

College of Computer, Science & Information Technology - Junagadh

AFFILIATED TO BHAKTA KAVI NARSINH MEHTA UNIVERSITY



◆ Syllabus ◆

Bachelor of Science

in

[CHEMISTRY]

[Semester – V & VI]

Academic Year : 2020 – 21

(Effective from June – 2020)



◀ C.C.S.I.T. - JUNAGADH ▶

Green City, Bypass Road, Nr. Chobari Railway Crossing, Junagadh.

Website : <http://ccsit.co.in>, Email : ccsit_junagadh@yahoo.co.in

Phone : 92280 06940, 79906 61530

(SEMESTER-V)					
Subject code	Subject Name	Credit	Int. Marks	Ext. Marks	Total Marks
C-501	Inorganic & Industrial Chemistry	4	30	70 (14x5)	100
C-502	Organic Chemistry & Spectroscopy	4	30	70 (14x5)	100
C-503	Physical & Analytical Chemistry	4	30	70 (14x5)	100
C-504	Chemistry Practical's	6	45	105	150
Total Credits		18	Total Marks		450

(SEMESTER-VI)					
Subject code	Subject Name	Credit	Int. Marks	Ext. Marks	Total Marks
C-601	Inorganic & Industrial Chemistry	4	30	70 (14x5)	100
C-602	Organic Chemistry & Spectroscopy	4	30	70 (14x5)	100
C-603	Physical & Analytical Chemistry	4	30	70 (14x5)	100
C-604	Chemistry Practical's	6	45	105	150
C-605	Chemistry Project & Viva	4		100	100
Total Credits		18	Total Marks		550

General Instructions:

1. Time duration of each theory paper will be of Two and Half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be five questions.
4. All questions are compulsory.

Instructions to the candidates for Practical Examination:-

1. Practical Exam. would be conducted for 1 ½ days, All the students have to remain present at the examination center 15 minutes before the scheduled time for examination.
2. Students have to carry with them certified Journal, I - card, Examination Receipt, and other necessary requirements for examination.
3. Student should not leave the laboratory without the permission of examiner.
4. Use of calculator is allowed but the use of mobile phones is strictly prohibited.
5. The candidate has to leave the laboratory only after the submission of all the answer sheets of the exercises performed.

Syllabus of B.Sc.(Chemistry) Semester – V

C – 501 : INORGANIC AND INDUSTRIAL CHEMISTRY

Unit - I

Chapter - 1 : Metal π - Complexes

[12 Hours]

- Metal carbonyls:
- Definition, preparation, physical and chemical properties,
- Classification of metal carbonyls,
- Nature of M-CO bond based on Molecular orbital model (with spectral support), Types of CO groups, (Terminal, doubly bridge, triply bridge and semi-bridge)
- Application of IR spectroscopy for

- (i) Determination of geometry of complex
- (ii) Determination of bond order
- (iii) Detection of terminal and bridging CO groups
- Structure of
 - (i) Ni(CO)₄
 - (ii) Fe(CO)₅
 - (iii) Fe₂(CO)₉
 - (iv) Fe₃(CO)₁₂
 - (v) Mn₂(CO)₁₀
 - (vi) Co₂(CO)₈
- 18-electron rule and Effective atomic number (EAN), calculation of metal-metal bond, number of metal and number of ligand if the complex follow 18 electrons rule,
- Only structure, number of bridge and non-bridge carbonyl in Co₂(CO)₈, Ru₂(CO)₉, Os₂(CO)₉, Ru₃(CO)₁₂, Os₃(CO)₁₂, Co₄(CO)₁₂, Rh₄(CO)₁₂, Ir₄(CO)₁₂, Rh₆(CO)₁₆.
- **Metal nitrosyls:** Definition, preparation, physical and chemical properties, Complex compounds having simple NO ligand (neutral), Linear (NO⁺) and Bent (NO⁻), terminal M-NO bonding, bridging NO groups, IR study of metal nitrosyls.

Chapter - 2 : Wave Mechanics

[8 Hours]

- Basic concepts, Operators algebra (addition, subtraction, multiplication), commutative property, linear operator, commutation operator, the operator DEL & DEL SQUERED, momentum operator, Hamiltonian operator,
- Particle in one dimensional box; Wave equation and energy related to a particle moving in one dimensional box, Energy levels and interpretation of energy equation,
- Normalization and orthogonally of wave function,
- Particle in three dimensional box; Derivation of normalized wave equation,
- Energy related with it,
- Degeneracy,
- Example based on energy of 1s orbital, normalization, orthogonally, particle in one and three dimensional box and degeneracy.

Unit-II

Chapter - 3 : Fertilizers

[12 Hours]

- Introduction, Plant nutrients and its role, Classification and Properties of fertilizers, Nitrogenous fertilizers
- Ammonium nitrate:
 - (i) Manufacture by Prilling method
 - (ii) Manufacture by Stengel method
- Ammonium Sulphate: Manufacture from gypsum (Sindri Process) & Action as fertilizer
- Urea:
 - (i) Manufacture from Ammonium carbide
 - (ii) Manufacture by Sindri process & Action as fertilizer
- Calcium cyanamide:
 - (i) Manufacture & Action as fertilizer
- Phosphate fertilizer
 - (i) Manufacture of Normal super phosphate
 - (ii) Manufacture of Triple super phosphate
- Ammonium Phosphate:
 - (i) Manufacture of Mono ammonium phosphate
 - (ii) Manufacture of Diammonium phosphate
- Potassium fertilizer: Potassium chloride, Potassium sulphate and Potassium nitrate.
- NPK fertilizer
- Nomenclature

Chapter - 4 : Cement

[8 Hours]

- Introduction, Type of cement,
- Raw material for manufacture,
- Cement rock beneficiation.
- Manufacturing Processes of Portland cement,
- Setting and Hardening of Portland cement,
- Properties and uses of cement,
- Indian Standard Institute (ISI) specification of cement,

- Mortar and concrete, curing and Decay of concrete,
- RCC and its advantage,
- Uses of cement

Unit-III

Chapter - 5 : Crystal field Theory – I

[10 hours]

- Introduction, Ligands, Concept of crystal field theory, splitting of d-orbitals in octahedral and tetrahedral complex with CFSE concept,
- Weak and strong field ligands,
- High spin and low spin complexes with pairing energy, Calculation of CFSE,
- Factors affecting on splitting energy,
- Magnetic behavior of transition metal complexes, (Equation for calculation of magnetic moment for d & f block elements)
- Orbital angular momentum contribution in magnetic momentum of various crystal fields,
- Application of magnetic momentum to determine the structure of the complexes with limitation,
- Example based on CFSE, Pairing energy and Magnetic momentum.

Chapter - 6 : Glass

[5 Hours]

- Introduction,
- Physical and chemical properties of glass,
- Raw materials for manufacturing of glass,
- Chemical reaction involved in manufacturing of glass,
- Manufacture process; formation of batch materials, melting, shaping, annealing and finishing,
- Types and uses of glass (high silica glass, fused silica glass, pyrex glass, photochromic glass, photosensitive glass, optical glass, lead glass, borosilicate glass, wool glass, rare earth glass, insulating glass, vitreosil glass, jena glass)

Chapter - 7 : Oils and Fats

[05 Hours]

- Introduction, Properties of oil and fats, Classification,
- Manufacture of Cotton seed oil:
 - (i) Solvent extraction method
 - (ii) Expression method
- Hydrogenation of oil:
 - (i) Optimum condition for the hydrogenation process
 - (ii) Preparation of Nickel catalyst,
- Process for hydrogenation of oil:
 - (i) Dry process
 - (ii) Wet process,
- Analysis of oil and fats:
 - (i) Saponification value
 - (ii) Acid value
 - (iii) Iodine value (WIJS method) (iv) Reichert – Meissl value.

Reference books:

1. UGC Inorganic Chemistry - H. C. Khera (Pragati Prakashan)
2. Inorganic Chemistry - J. N. Gurtu & H. C. Khera
3. Principles of Inorganic chemistry- B. R. Puri, L. R. Sharma and K. C. Kalia; Vallabh publications, Delhi.
4. Concise Inorganic Chemistry - J. D. Lee
5. Basic Inorganic Chemistry – Gurdeep & Chatwal
6. Advanced Inorganic Chemistry - Raymond Chang
7. Advanced Inorganic Chemistry- Cotton and Wilkinson
8. Co-ordination Chemistry - Banerjee
9. Quantum Chemistry by A. K. Chandra
10. Basic Concept of Quantum Chemistry by R. K. Prasad.
11. Physical Chemistry: A Molecular approach by McQuarrie
12. Reigel's Handbook of Industrial Chemistry by James A. Kent
13. Engineering Chemistry by Jain and Jain
14. Industrial Chemistry by B.K. Sharma

C – 502 : ORGANIC CHEMISTRY AND SPECTROSCOPY

Unit - I

Chapter - 1 : Amino acids, Peptides and Proteins [12 Hours]

- Introduction, Classification of amino acids name and formula
- Synthesis of amino acids by:
 - (i) Amination of α -haloacids
 - (ii) Gabriel phthalimide synthesis
 - (iii) Erlenmeyer azlactone synthesis
 - (iv) Hydantoin method
- Physical properties of amino acids, Chemical properties of amino acids, Isoelectric point
- Introduction to Polypeptides, Synthesis of Polypeptides by:
 - (i) Bergmann Method
 - (ii) Sheehan's Method (use of Phthaloyl group)
 - (iii) Fischer's Method (use of p-toluenesulphonylchloride)
- Introduction and classification of proteins,
- Constitution of Thyroxine, Synthesis of Thyroxine

Chapter - 2 : Sweetening agents [02 hours]

- Introduction,
- Synthesis and applications of Saccharin, p-anisylurea and dulcin.

Chapter - 3 : Stereochemistry [06 Hours]

- Difference between Asymmetric-Dissymmetric, enantiomers-diastereomers, Resolution- racemic modification, Anomers-epimers,
- Stereochemistry of compounds with 1 and 2 asymmetric carbon atoms and R, S nomenclature
- Conformations of cyclohexane: Explanations of various Conformations and energy level diagram
- Conformations of Methyl cyclohexane.

Unit- II

Chapter - 4 Molecular Symmetry [11 hours]

- Introduction,
- Symmetry element and symmetry operations with illustrations,
- Concept and properties of group,
- Products of symmetry operation,
- Symmetry point group [C_1 , C_s , C_i , C_n , C_{nv} , D_n , D_{nh} , D_{nd} , C_v , $D_{\infty h}$, T_d , O_h],
- Group multiplication tables for C_{2v} , C_{3v} and C_{2h} point groups.
- Order(h) of point groups: Definition & Determination.

Chapter - 5 Alkaloids [06 hours]

- Introduction,
- Occurrence,
- Classification and Isolation,
- General method of proving structure of alkaloids,
- Constitution, Properties and synthesis of
 - (i) Coniine (ii) Nicotine (iii) Papaverine

Chapter - 6 Name reactions, Rearrangements and Reagent [03 Hours]

- **Reactions:**
 - (i) Arndt Eistert reaction
 - (ii) Bischler Napieralski reaction
- **Rearrangements:**
 - (i) Curtius rearrangement
 - (ii) Benzil Benzilic acid rearrangement
- **Reagent:**

- (i) Lithium Aluminium hydride LiAlH_4
- (ii) Sodamide

Unit - III

Chapter - 7 Synthesis & use of Drugs and Dyes

[04 Hours]

- **Drugs:**
 - Definition,
 - Introduction to methods of classification,
 - Synthesis and applications of Ibuprofen, Atenolol and Adrenaline
- **Dyes:**
 - Definition,
 - Introduction to methods of classification,
 - Synthesis and applications of Orange II, Crysodine G, Auramine O

Chapter - 8 Nuclear Magnetic Resonance Spectroscopy

[12 Hours]

- Introduction: Principle; Magnetic properties-nuclear quantum number and orientation of magnetic moments of nuclei.
- Number of signals: Equivalent and non-equivalent protons with illustrations; enantiotopic and diastereotopic protons;
- Position of the signal: Shielding and deshielding of protons; Internal standard, chemical shift and factors affecting it; Magnetic anisotropic effect with examples;
- Intensity of signals: Peak area and number of protons
- Splitting of the signals: Spin-spin coupling, Theory of splitting (formation of doublet, triplet, quartet)
- Coupling constant; Geminal and Vicinal coupling, Calculation of Coupling constant(J).
- Low temp NMR, Deuterium labeling;
- Complications and limitations of PMR
- Applications of PMR in Various bonding and structural analysis
- Applications in inorganic chemistry, Biological applications of NMR, MRI.
- Problems related to determination of structure of organic molecules from PMR spectral data.

Chapter - 9 Mass spectrometry

[04 Hours]

- Introduction,
- Basic principle,
- Instrumentation,
- General fragmentation modes,
- Important features for the mass spectra of alkanes (without problems)

Reference books:

1. Spectroscopy by H. Kaur, Pragati Prakashan
2. Spectroscopy of organic compounds by P. S. Kalsi 5th Edition
3. Spectrometric identification of organic compounds By Silverstrin Bassler (16th Editim)
4. Organic Chemistry of Natural Products by Gurudeep Chatwal Vol L
5. Organic Chemistry by Morrison and Boyd,
6. Stereochemistry, conformation and mechanism By P. S. Kalsi 7th edition.
7. Chemical Application of Group theory by F Albert Cotton.
8. Symmetry in chemistry by H. M. Jahe.
9. Molecular spectroscopy by B. K. Sharma.
10. Organic Chemistry by Clayden 2nd Edition
11. Name Reactions in Organic Synthesis by Dr. A.R.Parikh et. Al.
12. Organic Name reactions by Gautam Brahmachari.
13. Reactions and Rearrangements by Gurdeep Chatwal.
14. March's Advanced Organic Chemistry Reactions, Mechanism and Structure by Michael B Smith and Jerry March.
15. Organic Chemistry by I.L.Finar
16. Organic Name reactions by Gautam Brahmachari.
17. A Text Book of Organic Chemistry (II Edition) by Raj K. Bansal.
18. Medicinal Chemistry by Ashutoshkar.

C – 503 : PHYSICAL AND ANALYTICAL CHEMISTRY

Unit-I

Chapter – 1 : Second Law of Thermodynamics

[12 Hours]

- Limitations of first law of thermodynamics
- Spontaneous process
- Carnot cycle and theorem
- Statements of second law of thermodynamics
- Perpetual machine of second kind (briefly)
- Concept of entropy and Definition of entropy
- ΔS in reversible & irreversible (spontaneous) process
- ΔS in ideal gases
- ΔS of mixture of ideal gas
- ΔS in physical transformations and heating of the substance
- Entropy and second law of thermodynamics
- Physical significance of entropy
- Numerical based on theory

Chapter – 2 : Free Energy and Chemical Equilibrium

[8 Hours]

- Work function : Its physical significance and variation with V and T
- Free Energy: its significance and variation with P and T
- ΔG for ideal gases,
- Gibbs Helmholtz equation and its applications
- Criteria for chemical equilibrium (According to $\Delta G = \Delta H - T\Delta S$),
- Vant Hoff reaction isotherm (By equilibrium box and chemical potential method),
- Law of active mass,
- Vant Hoff isochore,
- Clausius - Clapeyron equation,
- Numerical based on theory

Unit-II

Chapter – 3 : Phase Rule

[4 Hours]

- Two components partially miscible liquid pairs (1) Maximum critical solution temperature (2) Minimum critical solution temperature (3) Maximum and Minimum critical solution temperature.
- Influence of impurity on critical solution temperature,
- Three component partially miscible liquid system,
- Method of graphical presentation,
- Types of partially miscible three liquid systems :
- One partially miscible pair: Effect of adding third component, Nature of tie line, Plait point, Binodal curve, Characteristics of diagram, A is added to binary system, A is constant and B and C varied.
- Formation of two pairs of partially miscible liquid,
- Formation of three pairs of partially miscible liquid,
- Application of ternary liquid diagram

Chapter – 4 : Electrochemistry – I

[8 Hours]

- Introduction,
- Conventional sign and representation of cell,
- Reversible cell and Irreversible cell,
- Types of reversible electrodes,
- Half-cell, standard half-cell,
- Measurement of emf,
- Standard cell,
- Standard electrode potential,
- Single electrode potential,
- Reference electrodes: (1) Primary reference electrode (2) Secondary reference electrodes (Calomel, Ag/AgCl and Hg/HgSO₄ electrodes),
- Applications of emf series,
- Calculation of single electrode potential,

- Determination of equilibrium constant,
- Determination of ΔG , ΔS and ΔH from emf of cell,
- Determination of solubility sparingly soluble salt,
- Numerical based on theory

Chapter – 5 : Conductometry

[8 Hours]

- Electric conductance in metals and in electrolyte solution,
- Terms: Conductance, Specific resistance, Specific conductance, Equivalent conductance,
- Relationship between specific conductance and equivalent conductance,
- Effect of dilution on conductance, specific conductance and equivalent conductance,
- Conductivity cell and platinization of electrodes,
- Determination of cell constant,
- Conductivity water,
- Kohlrausch's law,
- Conductometric Titration: Introduction and dilution correction,
- *Acid base titration*: Strong acid - strong base Strong acid - Weak base Weak acid – Strong base Mixture of strong acid + Weak acid - strong base,
- *Replacement Titration*: Salt of weak acid – strong acid Salt of weak base – strong base,
- *Precipitation Titration*: (1) $\text{AgNO}_3 - \text{NaCl}$ (2) $\text{BaCl}_2 - \text{K}_2\text{SO}_4$ (3) $\text{Ba}(\text{OH})_2 - \text{MgSO}_4$,
- Determination of Degree or hydrolysis and Hydrolysis constant,
- Determination of solubility and solubility product of sparingly soluble salt,
- Numerical based on theory

Unit-III

Chapter – 6 : Colourimetry

[4 Hours]

- Introduction,
- Definition of colourimeter,
- Explanation of terms: Transmittance and Absorbance (Optical Density),
- Laws of Colorimetry (Grotthus - Draper, Lambert, Beer and Lambert-Beer laws),
- Nature of Molar absorptivity and Absorbance,
- Deviation of Beer Law,
- Instrumentation: Radiation source, Filter, Slit, Cell, and Detectors name.
- Selection of filter,
- Application in quantitative analysis,
- Spectrophotometer, Spectrophotometric Titrations: Introduction, Apparatus (Cell), Technique, Dilution Correction,
- Types of Spectrophotometric Titrations,
- Advantages of Spectrophotometric titrations,
- Numerical based on theory

Chapter – 7 : Volumetric Analysis

[16 Hours]

- Primary and secondary standard solution.
- **Neutralization Titration with Graphs:**
- Ostwald theory of indicator,
- Strong acid - Strong base titration,
- Weak acid - Strong base titration,
- Strong acid – Weak base titration,
- Poly protic acid - Strong base titration,
- **Redox Titration:**
- Principle of internal indicator, external indicator $\text{K}_3[\text{Fe}(\text{CN})_6]$ and reagent itself as indicator.
- Redox Titration with graph and calculation,
- Iodometry and Iodimetry titration and starch as indicator,
- **Precipitation Titration:**
- Argentometric Titration, Determination of end point by
- (I) Mohr's method (II) Fajan's method (III) Volhard's method.
- **Complexometry Titration**
- EDTA
- Velcher's law explanation of pMEDTA Vol. graph with stability constant value.
- Types of EDTA titration (i) Direct, (ii) Back titration, (iii) Substitution titration (iv) Alklometry titration mixture with the help of masking and demasking agent.
- Principle of metal ion indicator, Use of EBT, calcon, murexide as indicator with structure and characteristics.

- Numerical based on the theory.

Reference Books:

1. Elements of Physical Chemistry by Samuel Glasstone and D. Lewis
2. Principles of Physical Chemistry by S.H. Maron and C. F. Prutton
3. Thermodynamics for Chemists by Samuel Glasstone
4. Elements of Physical Chemistry by B. R. Puri, L. R. Sharma, M. S. Pathania
5. Advanced Physical Chemistry by J. N. Gurtu
6. Physical Chemistry by N. Kundu and S. K. Jain
7. Physical Chemistry by K. L. Kapoor
8. Physical Chemistry by B. K. Sharma
9. Thermodynamics by Gurudeeep Raj
10. Introduction to Electrochemistry by S. Glasstone
11. Fundamental of Analytical Chemistry by Skoog and West
12. Instrumental Methods of Chemical Analysis by B. K. Sharma
13. Water Analysis and Water Pollution by V. P. Kudesia
14. Instrumental Method of Chemical Analysis by Chatwal Anand
15. Thin Layer Chromatography by Egal Stall
16. Book for Water Analysis by R. K. Trivedi, and V. P. Kudesia
17. Analytical Chemistry by Dick
18. A Textbook of Quantitative Inorganic Analysis by A. I. Vogel
19. Electrometric Methods of Analysis by Browning
20. Principle of Instrumental Methods of Analysis by Skoog.

C – 504 : CHEMISTRY PRACTICALS

1. Organic Separation (Mixture of two compounds) [30+5 marks]

[Minimum 12 mixtures should be done]

- Separation & Analysis of an organic mixture containing
- (a) Two solid components using water, NaHCO_3 , NaOH and HCl for separation
 - (b) Liquid + liquid component - separation by physical method.
 - (c) Liquid + solid component - separation by physical method.

2. Inorganic Volumetric Analysis [30 marks]

[Minimum 8 exercises should be done]

i. Iodometry and Iodimetry

- (a) Estimation of Cu^{+2} and $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ in the given $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ using 0.05N $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ solution.
- (b) Estimation of As^{+3} and As_2O_3 in the given As_2O_3 using 0.05N $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ solution.

ii. Complexometric titration:

1. Estimation of the amount of Ni^{+2} in the given $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ solution using 0.02 N EDTA solutions.
2. Estimation of the amount of Mg^{+2} and Pb^{+2} in the given solution containing a mixture of Mg^{+2} and Pb^{+2} using 0.02 N EDTA solution
3. Estimation of the amount of Ca^{+2} and Zn^{+2} in the given solution containing a mixture of Ca^{+2} and Zn^{+2} using 0.02 N EDTA solution
4. Estimation of the amount of Fe^{+3} and Cr^{+3} in the given solution containing a mixture of Fe^{+3} and Cr^{+3} using 0.02 N/ 0.01 M $\text{Pb}(\text{NO}_3)_2$ and 0.02 N/ 0.01 M EDTA solution.

iii. Redox titration

1. Determination of the amount of NO_2^- in the given NaNO_2 or KNO_2 solution by reduction method using 0.1 N KMnO_4 solutions.

iv. Water Analysis

1. To determine the amount of chloride in the given sample of water using 0.02 N AgNO_3

v. To determine the purity of NaHCO_3 in the given sample

3. Physicochemical Exercise [30 marks]

[Minimum 10 exercises should be done]

1. Conductometry

- i. To determine normality and gms/lit of xN HCl and also determine specific conductance by conductometry.
- ii. To determine normality and gms/lit of the mixture of $\text{HCl} + \text{CH}_3\text{COOH}$ by conductometry.

- iii. To determine the normality of weak acid by conductometry
- iv. To determine the concentration of Ni^{+2} using 0.1M EDTA solution.
- v. To determine the normality of xNAgNO_3 using 0.5N NaCl by Conductometry.

2. Thermodynamics:

- i. Calculate entropy of vaporization (ΔS_v) of a given liquid by plotting a graph of $\log (1/\text{time})$ vs $(1/\text{temperature})$

3. Refractometer

- i. To determine specific refractivity and molecular refractivity of given pure liquid A, B, C, D.
- ii. To determine specific refractivity and molecular refractivity of glycerine (10%, 5%, 2.5%) and unknown glycerine solution.

4. Viscosity

- i. To determine relative and absolute viscosity of pure liquid A, B, C, D by Ostwald's viscometer.
- ii. Preparation three different 10%, 5%, 2.5% aqueous solution of glycerine, find viscosity of these three solutions as well as unknown concentration solution with the help Ostwald's viscometer.

5. Colourimetry

- i. Find out the amount of Ni^{+2} in the given solution by colourimetry method.
- ii. Find out the amount of Fe^{+3} in the given solution by colourimetry method.

6. Polarimeter

- i. To determine specific rotation of three different concentration (10%, 5%, 2.5%) of dextrose solution. From graph find out the unknown.
- ii. Study the inversion rate of sugar in presence of 1N HCl and determine the rate of reaction.

7. Viva.

[5+5=10 marks]



B.Sc.(Chemistry) Semester – VI

C – 601 : INORGANIC AND INDUSTRIAL CHEMISTRY

Unit - I

Chapter - 1 Multi electron systems

[12 hours]

- Introduction,
- Quantum numbers,
- Types of coupling: s-s coupling, l-l coupling for p^2 , p^3 and d^2 electronic configuration with vector diagram, L-S coupling, j-j coupling,
- Concept of spectral terms and term symbols,
- Derivation of spectral term symbol for p^1 to p^6 & d^1 to d^9 ,
- Hund's rules for the determination of ground state spectral term,
- Derive ground state spectral term for p^2 and d^2 electronic configuration.
- Microstates: Definition and calculation of microstates for p^2 and d^2 electronic configuration,
- Hole pegen diagram of p^2 and d^1 electronic configuration,
- Example based on calculation of S, MS, L, ML, J and MJ.

Chapter - 2 Magneto chemistry

[08 Hours]

- Introduction,
- Basic terminology: Magnetic field, Magnetic pole-dipole, Intensity of magnetization, Magnetic induction, Magnetic Permeability, Magnetic susceptibility,
- Magnetic behavior; Paramagnetism, Diamagnetism, Ferro magnetism, Anti-ferro magnetism and ferri magnetism,
- Effect of temperature on magnetic behavior of substances,
- Equation for magnetic moment of diamagnetic and paramagnetic substances,
- Methods for determination of magnetic susceptibility (Gouy method), Determination of magnetic susceptibility by using standard substance,
- Application of magnetic susceptibility

Unit - II

Chapter - 3 Soaps and Detergents

[10 Hours]

- Introduction, Raw materials for manufacture
- Methods for manufacture of soap
 - (i) Batch process
 - (ii) Continuous process
- Types of soap: Toilet soap, transparent soap, shaving soap, Neem soap, Liquid soap
- Recovery of glycerin from spent lye,
- Introduction to detergents, Principal group of synthetic detergents, Bio-degradability of surfactants
- Classification of surface active agents,
- Anionic detergents,
- Manufacture of anionic detergents
 - (i) Oxo Process (ii) Alfol Process (iii) Welsh process
- Cationic detergents,
- Non - Ionic detergents, amphoteric detergents,
- Manufacturing of Shampoo

Chapter - 4 Environmental Chemistry

[10 Hours]

- Environment – definition and introduction, Segments of environment
 - (i) Atmosphere
 - (ii) Hydrosphere

- (iii) Lithosphere
- (iv) Biosphere,
- Air Pollution:
- Major sources of air pollution, Control of Air pollution,
- Green House Effect,
- Photochemical smog,
- CFC and ozone depletion,
- Acid rain, Sources and effects of NOX and SOX,
- Water pollution:
- Classification of water pollution
 - (i) Physical pollution
 - (ii) Chemical pollution
 - (iii) Biological pollution
 - (iv) Physiological pollution
- Sources of water pollution
 - (i) Sewage and domestic waste
 - (ii) Industrial effluents
 - (iii) Agricultural discharges
 - (iv) Fertilizers
 - (v) Toxic metals
 - (vi) Siltation
 - (vii) Thermal pollutions
 - (viii) Radioactive materials
- Water Pollution Control
- Dissolved Oxygen (D.O.) determination
- Chemical Oxygen Demand (C.O.D.) determination
- Biological Oxygen Demand (B.O.D.) determination

Unit - III

Chapter - 5 Crystal field theory - II

[10 hours]

- Jahn-Teller effect - Statement and explanation,
- Strong and weak Jahn-Teller distortion,
- Explanation of distorted tetrahedron structure due to Jahn-Teller effect with example,
- Splitting of d-orbitals in square planar complexes with examples,
- Hole formalism and Hole formalistic pair,
- Splitting of D and F ground terms (using hole formalism),
- Orgel Diagram of D and F states,
- Selection rules for d-d transition,
- Types of electronic transition in metal complexes,
- Absorption spectrum of Ti^{+3} , Cu^{+2} & Ni^{+2} .

Chapter - 6 Polymers

[10 Hours]

- Introduction, Classification of Polymers based on source, structure, molecular forces (Thermo plastic and thermosetting plastic) and modes of polymerization,
- Addition (Chain growth)- and condensation (Step growth) Polymerization, Type of addition Polymerization (i) Free Radical Polymerization (ii) Ionic Polymerization,
- Ziegler- Natta Polymerization, Stereo Chemistry of Polymer
- Co-polymerization (Buna-S), Natural rubber, Vulcanized rubber, synthetic rubber (Neoprene, Buna-N), Bio-degradable and non-bio degradable polymer, (Synthesis of PHBV & Nylon-2-nylon-6),
- Number average molecular weight and weight average molecular weight, Poly Dispersity Index (PDI), only the name of methods use for determination of molecular mass of polymers.
- Synthesis, properties and use of Nylon-6, Nylon-66, Terylene, Teflon, PAN, Bachelite, melamine.

Reference books:

1. UGC Inorganic Chemistry - H. C. Khera (Pragati Prakashan)
2. Inorganic Chemistry - J. N. Gurtu & H. C. Khera
3. Concise Inorganic Chemistry - J. D. Lee
4. Basic Inorganic Chemistry - Gurdeep & Chatwal
5. Advanced Inorganic Chemistry - Raymond Chang
6. Advanced Inorganic Chemistry- Cotton and Wilkinson
7. Co-ordination Chemistry - Banerjee
8. Magneto Chemistry by Shyamal & Datta
9. Reigel's Handbook of Industrial Chemistry by James A. Kent
10. Engineering Chemistry by Jain and Jain
11. Industrial Chemistry by B.K. Sharma
12. Environmental Chemistry by A.K. De
13. Environmental Chemistry by Sharma & Kaur
14. Environmental Solution of Analysis by S.M. Khopkar
15. Inorganic inductive analysis by Vogel and Gehani Parekh
16. A Text Book of Petrochemicals by Bhaskar Rao
17. Advanced Petrochemicals by Dr. G.N. Sarkar
18. Chemicals from Petrochemicals by A.L. Waddam

C – 602: ORGANIC CHEMISTRY AND SPECTROSCOPY

Unit-I

Chapter - 1 Heterocyclic Compounds**[06 hours]**

- Classification and nomenclature of mono heterocyclic compound based on size of ring
- Aromaticity in 5 membered (Furan, Thiophene and Pyrrole)
- Preparation of Furan, Thiophene, and Pyrrole
- Chemical Properties (Electrophilic Substitution Reaction) of Furan, Thiophene and Pyrrole
 - (i) Nitration
 - (ii) Sulphonation,
 - (iii) Acetylation,
 - (iv) Chlorination
 - (v) Reaction with Organometallic Compounds
- Aromaticity of Pyridine
- Basicity of Pyridine
- Relative basicity of Pyridine, Pyrrole and Aliphatic amines
- Preparation of Pyridine from acetylene, Hantzsch's synthesis
- Chemical Properties of Pyridine
 - (i) Electrophilic Substitution Reaction
 - (ii) Nucleophilic Substitution Reaction

Chapter - 2 Introduction to Pericyclic Reactions**[06 hours]**

- Definition of Pericyclic Reactions.
- Types of pericyclic reactions;
 - (i) Electrocyclic: 4π & 6π electron systems
 - (ii) Cycloaddition: $[2+2]$ & $[4+2]$ systems
 - (iii) Sigmatropic reactions: $[1,3]$, $[1,5]$ & $[3,3]$ Systems
- Thermal and photochemical pericyclic reactions.

Chapter - 3 Infrared Spectroscopy**[08 Hours]**

- Introduction, Principle, theory of IR, selection rules, Normal modes of vibrations,

intensity

- Factors influencing IR vibrations: Coupled vibrations, Fermi resonance, electronic effects, Bond angles, H-bond
- Stretching frequency calculation equation (only for interpretation of Mass and bond dependency of frequency)
- Instrumentation, interpretation of IR, Finger print region
- Group frequencies and its applications to Aliphatic and aromatic Hydrocarbons, alcohols phenols, carbonyl compounds, carboxylic acids and its derivatives, ethers, halogen compounds and compounds containing C-N, C-S, C-X linkages
- Application of IR in chemical analysis, chemical reactions, H-bonding, tautomerism, and stereochemistry General
- Applications to inorganic complexes, pharmaceutical analysis and other industrial applications.

Unit-II

Chapter - 4 Synthesis and uses of Explosive and Perfumes

[04 Hours]

- **Synthesis and uses of:**

(a) Explosives:

- (i) RDX (Research Department Explosive)
- (ii) TNT (Trinitrotoluene)
- (iii) PETN (Pentaerythritol tetranitrate)

(b) Perfumes:

- (i) Musk Xylene
- (ii) Musk Ketone
- (iii) Musk Ambrette

Chapter - 5 Terpenoids

[06 Hours]

- Introduction, Occurrence, Isolation, General characteristics of Terpenoids, Isoprene Rule, Constitution and Synthesis of:
 - (i) Citral
 - (ii) α -Terpineol

Chapter - 6 Polynuclear Aromatic Hydrocarbons

[05 Hours]

- Introduction, Classification of Polynuclear hydrocarbon, Synthesis and chemical properties:
 - (i) Biphenyl
 - (ii) Diphenyl methane
 - (iii) Naphthalene
 - (iv) Anthracene

Chapter - 7 Problem based on UV, IR and NMR Spectroscopy

[05 Hours]

Chapter - 8 Carbohydrates

[12 Hours]

- Introduction, classification and nomenclature, general reaction of monosaccharides (with reference to Glucose and Fructose)
- Inter-conversions:
 - (i) Conversion of Aldose to the corresponding ketose
 - (ii) Conversion of Aldose to the next higher Ketose (Wolfson method)
 - (iii) Conversion of Aldose to the Ketose having two more carbon atom (Sowden method)

- (iv) Conversion of Ketose to the corresponding Aldose
- Step-up reaction (Ascending in Aldose series)
 - (i) Kiliani reaction
 - (ii) Sowden nitromethane reaction
- Step-down reaction (Descending in Aldose series – Aldohexose to Aldopentose) by
- Ruff's method
- Configuration of monosaccharides
- Ring structure of Aldoses
- Determination of ring size of Glucose by
 - (i) Methylation method
 - (ii) Periodic oxidation method
- Mutarotation of D (+) glucose

Chapter - 9 Synthesis and use of Insecticides

[02 Hours]

- **Synthesis and uses of Insecticides;**
 - (i) Baygon (ii) Carbendazim (iii) Parathion

Chapter - 10 Ultraviolet and Visible Spectra

[06 Hours]

- Instrumentation,
- Types of transition in organic molecules,
- Auxochrome; chromophore;
- Explanation of bathochromic shift and hypsochromic shift; hyperchromic and hypochromic effects;
- Calculation of λ_{\max} of
 - (i) dienes and conjugated dienes;
 - (ii) enones and dienones
 - (iii) aromatic carbonyl system;
- Factor affecting UV spectral bands;
- Application of UV.

Reference books:

1. Spectroscopy by H. Kaur, Pragati Prakashan
2. Stereochemistry, conformation and mechanism By P. S. Kalsi 7th edition.
3. Spectrometric identification of organic compounds By Silverstrin Bassler (16th Editim)
4. Organic Chemistry of Natural Products by Gurudeep Chatwal Vol L
5. Organic Chemistry by Morrison and Boyd,
6. Spectroscopy of organic compounds by P. S. Kalsi
7. Chemical Application of Group theory by F Albert Cotton.
8. Symmetry in chemistry by H. M. Jahe.
9. Molecular spectroscopy by B. K. Sharma.
10. Organic Chemistry by Clayden Greeves and Warren 2nd Edition
11. Name Reactions in Organic Synthesis by Dr. A.R.Parikh et. Al.
12. Organic Name reactions by Gautam Brahmachari.
13. Reactions and Rearrangements by Gurdeep Chatwal.
14. March's Advanced Organic Chemistry Reactions, Mechanism and Structure by Michael B Smith and Jerry March.
15. Organic Chemistry by I.L.Finar
16. Organic Name reactions by Gautam Brahmachari.
17. A Text Book of Organic Chemistry (II Edition) by Raj K. Bansal.
18. Medicinal Chemistry by Ashutoshkar.
19. Spectroscopy of organic compounds by P. S. Kalsi 5th Edition

C – 603: PHYSICAL AND ANALYTICAL CHEMISTRY

Chapter - 1 Activity of Electrolytes

[08 Hours]

- Introduction to Ionic Activity,
- Derivation of $a_2 = a_+^{v+} a_-^{v-}$ and $a_2 = a_+ a_-$ for 1-1 electrolyte,
- Mean Activity a_{\pm} , its relation with a_+ and a_-
- Relationship between a_2 and a_{\pm} i.e. $a_2 = a_{\pm}^{\nu}$
- Mean ionic activity coefficient f_{\pm} and f_+ , f_-
- Ionic Strength: Definition, Explanation and Equation
- Debye Huckel Limiting Law equation (Without derivation):
- Derivation of $-\log f_{\pm} = A z_+ z_- \mu^{1/2}$
- Interpretation of Equation
- Graph of $-\log f_{\pm} \rightarrow \mu^{1/2}$ and its explanation / discussion
- Empirical correction of Debye Huckel Limiting Law for
- Size of ion and (2) Orientation of solvent molecules
- Methods to Determine Activity Coefficient:
- Solubility method (2) emf method
- Numerical based on theory.

Chapter - 2 Third law of Thermodynamics

[04 Hours]

- Introduction
- Nernst heat theorem
- Third law of thermodynamics
- Determination of absolute entropies of solids, liquids and gases
- Applications of third law of thermodynamics (ΔS^0 , ΔG^0 and equilibrium constant of chemical reaction),
- Tests of third law of thermodynamics,
- Residual entropy.

Chapter - 3 Partial Molar Properties

[04 Hours]

- Introduction
- Definition of partial molar property
- Concept of chemical potential
- Physical significance (properties) of chemical potential
- Derivation of Gibbs-Duhem equation
- Variation of chemical potential with temperature and pressure
- Determination of partial molar properties by method of intercept
- Applications of chemical potential (Henry's law, Rault's law and Nernst's distribution law)
- Numerical based on theory

Chapter - 4 Photochemistry

[04 Hours]

- Difference between thermal and photochemical reaction,
- Stark Einstein photochemical equivalent law,
- Primary and secondary (Isomeric change, Double decomposition and dissociation) reaction,
- Chemical actinometer,
- Quantum yield,
- Reasons of low and high quantum yield,
- Mechanism of some photochemical reactions:
 - (1) Reaction between hydrogen and chlorine
 - (2) Reaction between hydrogen and bromine
 - (3) Decomposition of HI

- (4) Decomposition of HBr
- (5) Dimerization of anthracene,
- Photosensitized reactions,
- Fluorescence, Phosphorescence and Chemiluminescence,
- Numerical based on theory.

Unit-II

Chapter - 5 Electrochemistry - 2

[10 Hours]

- Definition of Concentration cells
- Types of concentration cell:
- Electrode concentration cells
- Electrolyte concentration cells
- Concentration cells without transference
- Concentration cells with transference
- Liquid junction potential
- Elimination of liquid junction potential.
- Applications of emf measurements:
- Solubility of sparingly soluble salts
- Valency of metal ion
- Dissociation constant of weak acid
- Transport number of ion
- Ionic product of water
- Degree of hydrolysis
- Numerical based on theory.

Chapter - 6 Potentiometry and pH metry

[06 Hours]

- Introduction and interpretation of pH metry and potentiometry.
- Importance of indicator and reference electrode in the measurement of EMF and pH
- E.M.F. method:
- Study of acid-base Titration
- Redox Titration
- Argentometric titration include mixture of Cl^- , Br^- , I^- with graph and proper explanation.
- **pH metry :**
- Definition, Interpretation of various methods of determining pH value like pH paper method, potentiometric method using only hydrogen electrode as indicator electrode and calomel electrode as reference electrode to determine pH value
- Weak acid-strong base titration with curve and determination of dissociation constant (K_a) of weak acid.

Chapter - 7 Basic Principle of Qualitative Analysis

[04 Hours]

- Principle of Flame, Charcoal cavity and Borax bead tests,
- Separation of the following ions in presence of each other,

(i) Cl^- , Br^- and I^- ions (iii) S^{-2} , SO_3^{-2} and SO_4^{-2} ions (v) CO_3^{-2} , SO_3^{-2} and S^{-2} ions	(ii) NO_2^{-1} , NO_3^{-1} and Br^{-1} ions (iv) PO_4^{-3} , AsO_3^{-3} and AsO_4^{-3} (vi) Cu^{+2} and Cd^{+2} ions
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Unit-III

Chapter - 8 Error and Statistics

[08 Hours]

- Introduction,
- Types of errors, Determinate (Instrumental, Operative and Errors of method) and indeterminate errors; Additive and Proportional errors

- Gaussian (Normal Distribution) curve and its explanation
- Minimization of errors (Calibration of instruments, Blank measurement, Independent method, Parallel method and Standard addition method)
- Accuracy and precision,
- Absolute error and Relative error,
- Mean and Median
- Deviation, Relative mean deviation, Width (Range), Standard deviation, Variance and Coefficient of variance
- Explanation of Significant figure and its laws.
- F-test, Q - test and t -test (Student t-test)
- Numerical based on theory

Chapter - 9 Chromatography

[12 Hours]

- Introduction
- Classification of chromatography - types of chromatography
- Principle of Chromatography
- **Column chromatography:** Principle, Adsorbents, Preparation of column, Method, Separation of green leaf pigment,
- **Paper chromatography:** Introduction, Principle, Types of Paper Chromatography (Ascending and Descending, Two dimensional; Circular), Migration parameters (R_f value and R_x value), Spotting and Visualization. Separation of amino acids and metal ions (Fe⁺, Co⁺², Ni⁺²) mixture using spray reagent ninhydrine and aniline phthalate
- **TLC:** Introduction, Principle, Method of preparation of chromplate, Experimental techniques, Superiority of TLC over other chromatographic Techniques, Application of TLC.
- **Gas chromatography;** Introduction, Types, Principle of GLC and GSC, Instrumentation, Carrier gas and Solvent, Column and Detectors (Briefly), Advantages of gas chromatography
- **Ion Exchange chromatography:** Introduction, Definition and Principle, Type of resins, Properties of ion exchange resins, Factors affecting separation of ions, Ion exchange capacity, Applications (Removal of interfering ion, Softening of water, Demineralization of water, Separation of lanthanides)

Reference Books:

1. Elements of Physical Chemistry by Samuel Glasstone and D. Lewis
2. Principles of Physical Chemistry by S.H. Maron and C. F. Prutton
3. Thermodynamics for Chemists by Samuel Glasstone
4. Elements of Physical Chemistry by B. R. Puri, L. R. Sharma, M. S. Pathania
5. Advanced Physical Chemistry by J. N. Gurtu
6. Physical Chemistry by N. Kundu and S. K. Jain
7. Physical Chemistry by K. L. Kapoor
8. Physical Chemistry by B. K. Sharma
9. Thermodynamics by Gurudeeep Raj
10. Introduction to Electrochemistry by S. Glasstone
11. Fundamental of Analytical Chemistry by Skoog and West
12. Instrumental Methods of Chemical Analysis by B. K. Sharma
13. Instrumental Method of Chemical Analysis by Chatwal Anand
14. Thin Layer Chromatography by Egal Stall
15. Analytical Chemistry by Dick
16. Electrometric Methods of Analysis by Browning
17. Principle of Instrumental Methods of Analysis by Skoog

C – 604: CHEMISTRY PRACTICALS

[Practical Exam. would be conducted for 1 ½ days]

[Total Marks: 105 marks]

1. **Inorganic Qualitative Analysis (six radicals)** [30 marks]
To identify 3-positive and 3-Negative radicals from the given inorganic mixture containing total six radicals. *[Minimum 12 inorganic mixtures should be analyzed]*

2. **Organic Synthesis** [35 marks]
[Minimum 8 syntheses should be done]
(Percentage of yield, crystallization, melting point)
 - i. **Acetylation / Benzoylation**
 1. Acetylation of salicylic acid
 2. Acetylation of aniline
 3. Acetylation of phenol
 4. Benzoylation of aniline
 5. Benzoylation of phenol

 - ii. **Aliphatic Electrophilic substitution**
 1. Preparation of iodoform from ethanol
 2. Preparation of iodoform from acetone

 - iii. **Aromatic Electrophilic Substitution**

Nitration:

 1. Preparation of m-dinitrobenzene,
 2. Preparation of nitro acetanilide.

Halogenation:

 1. Preparation of p-bromo acetanilide,
 2. Preparation 2:4:6 -tribromo phenol

 - iv. **Diazotization / Coupling**
 1. Preparation of methyl orange
 2. Preparation of methyl red

 - v. **Oxidation**
 1. Preparation of benzoic acid from benzaldehyde

3. **Physicochemical Exercise** [30 marks]
[Minimum 10 exercises should be done]
 - i. **pH metry**
 1. To determine normality and gms/lit. of xN HCl by pH metry
 2. To determine normality and dissociation constant of weak acid (xNCH₃COOH) by pH metry.
 3. To determine normality and dissociation constant of dibasic acid (xN oxalic acid/malonic acid/maleic acid) using 0.1N NaOH solution.

 - ii. **Potentiometry**
 1. To determine normality and dissociation constant of benzoic acid used 0.1N NaOH.
 2. To determine normality of given acid xN HCl using NaOH solution.
 3. To determine concentration of xN FAS using K₂Cr₂O₇.
 4. To determine normality of each halide in the mixture using 0.1N AgNO₃ solution.

iii. Surface tension:

1. Find the surface tension of the liquids A, B and C by using drop weight method. Find the value of parachor of liquid and CH₂ group.
2. Comparison of cleansing power of various detergent powders.

iv. Chromatography

1. To determine R_f value of individual and mixture of amino acid by ascending paper chromatography.
2. To determine R_f value of individual and mixture of amino acid by circular paper chromatography.
3. To determine R_f value of individual and mixture of amino acid by thin layer chromatography (TLC).
4. To determine R_f value of individual and mixture of metal ions by ascending paper chromatography.
5. To determine R_f value of individual and mixture of metal ions by circular paper chromatography.

4. Viva.

[5+5=10 marks]

Note:

- Students are not allowed to use practical manual for first 45 minutes for Inorganic Qualitative Analysis (Prior to submission of Dry Test Result - Six Radicals).
- In case of Organic Preparation Exercise students must write reaction in first 10 minutes and get it assessed by concerned examiner before availing the practical book.
- For inorganic qualitative analysis, positive radicals may include alkali metal ions, alkaline earth metal ions but not the rare earth metal ions. The negative radicals may include all other ions including AsO₃³⁻, AsO₄³⁻, BO₃³⁻, Water insoluble PO₄³⁻ also but not oxide.
- The detail instructions related to practical exam and exercise will be given in Chemistry practical exam related materials which will be uploaded by BKNMU before the Practical exam schedule.

C – 605: CHEMISTRY PROJECT

[Project viva would be conducted with Practical examination in separate session of 3 hours]

Industrial Project Report

Or

Industrial Visit Report

➤ **Total Marks: 100 (50-Project report + 50 Presentations)**

➤ **Guidelines for project format and page setup:**

1. Project viva will be conducted by University deputed examiners only.
2. Font must be either Times New Roman or Arial.
3. Font size for normal typing must be 12.
4. Font size for headings must be bold and 14.
5. Line spacing must not be 1 - 1.5.
6. Project must have watermark as student name. For example if a student name is Animesh Chakravorty, Every page has water mark in centre as Animesh Chakravorty.
7. Project report must be submitted in 40 to 50 pages.
8. One project can be for maximum 20 students. For example if total students in B.Sc. Semester-6 is 100, there must be 5 different projects.
9. It must contain a certificate signed by student, project guide, and Principal.
10. It must have industrial visit certificate.
11. Student will have to prepare power point presentation of 5 to 10 minutes.