St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC "A^{++}" Grade

Course structure and syllabus of

B.Sc.

CHEMISTRY

Under NEP Regulations, 2021

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ST ALOYSIUS COLLEGE(AUTONOMOUS)
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Re-accredited by NAAC with 'A' Grade with CGPA 3.62/4
Recognised by UGC as "College with Potential for Excellence"
Conferred "College with "STAR STATUS" by DBT, Government of India.
Centre for Research Capacity Building under UGC-STRIDE

Date:

NOTIFICATION

Sub: Syllabus of **B.Sc. CHEMISTRY** under NEP Regulations, 2021.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No: 6.19 (2021-22)
2. Decision of the Academic Council meeting held on 09-07-2022 vide Agenda No:
3. Decision of the Academic Council meeting held on 25-02-2023 vide Agenda No:
4. Office Notification dated 21-02-2022
5. Office Notification dated 17-082022
6. Office Notification dated

Pursuant to the above, the Syllabus of **B.Sc. CHEMISTRY** under NEP Regulations, 2021 which was approved by the Academic Council at its meeting held on 18-12-2021 & 09-07-2022 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL

ST ALOYSIUS COLLEGE MANGALORE 575 003 AUTONOMOUS

REGISTRAR

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

A meeting of the Board of Study in UG CHEMISTRY was held on 20.11.2021

Following members were present for the meeting.

1. Dr Ronald Nazareth (Chairman)
2. Prof Jagadish Prasad
3. Dr Vishwanatha P
4. Ms Helen Serrao
5. Dr Richard Gonsalves
6. Dr Nandini Shet
7. Dr Ashwini
8. Dr Rachael Natasha Mary
9. Ms Deepa Vasanth
10. Ms Sahana
11. Ms Divya Deepthi
12. Ms Crystal Menezes
13. Dr Laveena Dsouza
14. Ms Apeksha – Student representative

MEMBERS OF BOARD OF STUDIES

Chairman

Dr Ronald Nazareth, St Aloysius College (Autonomous), Mangaluru - 575 003.

University Nominee

Prof Jagadish Prasad D, Department of Chemistry, Mangalore University, Mangalagangothri.

Meritorious Alumnus

Dr Manoj Mathews, Department of PG studies and Research in Chemistry, St. Joseph's College (Autonomous), Devagiri, Kozhikode, Kerala – 673 008.

Representative from Industry/corporate sector/Allied area

Ms Meghana, Integrated Product Development, Dr Reddy's Laboratories Limited, Telangana State.

Subject Experts

***Dr Vishwanatha P*,** Associate Professor and Head, Department of Chemistry, SDM College (Autonomous), Ujire – 574 240.

Mrs Helen Serrao, Department of Chemistry, St Agnes College (Autonomous), Mangaluru – 575 002.

Members of the Department

Dr Richard A Gonsalves, St Aloysius College (Autonomous), Mangaluru

Dr Nandini Shet, St Aloysius College (Autonomous), Mangaluru

Dr Ashwini, St Aloysius College (Autonomous), Mangaluru

Dr Rachael Natash Mary, St Aloysius College (Autonomous), Mangaluru

Ms Deepa Vasanth, St Aloysius College (Autonomous), Mangaluru

Ms Sahana, St Aloysius College (Autonomous), Mangaluru

Ms Divya Deepthi Monteiro St Aloysius College (Autonomous), Mangaluru

Dr Roshan F D'Souza, St Aloysius College (Autonomous), Mangaluru

Ms Crystal Vivita Menezes, St Aloysius College (Autonomous), Mangaluru

Dr Laveena DSouza, St. Aloysius College (Autonomous), Mangaluru

Student Representative

Ms Mahima Rodrigues, II B.Sc, St Aloysius College (Autonomous), Mangaluru

A meeting of the Board of Study in UG CHEMISTRY was held on 22.02.2023

Following members were present for the meeting.

Chairman

Dr Ronald Aquin Nazareth, St Aloysius College (Autonomous), Mangaluru-575003.

University Nominee

Dr Mahagundappa R Maddani, Assistant Professor, Department of Chemistry Mangalore University Mangalagangothri -574199

Meritorious Alumnus

Mr Manoj Mathew, Assistant Professor, Research & PG Dept of Chemistry, St Josephs College (Autonomous), Devagiri, Kozhikode, Kerala-673008

Representative from Industry/ Corporate sector/ Allied area

Mr Reon Sylvester , Aragen Life Sciences Pvt Ltd, Survey No. 125 & 126, IDA Mallapur Hyderabad 500 076, India.

Subject Experts

Dr Edwin D'Souza, Assistant Professor, St Philomena College, Puttur

Dr A Chitharanjan Hegde, Professor, Department of Chemistry, NITK, Surathkal.

Members of the Department

Dr Richard Gonsalves, St Aloysius College (Autonomous), Mangaluru

Dr Nandini Shet, St Aloysius College (Autonomous), Mangaluru

Dr Ashwini, St Aloysius College (Autonomous), Mangaluru

Dr Rachael Natasha Mary, St Aloysius College (Autonomous), Mangaluru

Ms Deepa Vasanth, St Aloysius College (Autonomous), Mangaluru

Ms Sahana, St Aloysius College (Autonomous), Mangaluru

Dr Ranjitha , St Aloysius College (Autonomous), Mangaluru

Ms Divya Deepthi Monteiro, St Aloysius College (Autonomous), Mangaluru

Dr Roshan Fedrick D'Souza, St Aloysius College (Autonomous), Mangaluru

Ms Vilisha Rodrigues, St Aloysius College (Autonomous), Mangaluru

Dr Laveena Precilla D'Souza, St Aloysius College (Autonomous), Mangaluru

Ms Meghana, St Aloysius College (Autonomous), Mangaluru

Student Representative

Mr Glen Philip Sequeira, II Bsc, St Aloysius College (Autonomous), Mangaluru

STRUCTURE UNDER NEP

Course Code	Title of the course	Category of course	Teaching hours per week	ESE	CIA	Total Marks	Credits
SEMESTER I							
G 502 DC1.1	ANALYTICAL AND ORGANIC CHEMISTRY- I	DSC	4	60	40	100	4
G 502 DC2.1P	ANALYTICAL AND ORGANIC CHEMISTRY PRACTICALS-I	DSC	4	25	25	50	2
G 502 OE1.1	CHEMISTRY IN DAILY LIFE	-	3	60	40	100	3
SEMESTER II							
G 502 DC1.2	INORGANIC AND PHYSICAL CHEMISTRY-I	DSC	4	60	40	100	4
G 502 DC2.2P	INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-I	DSC	4	25	25	50	2
G 502 OE1.2	MOLECULES OF LIFE	-	3	60	40	100	3
SEMESTER III							
G 502 DC1.3	ANALYTICAL AND ORGANIC CHEMISTRY- II	DSC	4	60	40	100	4
G 502 DC2.3P	ANALYTICAL AND ORGANIC CHEMISTRY PRACTICALS-II	DSC	4	25	25	50	2
G 502 OE1.3	STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY	-	3	60	40	100	3
SEMESTER IV							
G 502 DC 1.4	INORGANIC AND PHYSICAL CHEMISTRY-II	DSC	4	60	40	100	4
G 502 DC 2.4P	INORGANIC AND PHYSICAL	DSC	4	25	25	50	2

	CHEMISTRY PRACTICALS-II						
G 502 OE1.4	ELECTROCHEMISTRY, CORROSION AND METALLURGY	-	3	60	40	100	3
SEMESTER V							
G 502 DC1.5	INORGANIC AND PHYSICAL CHEMISTRY-III	DSC	4	60	40	100	4
G 502 DC2.5P	INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-III	DSC	4	25	25	50	2
G 502 DC3.5	ORGANIC CHEMISTRY AND SPECTROSCOPY-I	DSC	4	60	40	100	4
G 502 DC4.5P	ORGANIC CHEMISTRY PRACTICALS	DSC	4	25	25	50	2
SEMESTER VI							
G 502 DC1.6	INORGANIC AND PHYSICAL CHEMISTRY-IV	DSC	4	60	40	100	4
G 502 DC2.6P	INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-IV	DSC	4	25	25	50	2
G 502 DC3.6	ORGANIC CHEMISTRY AND SPECTROSCOPY-II	DSC	4	60	40	100	4
G 502 DC4.6P	ORGANIC CHEMISTRY PRACTICALS	DSC	4	25	25	50	2

PATTERN OF THEORY QUESTION PAPERS

- Question Papers shall consist of Parts A, B and C
- The Syllabus of each paper shall be grouped into four (4) units.
- The question papers shall consist of Parts A, B and C containing questions drawn from each unit.
- Part A shall contain eight short answer type questions carrying 1 mark each drawn from each unit of the syllabus. All questions are to be answered.
- Part B shall contain ten questions carrying 3 marks each drawn from each unit of the syllabus. Eight questions are to be answered.
- Part C shall contain nine questions carrying 4 marks each drawn from each unit. Seven questions are to be answered.

Curriculum Structure for the Undergraduate Degree Program

BSc Chemistry (Discipline Specific Core)

Name of the Degree Program: B.Sc. **Discipline: Chemistry**

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships *etc*.

Semester	Title /Name Of the course	Assessment
1	**DSC-1: Analytical and Organic Chemistry-I**	Internal Exams, Continuous Evaluation, Sem Exams
	DSC lab-1: Analytical and Organic Chemistry Practicals-I	Internal Exams, Continuous Evaluation, Sem Exams
2	**DSC-2: Inorganic and Physical Chemistry-I**	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -2: Inorganic and Physical Chemistry Practicals-I	Internal Exams, Continuous Evaluation, Sem Exams
3	**DSC-3: Analytical and Organic Chemistry-II**	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-3: Analytical and Organic Chemistry Practicals-II	Internal Exams, Continuous Evaluation, Sem Exams
4	**DSC-4: Inorganic and Physical Chemistry-II**	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-4: Inorganic and Physical Chemistry Practicals-II	Internal Exams, Continuous Evaluation, Sem Exams
5	**DSC-5: Inorganic and Physical Chemistry-III**	Internal Exams, Continuous Evaluation, Sem Exams

	DSC Lab-5: Inorganic and Physical Chemistry Practicals- III	Internal Exams, Continuous Evaluation, Sem Exams
	DSC-6: Organic Chemistry and spectroscopy-I	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -6: Organic Chemistry Practicals	Internal Exams, Continuous Evaluation, Sem Exams
6	**DSC -7: Inorganic and Physical Chemistry-IV**	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-7: Inorganic and Physical Chemistry Practicals- IV	Internal Exams, Continuous Evaluation, Sem Exams
	DSC-8: Organic Chemistry and Spectroscopy-II	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -8: Organic Chemistry Practicals	Internal Exams, Continuous Evaluation, Sem Exams

COURSE CONTENTS

FIRST SEMESTER	
DSC-1: ANALYTICAL AND ORGANIC CHEMISTRY- I	**56 Hours**
UNIT I	
Introduction to Analytical Chemistry	2 h
Errors in Quantitative Analysis	3 h
Basic Laboratory practices	3 h
General Purification Techniques	6 h
UNIT II	
Titrimetric Analysis	10 h
Gravimetric Analysis	4 h
UNIT III	
Nature of bonding in Organic Molecules	4 h
Mechanism of organic reactions	2 h
Reactive Intermediates	4 h
Carbon-Carbon pi bonds	4 h
UNIT IV	
Dienes	4 h
Nucleophilic substitution at saturated carbon	4 h
Aromatic Electrophilic substitution reaction	3 h
Aromatic Nucleophilic substitution reaction	3 h
DSC LAB-1: ANALYTICAL AND ORGANIC CHEMISTRY PRACTICALS-I	
SECOND SEMESTER	
DSC-2: INORGANIC AND PHYSICAL CHEMISTRY-I	**56 Hours**
Unit I	
Quantum Mechanics- I	14 h
UNIT II	
Chemistry of s block elements	8 h
Chemistry of p block elements	6 h
UNIT III	
Gaseous state	8 h
Liquid state	6 h

UNIT IV	
Liquid Crystals	4 h
Solid state	10 h
DSC LAB - 2: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-I	
THIRD SEMESTER	
DSC-3: ANALYTICAL AND ORGANIC CHEMISTRY- II	**56 Hours**
Unit I	
Quantitative Analysis- Instrumental Methods	8 h
Flame Photometry	2 h
Nephelometry and Turbidimetry	4 h
Unit II	
Separation Methods: Chromatography	10 h
Solvent Extraction	4 h
Unit III	
Polynuclear Aromatic Hydrocarbons	4 h
Reaction intermediates	7 h
Methods for Identifying reaction mechanism	3 h
Unit IV	
Stereochemistry of Organic Compounds	14 h
DSC LAB-3: ANALYTICAL AND ORGANIC CHEMISTRY PRACTICALS-II	
FOURTH SEMESTER	
DSC-4: INORGANIC AND PHYSICAL CHEMISTRY-II	**56 Hours**
Unit I	
Structure and Bonding I	3 h
Classification of Ionic structures	7 h
Covalent Bond	4 h
Unit II	
Structure and Bonding II	3 h
Molecular Orbital Theory	7 h
Metallic Bonding	4 h
Unit III	
First law of Thermodynamics	4 h
Second law of Thermodynamics	4 h

Third law of Thermodynamics	2 h
Surface Chemistry	4 h
Unit IV	
Chemical Kinetics	7 h
Electrochemistry I	7 h
DSC LAB - 4: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-II	
FIFTH SEMESTER	
DSC-5: INORGANIC AND PHYSICAL CHEMISTRY-III	**56 Hours**
UNIT I	
Chemistry of *d*-block and *f*-block	7 h
Chemical bonding	7 h
UNIT II	
Coordination compounds	10 h
HSAB concept	4 h
UNIT III	
Dilute Solutions and Colligative Properties	6 h
Electrochemistry II	8 h
UNIT IV	
Nuclear Chemistry	6 h
Quantum mechanics -II	8 h
DSC LAB-5: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-III	
DSC-6: ORGANIC CHEMISTRY AND SPECTROSCOPY	**56 Hours**
Unit I	
Heterocyclic compounds	14 h
UNIT II	
Carbohydrates	8 h
Amino acids and peptides	6 h
UNIT III	
Molecular spectroscopy	2 h
Rotational spectroscopy	4 h
Vibrational spectroscopy	5 h
Raman spectroscopy	3 h
UNIT IV	

Nuclear Magnetic Resonance (NMR) spectroscopy	8 h
UV spectroscopy	6 h
DSC LAB - 6: ORGANIC CHEMISTRY PRACTICALS	
SIXTH SEMESTER	
DSC -7: INORGANIC AND PHYSICAL CHEMISTRY-IV	**56 Hours**
UNIT I	
Metal-Ligand equilibria in solution	10 h
Bioinorganic Chemistry	4 h
Unit II	
Electronic spectra of coordination compounds	12 h
Magnetic properties of coordination compounds	2 h
UNIT III	
Binary Mixtures	4 h
Phase Equilibrium	5 h
Thermo-analytical methods	5 h
UNIT IV	
Radiation Chemistry	6 h
Chemical Dynamics II	8 h
DSC LAB-7: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-IV	
DSC -8: ORGANIC CHEMISTRY AND SPECTROSCOPY	**56 Hours**
Unit I	
Aromatic Substitution Reactions	7 h
Vitamins	7 h
UNIT II	
Addition reactions	4 h
Rearrangements	5 h
Synthetic Polymers	5 h
UNIT III	
Symmetry and Group Theory in Chemistry:	6 h
Photochemistry	8 h
UNIT IV	
Photoelectron Spectroscopy	3 h
Electron Paramagnetic Resonance Spectroscopy	8 h

Atomic Absorption Spectroscopy	3 h
DSC LAB 8: ORGANIC CHEMISTRY PRACTICALS	

FIFTH SEMESTER

Course Title: **DSC-5: INORGANIC AND PHYSICAL CHEMISTRY-III**	
Course Code: **G 502 DC1.5**	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment Marks: 40	Duration of ESA/Exam: 2.5 hrs
Summative Assessment Marks: 60	

DSC-5: INORGANIC AND PHYSICAL CHEMISTRY

Course Outcomes: At the end of the course the student should be able to,

CO 1: Understand the general characteristics of transition elements, oxidation states, colour and magnetic property.

CO 2: Expose the students to new theories of chemical bonding.

CO 3: Know the applications of HSAB concept.

CO 4: Define magnetic behaviour of different metal complexes and explain geometry of the complex based on magnetic moment data.

CO 5: Learn the IUPAC nomenclature and theories of coordination compounds.

CO 6: Learn Nuclear reactions and their applications.

CO 7: Understand quantum mechanical concepts and Schrodinger wave equation and its solutions.

UNIT I

Chemistry of *d*-block and *f*-block Elements **7 Hrs**

Definition, transition elements four series of *d* block elements, general electronic configuration; Position in the periodic table. General characteristic properties - metallic character, ionisation energy, oxidation state, reducing property, colour, catalytic property and complexability. Magnetic property – expression for magnetic moment - spin only formula μ_s, calculation of μ_s for 3*d* series elements, Lande's calculation of theoretical magnetic moment. μ_{s+L}, comparison of magnetic moment μ_s and μ_{s+L} with

experimental value of μ. Comparative study of 4*d* and 5*d* elements with 3*d* elements - ionic radii, oxidation states, magnetic behaviour.

Lanthanides - Occurrence, properties - electronic state, oxidation state, ionic radii; lanthanide contraction, causes and consequences. complex formation, colour and magnetic properties. separation of Lanthanides by ion exchange method. Actinides - general features, electronic configuration, oxidation state, ionic radii, colour of ions, and formation of complex.

Chemical bonding **7 Hrs**

VSEPR model, shapes of molecules-ClF_3, ICl_4-, TeF_5-, I_3-, $TeCl_62$-, XeF_6, IF_7, Bent rules and energetics of hybridization; electronegativity and partial ionic character; Bonds-Multicenter, Synergic and Agostic bonding. Molecular orbital theory: MO diagrams of heteronuclear diatomic (CO, HF, ICl) molecules.

M-M bond and metal atom clusters, halide clusters, bonding in $[Re_2Cl_8]^2$.

UNIT II

Coordination Compounds **10 Hrs**

Nomenclature including bridging ligands; Isomerism in coordination compounds - ionization isomerism, hydrate isomerism, coordinate isomerism, linkage isomerism. Geometrical isomerism and optical isomerism (coordination numbers 4 and 6). Effective atomic number calculations, stability of complexes and factors affecting stability of complexes. Postulates of Valence Bond Theory (VBT); Examples for sp^3, dsp^2, dsp^3, d^2sp^3 and sp^3d^2 hybridization - $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[Cu(NH_3)_4]^{2+}$, $[Fe(CO)_5]$, $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$. Explanation for magnetic properties. Limitations of VBT. Crystal field theory (CFT) - important concepts of CFT, Crystal field splitting in octahedral and tetrahedral; crystal field stabilization energy (CFSE). Calculation of CFSE; weak and strong field ligands, Factors affecting the crystal field splitting. Limitations of CFT. Distortion of octahedral complex, Ligand Field Theory, MO theory: tetrahedral and octahedral complexes (including *p*- bonding), angular overlap model.

HSAB Concept **4 Hrs**

Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications of HSAB concept; Acid- base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3COOH.

UNIT III

Dilute Solutions and Colligative Properties **6 Hrs**

Ideal and non-ideal solutions - thermodynamic properties (ΔG, ΔH and ΔS) of ideal solutions, Activity and Activity coefficients, colligative properties – Definition and an elementary account of the four colligative properties. Raoult's Law of relative lowering of vapour pressure. Osmosis - Laws of osmotic pressure.

Elevation in boiling point and depression in freezing point. Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental determination of molecular weight by Walker-Lumsden method and Beckmann's method. van't Hoff factor, Abnormal molar mass, Degree of dissociation and association of solutes. Problems.

Electrochemistry II **8 Hrs**

Galvanic cells. Reference electrodes, Calomel, Quinhydrone, Ag-AgCl and glass electrode (Construction, Electrode reaction, Nernst equation), E.M.F. of cells and its measurements by potentiometric method, calculation of electrode potential, computation of cell EMF, relation between ΔG° and K for cell reaction, calculations, Concentration cells; electrolyte concentration cells with/without transport, liquid junction potential, calculations. Applications of concentration cells: Determination of (a) valency of ions, (b) solubility product.

Application of E.M.F. measurements: (a) Potentiometric titrations (acid- base and redox), (b) Determination of pH using hydrogen electrode, Quinhydrone electrode and Glass electrode by potentiometric methods.

UNIT IV

Nuclear Chemistry **6 Hrs**

Nuclear Reactions. Difference between nuclear and chemical reactions. Natural radioactivity, characteristics of alpha, beta and gamma rays. Group Displacement Law;

decay constant; Half-life period, Artificial transmutation of elements, Artificial radioactivity, Nuclear fission, Nuclear fusion, Carbon-14 dating. Problems.

The atomic nucleus-elementary particles, quarks, classification of nuclides based on Z and N values, nuclear stability, nuclear potential, binding energy. Nuclear Model: Liquid drop model, Radioactivity, radioactive decay kinetics. Applications of radioactive isotopes. (Numerical problems to be worked out wherever necessary).

Quantum Mechanics **8 Hrs**

Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Algebra of operators, commutator operator. Eigen functions and eigen values. Solutions of Schrödinger wave equation for a particle in a three-dimensional box, particle in a ring. Quantum mechanical degeneracy, tunneling (no derivation).

Schrodinger equation to hydrogen atom in spherical polar coordinates (no derivation). Quantum numbers and their characteristics. Coupling of Angular momenta. Russell-Saunders and JJ-coupling, Term symbols.

References:

1. A Textbook of Inorganic Chemistry, Puri and Sharma 2000, 33rd Ed. (2017), Milestone Publishers.
2. Concise Inorganic Chemistry, J. D. Lee, 5th Ed. (1999), Blackwell Science Ltd.
3. Essentials of nuclear chemistry, 4th edition; H. J. Arniker, NAIL publishers (1995); Chapters 1, 3 and 4.
4. Advanced Inorganic Chemistry, 6th edition; F. A. Cotton and G. Wilkinson.
5. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
6. Principles of Physical Chemistry- puri, Sharma and Pathania. Vishal Publishing Company.
7. Essentials of Physical Chemistry, bahl, Bahl and Tuli, S Chand and Company pvt Ltd.
8. Electrochemistry, Principles and applications, Edmund, C. Potter, Cleaver-Hume press London(1961).
9. Principles and applications of Electrochemistry- D. R. Crow 3rd edition Chapmanhall London (1988).

DSC LAB-5: INORGANIC CHEMISTRY PRACTICALS

Course Title: **DSC LAB-5: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-III**	
Course Code: **G 502 DC2.5P**	
Total Contact Hours: 4 hrs /week	Course Credits: 2
Formative Assessment Marks: 25	Duration of ESA/Exam: 4 hrs
Summative Assessment Marks: 25	

Inorganic Chemistry Practical

I- Preparation of inorganic complexes:

1. Preparation of tetraamminecopper(II) sulphate
2. Preparation of sodium tri(oxalato)ferrate(III).
3. Preparation of hexamminecobalt(III) chloride.
4. Preparation of pentaamminechlorocobalt(III) chloride.

II. Quantitative Estimation:

1. Estimation of Cu(II) using sodium thiosulphate solution (Iodimetrically).
2. Analysis of gun metal.
3. Analysis of Haematite.
4. Estimation of manganese in pyrolusite by volumetric method.
5. Estimation of nickel using EDTA and standard zinc sulphate.
6. Volumetric estimation of Ca and Mg in Dolomite solution.
7. Volumetric estimation of Ni in Ni and Fe mixture.
8. Determination of iron and Ni in a mixture.

Physical Chemistry Practical

Chemical kinetics:

1. Study the hydrolysis of methyl acetate in presence of two different concentrations of HCl and report the relative strength.
2. Study the hydrolysis of methyl acetate in the presence of HCl at different temperatures and report the energy of activation.
3. Study of variation of viscosity of a liquid with temperature, determine the

constant A and B.

4. Catalytic decomposition of H_2O_2

Conductometric titrations

1. Acid mixture *versus* NaOH.
2. Weak acid (CH_3COOH) with salt ($CuSO_4$) versus NaOH.
3. Strong acid (HCl) with salt (NH_4Cl) versus NaOH.

Course Title: **DSC-6: ORGANIC CHEMISTRY AND SPECTROSCOPY -I**	
Course Code: **G 502 DC3.5**	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment Marks: 40	Duration of ESA/Exam: 2.5 hrs
Summative Assessment Marks: 60	

Course Outcomes:

At the end of the course the student should be able to,

CO 1: Predict mechanism of electrophilic substitution reactions in heterocyclic compounds.

CO2: Compare the basicity of heterocyclic compound containing nitrogen.

CO3: Learn conformations and configurations of carbohydrates

CO4: To understand the structure and reactivity of amino acids.

CO 5: To gain knowledge of molecular-vibrational, rotational and Raman spectroscopy.

CO 6: To study the theory and applications of NMR and UV spectroscopy.

UNIT I

Heterocyclic Compounds **14 Hrs**

Introduction: Types and nomenclature, aromatic character of pyrrole, furan, thiophene. Comparison of aromaticity of these compounds. Methods of synthesis of pyrrole (Paal-Knorr, from acetylene), furan (Paal-Knorr, Feist-Benary), thiophene (Paal-Knorr, from Furan) and pyridine (Hantzsch, from acetylene). Electrophilic substitution reactions (nitration, sulfonation, halogenations, Friedel Craft's reaction). Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six- numbered heterocycles. Preparation of indole (Fischer Indole synthesis) and quinoline (Skraup synthesis), electrophilic substitution reactions of indole and quinoline (nitration, sulfonation, halogenation, Friedel-Crafts reaction). Introduction to heterocycles containing two hetero atoms: synthesis of pyrazole (from 1,3 dicarbonyl compounds), imidazole (from α-haloketone and amidine), oxazole (Robinson Gabriel synthesis),

thiazole (Gabriel synthesis), electrophilic substitution reactions of pyrazole, imidazole, oxazole, thiazole.

UNIT II

Carbohydrates **8 Hrs**

Classification. Monosaccharides: interconversions of glucose and fructose, chain lengthening of aldoses (Kiliani-Fischer method), Chain shortening (Ruff degradation); Conversion of glucose and mannose – epimerisation; Reduction, reaction with hydroxylamine, and semicarbazide; osazone formation – Mechanism; Amadori rearrangement; Formation of glycosides, ethers (methyl), esters (acetates). Configuration of glucose; Lobry de Bruyn-van Ekenstein rearrangement. Determination of ring size of monosaccharides (methylation and periodic acid method). Mechanism of mutarotation**.**

Amino acids and Peptides **6 Hrs**

Amino acids: Classification, structure and stereochemistry of amino acids, Acid–base behaviour, isoelectric point and electrophoresis – explanation. Preparation of α-amino acids from α-halogenated acids, from ethyl malonate; Strecker synthesis, Koops synthesis and Gabriel synthesis. Reactions due to -COOH groups – with bases, esterification and reduction. Reactions due to NH_2 groups – with acid, acylation, nitrous acid, DNFB. Action of heat.

Classification and nomenclature of peptides. Edmanmethods of sequencing. Cleavage of peptide bond by chemical and enzymatic methods. Protection of amino group and carboxyl group as alkyl and aryl esters. Coupling of protected amino acids.

UNIT III

Molecular Spectroscopy – I **2 Hrs**

Interaction of electromagnetic radiation with molecules and various types of spectra; Born - Oppenheimer approximation (Physical meaning only. No mathematical derivation).

Rotation spectroscopy **4 Hrs**

Rigid rotor and non-rigid rotor; expression for moment of inertia of diatomic molecule (No derivation), Selection rules, Frequency and wavenumber of lines in the rotational spectra. Intensity of rotational spectral lines (explanation by taking population of energy level and degeneracy only elementary account). Isotopic effect - explanation by taking ^{12}CO and ^{13}CO, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy **5 Hrs**

Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, Hooke's law, Energy levels of a simple harmonic oscillator, selection rules, anharmonicity, Morse potential, dissociation energies. Fundamental frequencies, overtones, hot bands, Applications of IR - calculation of moment of inertia, bond length, force constant, and dissociation energy, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Raman Spectroscopy **3 Hrs**

Qualitative treatment of Rotational Raman effect; effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference.

UNIT – IV

Nuclear Magnetic Resonance (NMR) Spectroscopy **8 Hrs**

Introduction, origin of spectra, instrumentation of PMR spectrometer, TMS as internal standard, solvents used, number of signals for simple organic molecule, area of signals. Chemical shift and factors affecting chemical shift (Inductive, anisotropic, hydrogen bonding). Nuclear shielding and deshielding, Spin-spin splitting, coupling constants. Interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane and ethyl acetate.

UV Spectroscopy **6 Hrs**

Types of electronic transitions, λ_{max}, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} for the following systems: α,β-unsaturated aldehydes, ketones,

carboxylic acids and esters; conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems (aldehydes, ketones and dienes).

References:

1. Organic Chemistry, S. M. Mukherji, S. P. Singh, R. K. Kapoor, R. Dass (2017), New Age Publications.
2. Organic Chemistry, Paula Y. Bruice, 8th Ed. (2016), Pearson Education Publishers.
3. Advanced Organic Chemistry, Arun Bahl, B. S. Bahl, 5th Ed (2012), S. Chand
4. Organic Chemistry, R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, 7th Ed. (2010), Pearson Education India.
5. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
6. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000).
7. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed.Tata McGraw-Hill:New Delhi (2006).
8. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
9. Kemp, W. Organic Spectroscopy, Palgrave.

DSC LAB-6: ORGANIC CHEMISTRY PRACTICALS

Course Title: **DSC LAB -6: ORGANIC CHEMISTRY PRACTICALS**	
Course Code: **G 502 DC4.5P**	
Total Contact Hours: 4 hours/week	Course Credits: 2
Formative Assessment Marks: 25	Duration of ESA/Exam: 4 hrs
Summative Assessment Marks: 25	

I- Preparation (one stage)

1. Synthesis of *p*-iodonitrobenzene from *p*-nitro aniline
2. Synthesis of benzoic acid from benzaldehyde
3. Synthesis of 7-hydroxy 4-methyl coumarin
4. Oxidation of cyclohexanol (to adipic acid)

5. Preparation of *S*- Benzylisothiuronium chloride
6. Preparation of *p*-nitroacetanilide from acetanilide
7. Synthesis of *p*-nitroaniline from *p*-nitroacetanilide
8. Preparation of 2,4,6-tribromoaniline.
9. Synthesis of N-phenyl-2,4-dintroaniline

Quantitative Analysis

1. Estimation of amino acids
2. Saponification value of oil
3. Estimation of sugars
4. Estimation of Phenols
5. Iodine value of oil (chloramine-T method)

SIXTH SEMESTER

Course Title: **DSC -7: INORGANIC AND PHYSICAL CHEMISTRY-IV**	
Course Code: **G502 DC1.6**	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment Marks: 40	Duration of ESA/Exam: 2.5 hrs
Summative Assessment Marks: 60	

Course Outcomes:

At the end of the course the student should be able to,

CO1: Be aware of the kinetics, stability, electronic spectra and types of bonding in complex compounds.

CO2: Know the importance of essential elements in the biological system.

CO3: Explain the basic definitions and terms in a phase diagram.

CO4: Learn the applications of radioisotopes.

CO5: Understand the applications of thermo-analytical methods.

CO6: Study the mechanisms of thermal and photochemical reactions.

UNIT I

Metal-Ligand equilibria in solution **10 Hrs**

Kinetic and thermodynamic stability of metal complexes, stepwise and overall formation constant and their relationship, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect, macrocyclic effect and their thermodynamic origin. Spectrophotometric determination of stability constant. Substitution reaction in square planar complexes, trans effect. macrocyclic effect and their thermodynamic origin.

Bioinorganic Chemistry **4 Hrs**

Essential and trace elements in the biological processes. Metalloporphyrins with reference to haemoglobin and Myoglobin, skeletal structure and functions. Explanation for cooperativity effect and Bohr effect. Biological role of some important metals- Ca^{+2},

Mg^{+2}, Na^{+}, K^{+}, Fe^{+2}, Cu^{+}, Zn^{+2}. Mechanism of $Na+/K^{+}$ pump. Effect of excess intake of metals.

UNIT II

Electronic spectra of transition metal complexes **12 Hrs**

Introduction, microstates and microstate table for p^2 and d^2, types of electronic transitions, Spectroscopic ground states, selection rules, term symbols for d^n ions, Racah parameter, Orgel, Tanabe-Sugano diagrams of d^1 d^2 and d^6 system, spectra of 3d metal-aqua complexes of trivalent V, Cr, Co and Ni, calculation of Dq, B and ß parameters, CT spectra.

Magnetic Properties of coordination compounds **2 Hrs**

Classification of magnetic materials, magnetic susceptibility, and its determination by Gouy method.

UNIT III

Binary Mixtures **3 Hrs**

Ideal liquid mixtures - Raoult's law, Vapour pressure *vs* composition (mole-fraction) curves. Azeotropes - HCl-H_2O and Ethanol-Water system; Fractional distillation, partially miscible liquids - phenol-water, triethanol-water and nicotine-water systems. Lower and upper consolute temperature; Effect of impurity on consolute temperature. Immiscible liquids – steam distillation.

Phase Equilibrium **6 Hrs**

Phase rule - statement (mathematical expression) and meaning of the terms. Explanation for the terms phase, component and degrees of freedom with suitable examples for each. Derivation of phase rule from thermodynamic consideration. Explanation of phase equilibria of one component system (water and sulphur system) using phase diagram. Two component system - classification with examples, simple eutectic system (lead-silver system) - phase diagram and explanation, desilverisation of lead (Pattinson's process). Compound formation with incongruent melting point (NaCl + water system) - phase diagram and explanation. Solid solutions - compound formation with congruent melting point (Mg-Zn system) phase diagram and explanation. Freezing mixtures (acetone-dry ice). Solid solution formation.

Thermo-analytical methods **5 Hrs**

TGA - Principle, instrumentation, types of thermo balances; Deflection and null type; Factors affecting TGA curves – rate of heating and furnace atmosphere; Determination of composition of a compound with example of $CaC_2O_4.H_2O$; Quantitative applications – evaluation of suitable standard, testing of sample purity, study of organic compound, drying and ignition temperature. Qualitative application – determination of curie point. DTG – Advantages over TGA; Significance of DTG curves. DTA - Principle, Factors affecting DTA curves – rate of heating and furnace atmosphere (N_2 and O_2) with example of $CaC_2O_4.H_2O$; Simultaneous TGA and DTA curves; interpretation of DTA curve; applications. DSC – Principle, types – power compensated and heat flux; Advantages of DSC over TGA; applications.

UNIT IV

Radiation Chemistry **6 Hrs**

Introduction. Radiation sources and units. Radiation dosimetry, dosimeter. Radiolysis of water (using gamma rays), radiolysis of gases and liquids. Application of radioisotopes in the study of organic reaction mechanism. Industrial applications.

Chemical Dynamics II **8 Hrs**

Concept of Steady state kinetics, Chain reactions - chain length and chain inhibition, comparison of photochemical and thermal reactions, mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. comparative study of thermal and photochemical hydrogen- halogen reactions. pyrolysis of acetaldehyde, decomposition of ethane.

Kinetics of Fast reactions: Introduction, study of reactions by relaxation methods (temperature and pressure jump) Flow method (Plug flow method and stopped flow method), Flash Photolysis and Shock tube method.

References:

1. Textbook of Physical Chemistry, P. L. Soni, O. P. Dharmarha and U. N. Dash, 2016, Sultan Chand & Sons.
2. Atkin's Physical Chemistry, Peter Atkins & Julio de Paula, Indian Edition 2006, Oxford Publication.
3. Chemical Kinetics- K. J. Laidler, McGraw Hill. Inc. New York (1988).
4. Concise Inorganic Chemistry, J. D. Lee, 5th Ed. (1999), Blackwell Science Ltd.
5. Physical Chemistry- P. Atkins and J. D. Paula, 9th Edn., Oxford University Press (2010).
6. Nuclear and Radioactive chemistry; Friedlander, Kennedy and Miller; Chapters 8 and 9.

DSC LAB-7: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS

Course Title: **DSC LAB-7: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-IV**	
Course Code: **G502 DC2.6P**	
Total Contact Hours: 4 hrs/week	Course Credits: 2
Formative Assessment Marks: 25	Duration of ESA/Exam: 4 hrs
Summative Assessment Marks: 25	

Inorganic Chemistry Practicals:

Semi micro qualitative analysis of mixtures containing two anions, two common cations and one less familiar element: W, Mo, Ce, Th, Zr, V, U and Li (any 5 combinations)

Physical Chemistry Practicals

1. The percentage of NaCl present in water - phenol system.
2. Determination of composition of a binary liquid mixture (alcohol & toluene) by Refractometry.
3. The molecular weight of a non - volatile solute by Walker - Lumsden method.
4. Determination of degree of dissociation of an electrolyte by ebullioscopic method.

Conductometric Experiments

1. Precipitation titration: conductometric titration of lithium sulphate versus $BaCl_2$.
2. Conductometric titration of weak acid versus weak base.

Potentiometric titration

1. $K_2Cr_2O_7$ versus FAS.
2. Weak acid versus NaOH
3. Determination of single electrode potential of M^{2+}/M and estimate the given unknown concentration (Zn^{+2}/Zn, Cu^{+2}/Cu)
4. Titration of weak acid against a strong base using quinhydrone electrode and calculation of pKa and Ka of the weak acid.

Course Title: **DSC -8: ORGANIC CHEMISTRY AND SPECTROSCOPY-II**	
Course Code: **G502 DC3.6**	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment Marks: 40	Duration of ESA/Exam: 2.5 hrs
Summative Assessment Marks: 60	

Course Outcomes:

At the end of the course the student should be able to,

CO1: Understand the mechanism of nucleophilic substitution reactions and addition reactions with suitable examples.

CO2: Know the importance and synthesis of vitamins.

CO3: Study mechanism of rearrangement reactions.

CO4: Learn the basics of symmetry and group theory.

CO5: Learn different photochemical processes.

CO6: Learn principles and applications of atomic absorption spectroscopy.

UNIT I

Aromatic Substitution Reactions **7 Hrs**

Electrophilic Substitution Reactions: sulfonylation reactions; Diazonium coupling, Vilsmeier-Haack reaction, Gatterman reaction.

Nucleophilic substitution reaction: Goldberg reaction, Bucherer reaction, Schiemann reaction.

Vitamins **7 Hrs**

Definition, classification with example and their importance. Synthesis of Vitamins A, Vitamin B1 (thiamine), Vitamin B6 (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α-tocopherol), Vitamin H (biotin), Vitamins K1 and K2.

UNIT II

Addition Reactions **4 hrs**

Addition to carbon-heteroatom multiple bonds: Addition of Grignard reagents and organolithium reagents to carbonyl compounds and unsaturated carbonyl compounds.

Wittig, Mannich and Stobbe reactions.

Rearrangement reactions: 5 Hrs

Wagner-Meerwein, Fries, Wolff, Hofmann, Lossen, Schmidt, Benzil-benzilic acid, Favorskii and Baker-Venkatraman rearrangement.

Synthetic Polymers: 5 Hrs

Introduction, addition polymerisation – mechanism of free radical, cationic and anionic, Ziegler-Natta Catalyst. Condensation polymerisation-manufacture and applications of polyesters (Dacron), polyamides (nylon6, nylon 6,6) phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers (neoprene, SBR, BUNA N), Vulcanisation.

UNIT III

Symmetry and Group Theory in Chemistry 6 Hrs

Definition of groups, subgroups, simple theorems in group theory. Symmetry elements and symmetry operations, point groups, Schöenflies notations, representations of groups by matrices, reducible and irreducible representations, character tables, Great Orthogonality Theorem (without proof) and its applications.

Photochemistry 8 Hrs

Interaction of radiation matter; Differences between thermal and photochemical reactions. Laws of photochemistry: Grothus-Draper law, Stark - Einstein law, primary and secondary reactions, Quantum yield - reasons for low and high quantum yield, Examples for high quantum yield with explanation (decomposition of HI, combination H_2 and Cl_2 reaction), Examples for low quantum yield with explanation (combination of H_2 and Br_2). Photosensitized reactions with examples - Photosynthesis in plants, dissociation of H_2, Isomerization of 2-butene and butadiene. Photo-physical processes - Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Types of fluorescence-sensitized and resonance fluorescence (examples), explanation of phosphorescence with examples. Chemiluminescence. Norrish type I and type II reaction.

UNIT IV

Photoelectron Spectroscopy **3 Hrs**

Principle, valence and core binding energies, shifts in energies due to chemical forces, photoelectron spectra of simple molecules.

Electron Paramagnetic Resonance Spectroscopy **8 Hrs**

Electron Paramagnetic Resonance (EPR) Spectroscopy: Basic principles, selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zero field splitting and Kramer's degeneracy, rules for interpreting spectra, factors affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, coordination compounds.

Atomic Absorption Spectroscopy **3 Hrs**

Atomic absorption, atomic emission, and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

References:

1. Elementary Organic Spectroscopy, Y. R. Sharma, 5th Ed. (2013), S. Chand Publication.
2. Fundamentals of Molecular Spectroscopy, C. N. Banwell, E. McCash, 4th Ed. (1994), Tata McGraw-Hill.
3. Spectrometric Identification of Organic Compounds, R. M. Silverstein, F. X. Webster, D. J. Kiemle, 8th Ed (2014), John Wiley & Sons.
4. New Trends in Green Chemistry, V.K. Ahluwalia, M. Kidwai (2004), Springer Science.
5. Organic Chemistry of Natural Products (Vol - I and II), Gurudeep R. Chatwal, M. Arora, (2009), Himalaya Publishing House.
6. Biopolymers, R.M. Johnson, L.Y. Mwaikambo and N. Tucker (2010).

7. Handbook of Bioplastics & Biocomposites for Engineering Applications, Srikanth Pilla (2011), John Pillai & Sons.
8. Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee., 3rd Ed. (2017), New Age Publishers.
9. Group Theory and Symmetry in Chemistry, Gurudeep Raj, A. Bhagi, V. Jain (2017), Krishna Prakashan Media Ltd.
10. Chemical Applications of Group Theory, F. A. Cotton, 3rd Ed (2008), Wiley.

DSC LAB-8: ORGANIC CHEMISTRY PRACTICALS

Course Title: **DSC LAB -8: ORGANIC CHEMISTRY PRACTICALS**	
Course Code: **G502 DC 4.6P**	
Total Contact Hours: 4 hrs/ week	Course Credits: 2
Formative Assessment Marks: 25	Duration of ESA/Exam: 4 hrs
Summative Assessment Marks: 25	

Organic Chemistry Practicals

I Preparation of Organic Compounds (Two and three step) and characterization by IR spectroscopy.

1. 2,4-Dinitrophenylhydrazine from chloronitrobenzene.
2. Anthranilic acid from phthalic acid.
3. Benzanilide from benzophenone.
4. Benzilic acid from benzoin.
5. Synthesis of acridone.

II Qualitative analysis

Systematic analysis and identification of organic compounds:

1. *p*-nitrobenzoic acid 2. *p*-nitrophenol 3. anthranilic acid
4. *o*-chloroaniline 5. *p*-nitroaniline 6. *p*-nitrobenzaldehyde

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