Biosynthesis

of DNA and its replication; Mutation; Physical and chemical mutagenesis; DNA repair mechanism; Biosynthesis of RNA.

7. **Genetic Code and Protein Synthesis:** Genetic code; Components of protein synthesis; Brief account of genetic engineering and Polymerase Chain Reaction.

8. **Regulation of gene expression.**

# SEMESTER 9

## PHARMACOGNOSY-3

COURSE CODE: CH 501 CREDITS: 3

1. Systematic study of sopurce, cultivation, collection, processing, commercial varieties, chemical constituents, substitutes, adulterants, use, diagnostic macroscopic and microscopic features and specific chemical tests of the following alkaloid containing drugs.

   (a) Pyridine-piperidince: Tobacco, Areca and Lobelia.

   (b) Tropane: Belladonna, Hyocyamus, Datura, Duboisia, Coca and Withania.

   (c) Quinoloine and isoquinoline: Opium,

   (d) Indole: Catharanthus and Physostigma.

   (e) Imidazole: Pilocarpus

   (f) Steroidal: Veratrum, Kurchi

   (g) Alkaloidal amine: Ephidra and Colchicum.

   (h) Glycoalkaloids: Solanum.

   (i) Purines: Coffe, Tea and cocoa.

1. Plant bitter and sweetener

2. Phytochemical screening:

   (a) Preparation of extracts

   (b) Screening of alkaloids, Saponins, Cardenolides and Bufadienolides, Flavonoids and leucoanthrocyanides, Tannis and Polypheroids, Aththaqunones, Cyanogenetic glycosides, amino acids in plant extracts.

3. Brief introduction to biological sources preparation, identification, studies and basic metabolic pathways, Biogenesis of secondary metabolites of pharmaceutical importance.

4. Introduction, Classification and study of different choramtographic methods and their applications in evaluation of herbal drugs.

## PRACTICAL
## PHARMACOGNOSY

COURSE CODE: CH 551 CREDITS: 2

1. Chromatographic studies of phytoconstituents present in crade drug.
2. Experiments on plant tissue culture.
3. Specific chemical tests of the following groups of medicinal compounds containing glycosides:

    (a) Saponins, Ginseng, Dioscorea, Sarsapaulla and senegu.

    (b) Cardioactive sterols: Squill, Stropharthus, Thervelia

    (c) Anthroqunine cathartise: Cas care

    (d) Othis: Psoralea, Anni majus, annivisnage, Gertian, Saffron, Chirates, Quasia

## MICROBIOLOGY-1

COURSE CODE: CH 503 CREDITS: 3

1. Introduction to scope of microbiology.
2. Structure of bacterial cell
3. Classification of microbes and their taxonomy-Actinomycetes bacteria, Ricketsiae.
4. Identification of microbes: Stains and types of staining techniques, Electron microscope.
5. Nutrient, Cultivation, Isolation of bacteria, actinomycetes, fungi, viruses etc.
6. Microbial genetics and variation.
7. Control of microbes by physical and chemical methods

    (b) Disinfection: Factors influencing disinfectants, Dynamics of disinfection, Disinfectants' and antiseptics and their valuation.

    (c) Sterilization: Different methods, Validation of sterilization methods and experiments.

8. Sterility testing of all pharmaceutical products.

9. Microbial assay and antibiotics, Vitamins ($B_{12}$ and Niacin), Amino acids.

   Antibiotics:
   (a) Antimicrobial spectrum and methods used for their standardizations.

   (b) Screening of soil organism producing antibiotics

   (c) Farmenter, its design, control of different parameters.

   (d) Isolation of mutants, factors influencing rate of mutation; Design of fermentation process; Isolation of fermentation products with special reference to other products of industrial use.

10. Microbial transformation: Introduction, Types of reactions mediated by microorganisms, Design of biotransformation process, Selection of organisms, Biotransformation process and its improvements with special reference to steroids.

11. Diseases and diseases producing microorganisms: Like Staphylococcus areus, Streptococcus pyrogenus, E. Coli, Sulmonella typhi, Vibrio choleri and Yersinia pestis, Virulence factors.

12. Fermentation production of Alcohol: Fermentation, its design, control of different parameters, Isolation of mutant factors influencing the rate of mutation,

## PRACTICAL MICROBIOLOGY

COURSE CODE: CH 553 CREDITS: 2

1. Preparation of different types of culture media, Sub-cultureing and common aerobic and anaerobic bacteria, Fungus and yeasts.

2. Various staing methods.

3. Various methods of isolation and identification of microbes, Sterilization techniques.

4. Evaluation of antiseptics and disinfectants

5. Testing the sterility of pharmaceutical products as per I.P. Regulations.

6. Microbial assay of antibiotics and vitamins.

## IMMUNOLOGY (I)

**COURSE CODE: CH 505** **CREDITS: 3**

1. Immune system
2. Vaccination and Immunization
3. Non specific defense mechanism ---- Anatomical Barrier, Physiological Barrier, Phagocytic Barrier, Inflammatory Barrier, Fever, Antimicrobial substances.
4. Specific defense mechanism --- B-Lymphocytes and T- Lymphocytes.
5. Mechanism of immune systems --- Antibody mediated immunity and Cell mediated immunity.
6. Antibody-Antigen, Heptanes and their tests.
7. Development of immunity.
8. Types of immunity
9. Clonal selection; Primary and secondary immune response.
10. Lymphoid organs.
11. Blood groups
12. Organ transplantations and antibody
    a. Rejection reaction, Prevention of graft rejection, skin grafting, and types of graft.
13. Immune system disorder
    a. Allergies, Autoimmunity and Immune Deficiency.

## *PHARMACOLOGY- I*

COURSE CODE: 507 CREDIT 3

1. General Pharmacology:
   Introduction to pharmacology, Sources of Drugs, Dosage, Forms and routes of administration, Mechanism of action, Combined effect, Factors modifying Drug Action- Tolerance, dependence

2. Pharmacogerotics- Absorption, Distribution, Metabolism, Excretion

3. Pharmacology of Peripheral Nervous system

4. Pharmacology of Central Nervous System

5. Bioassay
   Definition, Merits and demerits of bioassay
   Biological Standardization, Threshold dose
   Bioassay of acetylcholine , Hydroxytriptamine, adrenaline, noradrinaline, sedative agents, oxitosin, digitals, different hormones, anesthetics, local anesthetics,

**PHARMACOKINETICS AND PHARMACODYNAMICS**

COURSE CODE: 509 CREDIT: 3

1. Biopharmaceutics:

(a) Passage of drugs across the biological bariier ( Passive diffusion, active transport, facilitated diffusion, pinocytosis).
(b) Factors affecting absorbtion.
© Bioavailibilty and bioequivalents.

2. Pharmacokinetics:
   (a) Significance of plasma-drug concentration measurement.
   (b) Compartment model and compartment kinetics.
   (c) Pharmacokinetics of drug absorption.
   (d) Clearance concept
   (e) Excretion ratio.
   (f) Non linear pharmacokinetics.

3. Pharmacodynamics:
   (a) Protein therapeutics
   Its pharmacodynamics binding, Interspecis scaling, Heterogenecity, Chemical modification, immunogenicity.
   (b) Physiological pharmaceutical model – Mean residence time (MRT), Statistical memory theory (SMT), Mean absorbtion time(MAT) and mean dissolution time (MDT).

## PHARMACOLOGY LAB

COURSE CODE: 555 CREDIT: 2

1. Colorimetric analysis of different drugs from blood samples.
2. Drug dilution, use of molar and W/V solutions in experimental pharmacology.
3. Introduction to instruments commonly used in experimental pharmacology.
4. Effect of agonists and antagonists on concentration and relaxation response of smooth muscles.
   To record concentration – Response curve (CRC) of acetylcholine, using rectus abdominis muscle preparation frog.

## MATHEMATICS APPLIED IN MEDECINAL CHEMISTRY

COURSE CODE: CH 511 CREDITS: 3

**Algebra**

Common and natural logarithm. Linear and quadratic equation, Equations reducible to quadratic form, Binomial theories, Simple application, Solution to simultaneous equation, Determinant and matrix.

**Differential Calculus**

Limit, Concept of derivation, Rules of differentiation, Examples of evaluation of derivations, Derivation of aljebric, trigonometric, exponential and logarithmic functions, Partial derivations, Higher order derivations, Maxima and minima point of inflection.

**Integral Calculus**

Concept of integration, Rules of integrations, Integration of aljebric, trigonometric, logarithmic functions using different techniques and numerical integration.

**Molecular Topology-and Graph theory**

Its use in QSAR, Derivation of graph theories induces and its use in designing bioactive compounds.

**Information Theory**

Shannon’s formula for diversity measurement, Derivation of Information Theory, Topological Indices.

# SEMESTER 10

## COMPUTER APPLICATION IN MEDICINAL CHEMISTRY

COURSE CODE: 502 CREDITS: 3

1. Computer preliminaries

   (a) Introduction to computer, comparison of analog and digital computer, Hardware and software,

2. Oparating system – Types,

3. Types of languages – An introduction to data structure, algotithm, SQL, Gate way.

4. Application in medicinal and pharmaceutical studies:

   (a) Statistical using standard pacage

   (b) Chi square test and f distribution

   (c) Statistical variance , Confidence intervals, Hypothesis testing

   (d) ANOVA study – Experimental design in clinical trial principles, parallel design, cross over design.

   (e) Linear and non linear regration and correlations.

   (f) Database management – Data type, storage of information by Foxpro and rational data system, its use in clinical drug interaction and drug information service.

   (g) Smiles notation for structure of chemical compounds

## INDUSTRIAL MANGEMENT

COURSE CODE: 504 CREDITS: 3

1. Concept of Management,
   Administrative Management (Planning, Organization, staffing, Directing and controlling)

2. Entrepreneurship Development

Operative management (Personal, Material, Production, Financial, Marketing, Time/Space, Margin/Morale)

3. Principles of Management (Coordination, Communication, Motivation, Decision Making, Leadership, Innovation, Creativity, Delegation of Authority/Responsibility, Record Keeping)
4. Identification of Key points to give maximum thrust for development and perfection.

## QUANTITATIVE STRUCTURE ACTIVITY RELATION AND DRUG DESIGN

COURSE CODE: 506 CREDITS:4

1. Topology of molecule.
2. Interrelation between structure and property / activity / function
3. Structure as an encoded source of information
4. Graph invariants and computation of graph theoretic indices.
5. Information theory and computation of information theoretic topological indices.
6. Classification of molecular indices and their applications.
7. Classical QSAR and its limitations.
8. Similarity and dissimilarity concepts, measure of similarities between molecules.
9. Neoclassical QSAR and its applications.
10. Hierarchical QSAR.
11. Chemo-descriptors, Bio-descriptors and chirality; Bio-descriptors for higher complex biological systems *e.g.* Cell, Nucleic Acids and Proteins (Genomics, Proteomics etc).
12. Integrated QSAR and its applications.
13. Differential QSAR and silent receptors.
14. Application of QSAR in predicting properties of molecules, in predictive toxicology and in drug design.
15. Computer assisted QSAR modeling and computer assisted drug design.

## PHARMACOLOGY-2

COURSE CODE: 508 CREDITS: 3

1. Receptor pharmacology:

(a) 5-hydroxy-tryptamine (HT) : Intrioduction, chemistry, biosynthesis, and metabolism.

5-HT receptor subtle, site of 5-HT action,

5-HT agonist, antagonist,

Serotogeneric receptors and cardiovascular system:

Signaling pathway, Biochemical and molecular aspects, clinical implications,

(b) Molecular and cellular mechanism of

i) Glutamate receptors
ii) GABA and its receptors,
iii) Catecholamine receptors (α and β adrinogencs receptors, Dopamine receptors)
iv) Acetylcholine receptors, (Nicoine and Muscarine receptors)
v) Opioid receptors

2. (a) Ion channels exchangers and pumps, transduction, mechanism as targetes of drug action, Voltage retentive ion channels, and pharmacology of their inhibitors, antagonists of β-adrino receptors, Pharmacology of sodium / potassium ATPase, and gap junction.
   (b) Vassodialators: nitric oxide (NO), Biosynthesis of nitric oxide and its control, degradation and carriage of NO, Effects of NO, Therapeutic uses of NO, and NO donors, Inhibition of NO, Clinical coordination in which NO placed a part, Pathophysiology of Heart failures, MAP kinase signaling pathway, drugs of heart disease -- Thrmbolites, Lipid lowering agents.

3. Neuropharmacology:
   Pathology of CNS diseases and treatment of neurogenerative disorders,
   Introduction, mechanism of neuronal death, Ischemic brain damage (strokes), Aligheimer's diseases, Perkinson disease, Huntingtons disease, neurogenerative prion disorders.

## FUNCTIONAL ENGLISH

COURSE CODE: 512 CREDITS: 3

1. General instruction for scientific writing and style manual
   Grammar, Syntax and Punctuation etc

2. Writing of abstracts of scientific paper.

3. (a) Writing of Scientific paper
   (b) Reference citation
   (c) Presentation of data in the form of table, graph, charts etc
   (d) Title of Scientific paper.

4. Comprehension of scientific paper

5. Writing of review articles.

6. Writing of research grant proposal

# SYLLABUS FOR SUBSIDIARY CHEMISTRY

**SEMESTER – 1**

COURSE CODE: CH 131 CREDITS:3

Course content same as CH 101 and CH 151

**SEMESTER – 2**

COURSE CODE: CH 132 CREDITS:3

Course content same as CH 102 and CH 152

## SEMESTER – 3

## INORGANIC

COURSE CODE: CH 231 CREDITS:3

### *3. Chemical Periodicity II*

Comparative study of p-block elements: Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

(i) s-block elements: Li-Na-K, Be-Mg-Ca-Sr-Ba.

Extraction and purification of elements from natural sources: Li, Cr, Ni, Ag, Au. Electroplating, galvanizing and anodizing.

### *4. Other Types of Bonding*

Coordinate bonding: Lewis acid-base adducts (examples), double salts and complex salts, Werner theory of coordination compounds. Ambidentate and polydentate ligands, chelate complexes. IUPAC nomenclature of coordination compounds (up to two metal centers). Coordination numbers, constitutional isomerism. Steriochemistry of coordination number 4 and 6

Hydrogen bonding and its effects on the physical properties of compounds of the main group elements.

Metallic bonding: qualitative idea of band theory, conducting, semi conducting and insulating properties with examples from main group elements.

## ORGANIC

COURSE CODE: CH 233 CREDITS: 3

### *1. Alkanes, alkenes and alkynes*

Alkanes, alkenes and alkynes: Synthesis and chemical reactivity of alkanes, mechanism of free-radical halogenation of alkanes, general methods of synthesis of alkenes, electrophilic addition reaction, mechanism of bromination and hydrohalogenation, Markownikoff's addition, peroxide effect, hydroboration, ozonide

formation, polymerization reaction of alkenes (definition and examples only), general methods of synthesis, acidity, hydration and substitution reactions of alkynes

***2. Other aliphatic compounds***

Aldehydes and ketones: the nature of carbonyl group, methods of synthesis, physical properties, Cannizzaro reaction, relative reactivities and distinction of aldehydes and ketones, Aldol condensation (with mechanism), Perkin reaction, Benzoin condensation, Claisen condensation, Oxidation and reduction reactions.

Alkyl and Aryl halides: SN1, SN2, E1 and E2 reactions (elementary mechanistic aspects), Saytzeff and Hoffmann elimination reactions. Nucleophilic aromatic substitution.

Carboxylic acids and their derivatives: acidity of carboxylic acids and effects of substituents on acidity, chemical reactivity, mechanism of esterification of carboxylic acids and hydrolysis of esters (BAC2 and AAC2 only)

***3. Aromatic Hydrocarbons:***

Aromatic Hydrocarbons: Structure of benzene, general mechanism of electrophilic substitution, reactions of benzene, synthesis of aromatic compounds using nitration, halogenation, Friedel-Craft's reactions

Phenols: synthesis, acidic character and chemical reactions of phenols, Kolbe reactions, Reimer-Tiemann reaction, Fries rearrangement, Claisen rearrangement.

***4. Principles of organic qualitative analysis***

Reactions involving the detection of special elements N, S and Cl in an organic compound (only Lassaigne’s test).

Reactions involving the detection of the following functional groups:

Aromatic primary amino group (Diazo-coupling reaction); Nitro group (Mulliken Barker’s test); Carboxylic acid group (reaction with $NaHCO_3$); Phenolic OH ($FeCl_3$ test); Carbonyl (aldehyde and ketone) group (DNP Test, etc.).

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## PHYSICAL

COURSE CODE: CH 235 CREDITS: 3

### *1. Chemical equilibrium*

Chemical equlibria of homogeneous and heterogeneous systems, derivation of expression of equilibrium constants; temperature, pressure and concentration dependence of equilibrium constants ($K_P$, $K_C$, $K_X$); Le Chatelier's principle of dynamic equilibrium

### *2. Colloids*

Colloids and crystalloids, classification of colloids, preparation and purification of colloids: ferric hydroxide sol and gold sol. Properties of colloids: Brownian motion, peptization, dialysis, Tyndal effect and its applications. Protectin colloids, gold number, isoelectric points, coagulation of colloids by electrolytes, Schulze-Hardy rule.

### *3. Liquid State and Viscosity of Fluids*

Liquid state: physical properties of liquids and their measurements: surface tension and viscosity.

## PRACTICAL

COURSE CODE: CH 261 CREDITS: 2

### *1. Detection of functional groups –*

$NO_2$, $-NH_2$, -COOH, carbonyl (-CHO, >C=O), -OH (phenolic) in solid organic compounds.

Experiments A - C with unknown (at least 6) solid samples containing not more than two

of the above types of functional groups should be done.

## SEMESTER – 4

## INORGANIC

COURSE CODE: CH 232 CREDITS: 3

***1. Chemical Periodicity III***

Comparative study of p-block elements: Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

(ii) p-block elements: B-Al-Ga-In-Tl, C-Si-Ge-Sn-Pb, N-P-As-Sb-Bi, O-S-Se-Te, F-Cl-Br-I,

***2. Principles of qualitative inorganic analysis***

Formation of sublimates; principle of flame test, borax-bead test, cobalt nitrate test, fusion test, chromyl chloride test; analytical reactions for the detection of nitrate, nitrite, halides, phosphate, arsenate, arsenite, sulphide, thiosulphate, sulphate, thiocyanate, borate, boric acid, carbonate. Analytical reactions for the detection of Cr3+, Fe3+, , Ni2+, Cu2+, As3+, Mn2+, Importance of common-ion effect in the separation of Group II cations, and Group III cations.

## ORGANIC

COURSE CODE: CH 234 CREDITS: 3

***3. Nitrogen compounds and Organometallics***

Aromatic nitro compounds – reduction under different conditions. [acidic, neutral and alkaline]. Methods of synthesis of aliphatic amines, Heinsberg's method of amine separation, Hofmann degradation, Gabriel's phthalimide synthesis, distinction of primary, secondary and tertiary amines; methods of synthesis of aromatic amines, basicity of aliphatic and aromatic amines. Diazotization and coupling reactions and their mechanisms; synthetic applications of benzene diazonium salts. [Sandmeyer’s reaction, preparation of nitro compounds, phenols, carboxylic acids and hydrocarbons thereby]

***4. Organometallic compounds:***

Grignard reagents – preparations and reactions, application of Grignard reagents in organic synthesis. [10-, 20- and 30-alcohols, aldehydes, ketones and carboxylic acids.]

***5. Biomolecules***

Carbohydrates: Introduction, occurrence and classification of carbohydrates, constitution of glucose, osazone formation, reactions of glucose and fructose, mutarotation, cyclic structures – pyranose and furanose forms (determination of ring-size excluded), epimerization, chain-lengthening (Kiliani –Fischer method) and chainshortening (Ruff's method) in aldoses.

Amino acids, Proteins: methods of synthesis of α –amino acids (glycine and alanine using Gabriel's phthalimide synthesis and Strecker synthesis). Physical properties. Zwitterion structures, isoelectric point.

## PHYSICAL

COURSE CODE: CH 236 CREDITS: 3

***1. Acids-bases and solvents***

Modern aspects of acids and bases: Arrhenius theory , theory of solvent system, Bronsted and Lowry's concept, Lewis concept with typical examples, applications and limitations. Strengths of acids and bases (elementary idea).

Ionization of weak acids and bases in aqueous solutions, application of Ostwald's dilution law, ionization constants, ionic product of water, pH-scale, buffer solutions and their pH values, buffer actions; hydrolysis of salts.

***2. Solutions of electrolytes***

Electrolytic conductance, specific conductance, equivalent conductance and molar conductance of electrolytic solutions. Influence of temperature and dilution on weak electrolytes.

### *3. Electrode potential*

Electrode potentials, Nernst Equation, reference electrodes: normal hydrogen electrode and calomel electrodes, Emf of electrochemical cells and its measurement, electrode potential series and its applications.

### *4. Solutions of non-electrolytes*

Colligative properties of solution, Raoult's Law, relative lowering of vapor pressure, osmosis and osmotic pressure; elevation of boiling point and depression of freezing point of solvents.

## PRACTICAL

COURSE CODE: CH 262 CREDITS: 2

### *1. Qualitative Analysis of Inorganic Mixtures*

Experiments A: Preliminary Tests for Acid and Basic radicals in given samples.

Experiments B: Wet tests for Acid and Basic radicals in given samples.

Experiments C: Confirmatory tests.

Acid Radicals: $Cl^-$, $Br^-$, $I^-$, $NO_2^{-1}$, $S^{2-}$, $SO_4^{-2}$, $PO_4^{-3}$, $BO_3^{3-}$, $H_3BO_3$.

Basic Radicals: $Na^+$, $K^+$, $Ca^{+2}$, $Sr^{+2}$, $Ba^{+2}$, $Cr^{+2}$, $Mn^{+2}$, $Fe^{+3}$, $Ni^{+2}$, $Cu^{+2}$, $NH_4^+$.

Note: At least 6 unknown samples are to be analyzed by each student during the laboratory session.