गोविन्द गुरू जनजातीय विश्वविद्यालय, बाँसवाड़ा

चयन आधारित क्रेडिट व्यवस्था की पाठ्यचर्या के अन्तर्गत अधिस्नातक पाठ्यक्रम

Choice Based Credit System (CBCS)

विषय नाम : **Chemistry**

प्रश्न पत्र सूची

प्रथम सेमेस्टर

क्रम	पेपर कोड	प्रकार	प्रश्न पत्र निर्धारण	पेपर नाम	क्रेडिट
1.		विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Inorganic Chemistry - I	4
2.		विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Organic Chemistry - I	4
3.		विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Physical Chemistry -I	4
4.		विषय विशिष्ट ऐच्छिक कोर्स (DSE)	1	Group theory and spectroscopy	4
5.		सामान्य ऐच्छिक कोर्स (GE)	1	Analytical Chemistry and inorganic spectroscopy	4
Total					20

Abbreviations

- DCC: Discipline Centric Compulsory
- DSE: Discipline-Specific Elective
- GE: Generic Elective
- OJT: On Job Training
- CEE: Community Enhancement Experience
- RCC: Research Centric Course
- DPR: Dissertation/Project/Field Report
- SEM: Course Seminar

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Choice Based Credit System (CBCS)

विषय नाम : **Chemistry**

प्रश्न पत्र सूची

द्वितीय सेमेस्टर

क्रम	पेपर कोड	प्रकार	प्रश्न पत्र निर्धारण	पेपर नाम	क्रेडिट
1.	CHY501	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Inorganic Chemistry - II	4
2.	CHY502	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Organic Chemistry - II	4
3.	CHY503	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Physical Chemistry - II	4
4.	CHY504	विषय विशिष्ट ऐच्छिक कोर्स (DSE)	1	Enviornment & Green Chemistry	4
5.	CHY505	सामान्य ऐच्छिक कोर्स (GE)	1	Superamolecular Chemistry	4
Total					20

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(Choice Based Credit System)

विषय नाम : Chemistry

प्रश्न पत्र सूची

तृतीय सेमेस्टर

क्रम	पेपरकोड	प्रकार	प्रश्न पत्र निर्धारण	पेपरनाम	क्रेडिट
1.	CHY601	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Inorganic Chemistry- III	4
2.	CHY602	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Organic Chemistry- III	4
3.	CHY603	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Modern Interface of Organic Chemistry	4
4.	CHY604	विषय विशिष्ट ऐच्छिक कोर्स (DSE)	1	Textile Chemistry	4
5.	CHY605	On-Job Experience (OJT) course or Community Engagement Experience (CEE)	1		4
Total					20

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(Choice Based Credit System)

विषय नाम : **Chemistry**

प्रश्न पत्र सूची

चतुर्थ सेमेस्टर

क्र. सं.	पेपरकोड	प्रकार	प्रश्न पत्र निर्धारण	पेपरनाम	क्रेडिट
1.	CHY701	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Photochemistry &Nano Chemistry	4
2.	CHY702	विषय केन्द्रित अनिवार्य कोर्स (DCC)	1	Special Methods of Analysis	4
3.	CHY703(Org) OR CHY703(Inorg)	विषय विशिष्ट ऐच्छिक कोर्स (DSE)	1	Heterocyclic and Natural Products or Inorganic Polymer (According to specialization)	4
4.	CHY704(Org) OR CHY704(Inorg)	सामान्य ऐच्छिक कोर्स (GE)	1	Organometallic Chemistry OR Advanced Photochemistry and Radiation Chemistry (According to specialization)	4
5.	CHY705	Dissertation/Project/Field Study (DPR) course, Internship or On-Job Experience (OJT) Or Course Seminar (SEM),Research Credit Courses (RCC)	1		4
Total					20

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- RCC: Research Centric Course
- DPR: Dissertation/Project/Field Report
- SEM: Course Seminar

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Two Year Post Graduate Course

Semester I

CHEMISTRY

DCC

Inorganic Chemistry - I

Unit-I

- VSEPR Theory of coordination compounds, Walsh diagrams (tri and penta-atomic molecules), dπ-pπ bonds, Bent rule and energetics of hybridization
- **Metal-Ligand Bonding:** Nephlauxetic effect, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.
- **Metal-Ligand Equilibria in Solution:** Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic orgin, determination of binary formation constants by pH- metry and spectrophotometry.

Unit-II

- **Reaction Mechanism of Transition Metal Complexes:** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage.
- Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, inner sphere type reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory.

Unit-III

- **Electronic Spectra and Magnetic Properties of Transition Metal Complexes:** Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), Calculations of Dq, B and ß parameters, charge transfer spectra, spectroscopic

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method of assignment of absolute configuration in optically active metal chelates and their stereo chemical information, anomalous magnetic, magnetic exchange coupling and spin crossover.

Books Recommended:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, ABP Lever, Elsevier
5. Magnetochemistry, R.L. Carlin, Springer Verlag

Inorganic Chemistry Laboratory-I

1 Qualitative analysis of Inorganic mixture– (minimum -6)

Qualitative analysis of inorganic mixture containing SIX radicals from the following list: (at least three from Group B)

Group A - Carbonate, Sulphite, Sulphate, Sulphide, Nitrite, Acetate, Oxalate, Nitrate, Chloride, Iodide, Phosphate, Fluoride, Borate, Silver, Lead Mercury, Bismuth, Copper, Cadmium, Tin, Arsenic, Antimony, Aluminium, Chromium, Iron, Nickel, Cobalt, Zinc, Manganese, Calcium, Barium, Strontium, Magnesium, Ammonium.

Group B - Thiosulphate, Cyanate, Thiocyanate, Hypochlorite, Chlorate, Percholrate, Iodate, Persulphate, Silicate, Chromate, Arsenate, Benzoate, Thalium, Tungsten, Molybdenum, Vanadium, Beryllium, Uranium, Thorium, Titanium, Zirconium, Cerium.

1 Gravimetry: Determination of unknown concentration of Barium, Lead, Copper, Nickel and Aluminium by gravimetric technique.
2 Paper Chromatography: Separation of metal complexes using paper chromatography.
3 Separation of colored and non-colored compounds by TLC.
4 Synthesis and purification of acetyl ferrocene by column chromatography and recording their absorption spectrum. Gravimetry: Determination of unknown concentration of Barium, Lead, Copper, Nickel andAluminium by gravimetric technique.
5 Paper Chromatography: Separation of metal complexes using paper chromatography.
6 Separation of colored and non-colored compounds by TLC.
7 Synthesis and purification of acetyl ferrocene by column chromatography and recording their absorption spectrum.
8 Determination of KCl concentration by ion exchange column chromatography.
9 Chemistry of Blue printing.
10 Compare the Δ^0 (cm^{-1}) value for three different ligands (H_2O, EDTA, en) of copper complex.

Assessment method: Based on experimental skill, Quiz and Viva.

Reference Books

1. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge University Press, 1970.
2. Vogel's Textbook of Quantitative Analysis, revised J. Bassett, R. C. Denney, G.H. Jefferyand J. Mendham, ELBS.
3. Advanced Experimental Inorganic Chemistry by V. K. Ahluwalia and Sunita Dhingra, Manakin Press, New Delhi.

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Semester I

CHEMISTRY

DCC

Organic Chemistry -1

Unit-I

- **Nature of bonding in organic molecules:** Delocalized chemical bonding-conjugation, cross conjugation, bonding in fullerenes, aromaticity in benzenoid and non-benzenoid compounds, annulenes, ferrocenes and helicenes, alternant and non-alternant hybrocarbons, Huckel's rule, energy level of II-molecular orbitals, anti-aromaticity, Homo-aromaticity.
- **Reaction mechanism, structure and reactivity** – A review of types of mechanism and reaction, Methods of determining mechanisms, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, potential energy diagrams, transition states and intermediates, Generation, Structure, Stability and reactivity of reactive intermediates, isotope effects, effect of structure on reactivity-resonance and field effects, steric effect, steric inhibition to resonance, substituent and reaction constants, Hammett and Taft equation.

Unit-II

Aliphatic reaction Mechanism:

(i) Nucleophilic substitution – The S_N2, S_N1, mixed S_N2 and S_N1, S_Ni and SET mechanisms, Neighboring group participation.

Classical and nonclassicalcarbocations, phenonium ions, norbornyl system, common carbocation, rearrangements, nucleophilic substitution aatallylic, trigonal and vinylic carbon, reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambient nucleophile, regioselectivity.

(ii) Electrophilic substitution – S_E2 and S_E1 mechanism, electrophilic substitution accompanied by double bond shift, effect of substrates, leaving group and the solvent polarity on reactivity.

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Aromatic reaction Mechanism:

(i) **Electrophilic substitution** – The arenium ion mechanism, orientation and reactivity, energy profile diagrams, the ortho/para ratio, ipso attack, orientation in other ring systems, diazonium coupling, Vilsmeir-Haak reaction, Bischler-Napieralski reaction, Pechmann reaction.

(ii) **Nucleophilic substitution** – The S_NAr, S_N1, benzyne and SR_N1 mechanisms, reactivity- effect of substrate structure, leaving group and attacking nucleophile. Von Richter, Sommelet- Hauser and Smiles rearrangements.

(iii) **Free radical reaction** – Types of free radical reactions, free raical substitution mechanism, neighboring group assistance, reactivity for aliphatic and aromatic substrate at a bridgehead, reactivity in the attaching radical, the effect of solvents on reactivity, allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sabdmeyer reaction, free radical rearrangement, Hunsdiecker reaction.

Unit-III

Addition Reaction

- **Carbon-Carbon multiple bonds-** Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, region and chemoselectivity, orientation and reactivity, addition to cyclopropane ring, hydrogenation of double bond, triple bonds and aromatic rings, hydroboration of double bond, triple bonds and aromatic rings, hydrobotation, Michael reaction.
- **Carbon-Hetero multiple bonds** – Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction, mechanism of condensation reaction involving enolates- Aldol, knoevengel, Mannich, Benzoin, Perkin and Stobbe reactions.
- **Elimination reaction** – The E2, E1, E1cB and E2cB mechanisms, orientation of the double bond, reactivity- effect of substrate structures, attacking base, the leaving group and the medium, stereochemistry, elimination v/s substitutions, pyrolytic eliminations.

Book Recommended :

1. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum
3. A Guide book of Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Modern Organic Reactions, H.O. House, Benjamin.
6. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
7. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh Macmillan.
8. Stereochemistry of Organic Compounds, D. Nasipurti, New age International.
9. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age Intenational.
10. Organic Reaction and Their Mechanisms, P.S. Kalsi, New Age Intenational.
11. Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Parshar, New age International.

SEMESTER-I

Organic Chemistry Laboratory-I

1. Purification and identification of compounds in a binary mixture of two solids or solid- liquid and preparation of their suitable derivatives
2. **One Step Organic Synthesis (minimum -4)**

   (One experiment to be performed from the following in the examination)

   I. Acetylation- Acetylation of Salicylic acid using acetyl chloride
   II. Benzoylation- Benzoylation of phenol/ aniline/ glycine
   III. Oxidation- Phenanthroquinone from Phenanthrene
   IV. Sandmayer Reaction- o-Chlorotoluene from o-Toluidine
   V. Acetoacetic ester Condensation- Synthesis of ethyl-n-butylacetoacetate
   VI. Bromination Reaction- to prepare dibromoflurorescein from fluorescein.
   VII. Claisen-Schmidt Condensation- Benzalacetophenone/Bezalacetone/diBenzalacetone from Benzaldehyde

3. **Two step Organic Synthesis (minimum -2)**

   I. Preparation of Acetanilide from Acetophenone (Beckmann Rearrangement)
   II. Preparation of *m*-Nitroaniline from nitrobenzene
   III. Preparation of *m*-phenylenediamine from nitrobenzene
   IV. Preparation of Methyl orange from aniline

Reference books:

1. Vogel's book of Practical Organic Chemistry, Longman Scientific & Technical, 5th Edition, 2006.
2. Organic chemistry experiments: Microscales and semimicroscales, Campbell, B. N. and Ali M, McCarty M, Books/Cole, 1994.
3. Techniques and experiments for organic chemistry, Ault A., University Science Books, 1998.
4. Multiscale Operational Organic Chemistry: A problem solving approach to laboratory course, Lehman,Prentice Hall, 2002.
5. Practical Organic Chemistry, F. G. Mann and B. C. Saunders, ELBS, Longmann, London, 1978.
6. The Systematic Identification of Organic Compounds, Shriner, R. L., Hermann, C. K. F., Morrill, D. Y., Curtin, D. Y. and Fuson, R. C. 8th Edition, 2004.
7. Systematic Qualitative Organic Analysis, H Middleton, Edward Arnold and Co., 1939.
8. A handbook of Organic Analysis: Qualitative and Quantitative, H. C. Clarke, CBS Publishers, 2007.

Assessment method: Written, Viva, Practical

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Semester I

CHEMISTRY

DCC

Physical Chemistry -1

Unit-I

- **Quantum chemistry:** The Schrodinger equation and the postulates of quantum mechanics, solutions of the Schrodinger equation to some model system viz. particle in a box, the harmonic oscillator.
- **Approximate methods:** First order time-independent perturbation theory for non-degenerate states. Variation theorem and variational methods. Use of these methods illustrated with some examples (particle in a box with a finite barrier, anharmonic oscillator, approximate functions for particle in a box and hydrogen atom).

Unit-II

- **Angular momentum:** Ordinary angular momentum, generalized angular momentum, eigen functions and eigen values of angular momentum, operators, algebra of operators, ladder operators, addition of angular momenta, spin, antisymmetry and Pauli's exculusion principle.
- **Electronic structure of atoms:** Electronic configuration, Russell-Saunder's terms and coupling schemes, molecular orbital theory, Huckel theory of conjugated systems, bond order and charge density calculations, application to ethylene, allyl and cyclobutadiene systems.

Unit-III

- **Chemical dynamice:** Methods of determining rate laws and mechanism, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and thermodynamic parameters, ionic ractions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, dynamics of unimolecular reactions.
- Catalysis, homogeneous and heterogeneous catalysis, kinetics of enzyme reactios, chain reactons, photochemical chain reactions (Hydrogen-bromine and hydrogen-chlorine reactions) oscillatory reactions (Belousov-Zhabotnsky reaction), general features of fast reactions.

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Books Recommended :

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum
3. A Guide book of Mechanism in Organic Chemistry, Peter Sykes, Longman
4. Structure and Mechanism in Organic Chemistry, Peter Sykes, Longman
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7. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh Macmillan.
8. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
9. Stereochemistry of Organic Compounds, P.S Kalsi, New age International
10. Organic Reaction and Their Mechanisms, P.S. Kalsi, New Age International
11. Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Parshar, New Age International.

SEMESTER-I
Physical Chemistry Laboratory-I

1. Kinetics – (minimum -4)

I. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the Initial Rate Method.

II. Compare the strengths of hydrochloric acid and sulphuric acid by studying rate of hydrolysis of methyl acetate.

III. Determine the specific reaction rate constant of the potassium persulphate-iodide reaction by the Initial Rate Methods.

IV. Study the kinetics of the iodination of acetone in the presence of acid by the Initial rate Method.

2. Conductometry – (minimum -4)

I. Determine the equivalent conductance, degree of dissociation, dissociation constant (Ka) for weak electrolytes (CH3COOH, NH4OH) and verify Ostwald dilution law.

II. Determine the solubility of sparingly soluble salt and its solubility product.

III. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in a commercial sample of soda ash.

IV. Determine basicity of weak organic acid.

V. Determine the strength of strong and weak acids in a given mixture.

VI. To determine the critical miceller concentration (CMC) of sodium dodecylsulphate (SDS) and cetyltrimethylammonium bromide (CTAB) using conductivity method.

VII. Precipitation titration and determination of solubility of sparingly soluble salts (Lead sulphate) by conductometry.

Wet-Lab Physical
ChemistrySpectroscopy

1. Determination of composition of KMnO4 + K2Cr2O7 solution.
2. Determination of pKa of an indicator (e.g. methyl red) in (a) aqueous and (b) micellar

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media.

3. Nickel/ molybdenum/ tungsten/ vanadium/ uranium by extractive spectrophotometric method.

Books & Reading References

1. Experiments in Physical chemistry, Shoemaker D.P., Garland C.W. and Nibler J.W., McGraw Hill.

Assessment method: Experiment need to be performed (and if necessary- Seminar/Assignment/Viva/lab quiz)

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Semester I

CHEMISTRY

DSE / GE

Group Theory and Spectroscopy -1

Unit-I

- **Symmetry and Group theory in Chemistry:**
- Symmetry elements and symmetry operation, definition of group, subgroup, Conjugacy relation and classes. Point symmetry group, Schonfilies symbols, representation of group by matrices (representation for the C_{nh},C_{nv},etc. group to be worked out explicitl). Characters of a representations, Great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy, Derivation of character table for C_{2v} and C_{3v} point group, symmetry aspects of molecular vibrations of H_2O molecule.

Unit-II

- **Unifying Principles:** Electromagnetic radiations, Interaction of electromagnetic radiation with matter, Uncertanity relation and natural line width.Factors affecting natural line width.
- **Rotational spectroscopy:** Classification of molecules, rigid rotator, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, stark effect, nuclear and electron spin interaction and effect of external field, applications.
- **Vibrational Spectroscopy:**
- **Infra red spectroscopy**
- Review of linear harmonic oscillator, Vibrational energies of diatomic molecules, Zero Point energy, force constant and bond strength, anharmonicity, Morse Potential energy diagram, Vibraiton-rotation spectroscopy, P.Q.R. branches, breakdown of oppenheimerapprozimation, selection rules, finger print region, Group frequencies and intensities, overtones, hot bands, combination bands and Fermi resonance.
- **Reman spectroscopy:** Classical and quantum theories of Raman effect, Stokes and anti-Stokes lines, Pure rotational, vibrationa, rotational – vibrational Raman spectra, Mutual exclusion principle.

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Unit-III

- **Electronic spectroscopy**
- **Atomic Spectroscopy**
- Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.
- **Molecular Spectroscopy**
- Electronic spectra of diatomic molecules: Born oppenheimer approximation, vibrational progressions, Franck-Condon principle. Electronic spectra of polyatomic moleules.Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.
- **Photoelectron Spectroscopy:** Basic principles, photo-electric effect, ionization process, koopman's theorem, ESCA- theory, Auger emission spectroscopy – Basic idea.

Books Recommended:

1. Lowe, J. P. & Peterson, K. Quantum Chemistry Academic Press (2005).
2. McQuarrie, D. A. Quantum Chemistry Viva Books Pvt. Ltd.: New Delhi (2003).
3. Mortimer, R. G. Mathematics for Physical Chemistry 2nd Ed. Elsevier (2005).
4. Pilar, F. L. Elementary Quantum Chemistry 2nd Ed., Dover Publication Inc.: N.Y. (2001).
5. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press
6. Levine, I. L Quantum Chemistry 5th Ed., Prentice-Hall Inc.: New Jersey (2000).
7. Engel, T. & Reid, P. Physical Chemistry Benjamin-Cummings (2005).
8. McQuarrie, D.A. & Simon, J.D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books (2001).
9. Chemical Kinetics, K.J. Laidler, Mcgraw-Hill.
10. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.

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Semester I

CHEMISTRY

DSE / GE

Analytical Chemistry and Inorganic Spectroscopy

UNIT I

Data analysis and Fingerprint: Accuracy, precision, sensitivity and specificity. Significant figures. Determinate and indeterminate errors and minimization of errors, standard deviation. Fingerprint: Types, characterize and application.

- **Solvent extraction:** Classification, distribution law, separation factor, extraction equilibria and extraction systems - Chelation, solvation and ion-pair formation. Application in metal ion separation. Batch, continuous and counter current extractions. Membrane separation.
- **Radioanalytical methods:** Radioactivity as analytical tool. Neutron activation analysis- Instrumentation and application for trace and ultra trace analysis, isotope dilution analysis.

UNIT II

- **Chromatography:** Types. Ion exchange chromatography, planar chromatography - paper and TLC. Stationary and mobile phases. GC – Theory, instrumentation and applications. Liquid-liquid partition chromatography. HPLC. Reverse phase chromatography. Size exclusion and Affinity chromatography.
- **Spectral methods:** Basic Principles, Bear-Lambert Law. UV-Visible spectrophotometry - Instrumentation and application. AAS - Hollow cathode lamp, graphite furnace, interferences. AES. Flame photometry, ICP - AES. Fluorescence spectrophotometry - Principle and instrumentation. Basic principles of UPS, XPS and Auger Spectroscopy.

UNIT III

- **Mossbauer spectroscopy:** Principle, isomer shift, isotropic and anisotropic electronic fields for iron and tin complex, effects of nuclear quadrupole on Mossbauer spectra.
- **ESR spectroscopy:** ESR spectra of metal complexes: Zeeman interaction and energy levels,g factor, Ligand field effects, dipolar coupling, Hyperfine coupling and A parameter, super-hyperfine coupling. Orbital moment quenching and g values, Anisotropy in g and A values. ESR spectra of multielectronic ion complexes. Zero field splitting and Kramer's degeneracy,

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ESR spectra of d1 to d9 metal ions.

Reference Books:

1. Analytical Chemistry, G.D. Christian, P.K. Dasgupta, K.A. Schug, (2004), 7th edn, John Wiley.
2. Fundamentals of Analytical Chemistry. D. A. Skoog. F. J. Holler, (1995), 7th edition, Brooks Cole.
3. Analytical Chemistry: Principles, J. H. Kennedy, (2011), 2nd edition, Cengage.
4. Analytical Chemistry: Principles and Techniques, L. G. Hargis, (1988), Englewood Cliffs (N.J.): Prentice-Hall.
5. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, (2006), 6th edition, Cengage Learning.
6. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler, T. A. Nieman, (1998), 5th edition, Harcourt Asia PTE Ltd.
7. Basic Concepts of Analysis Chemistry, S.M. Khopkar, (2008), 3rd edition, New Age Science.
8. Vogel's Textbook of Quantitative Chemical Analysis, D. J. Barnes, J. Mendham, R. C. Denney, M. J. K. Thomas (2008), 6th edition, Pearson Education.
9. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, (2004), 7th edition, CBS Publishers & distributors.
10. Mossbauer Effect and its Applications, V. G. Bhide, (1973), Tata McGraw Hill.
11. Physical Methods for Chemists, R. S. Drago, (2016), 2nd edition, Affiliated East West Press Pvt. Ltd.

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Semester II

CHEMISTRY

DCC

Inorganic chemistry –II

UNIT-I

- **Metal π – complexes I:** Carbonyls,, structure and bonding, use of vibrational spectra of metal carbonyls for bonding and structure elucidation, types of carbonyls, their preparations and important reactions.

- **Metal π – complexes II:** Preparation, bonding, structure and important reactions of transition metal nitrosyls, dinitrogen and dioxygen complexes.

UNIT-II

- **Boranes**: Preparation and important reactions, electron deficient characters of boranes, structure and bonding in boranes, concept of multicentric bonding and M.O. Description, Lipscomb concept of bonding elements, semitopological description of s,t,y and x nomenclature.

- **Silicones-** Preparation, properties and structure of silicones, their industrial and technical importance.

UNIT-III

- **Sulphur-Nitrogen compounds:** Preparation, properties of tetrasulphur tetranitride Disulphur, dinitride, polythiozyl and other sulphonitrides, sulphur imides

- **Phosphorus-Nitrogen compounds:** Linear and cyclic polymers, their synthesis and reactions, structure and bonding Alcok's skeletal π-bonding concept.

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- **Metal Clusters:** Higher boranes, carboranes, metalloboranes, Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

Books Recommended:

1. Advanced Inorganic Chemistry, F. A. Cotton and Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huhey, Harpes & Row
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon
4. Inorganic Electronic Spectroscopy, ABP Lever, Elseview
5. Magnetochemistry, R.L. Carlin, Springer Verlag

SEMESTER II

Inorganic Chemistry Laboratory – II

I. Water Analysis - (minimum -4)

1. Determination of hardness of water
2. Determination of BOD in water sample
3. Determination of COD in water sample
4. Determination of DO in water sample
5. Determination of available Chlorine in water sample
6. Determination of Fluoride in water

II. Analysis of purity of chemicals (-3)

1. Determination of available oxygen in hydrogen peroxide
2. Determination of phosphoric acid in phosphoric acid
3. Determination of available chlorine in bleaching powder

III. Volumetric estimation (-4)

1. Determination of Al, Ba, Ca, Cu, Fe, Cr, Ni and Co using complexometric titration
2. Determination of Fe^{2+}, nitrite by cerimetry
3. Determination of Iodide, Sn^{2+} by Potassium iodate

IV. Chromatography (-3)

Separation of a mixture of cations/anions by paper chromatographic technique usingaqueous/nonaqueous media:

(i) Pb^{2+} and Ag^{+} (aqueous & non-aqueousmedia)

(ii) Co^{2+} and Cu^{2+} (non-aqueousmedium)

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(iii) Cl^- and I^- (aqueous-acetone medium)

(iv) Br^- and I^- (aqueous-acetone medium)

V. Analysis of Electronic Spectra (-1)

Analysis of Electronic Spectra of transition metal complexes at least for one system [dn (Oh) or (Td)] and calculation of Crystal, Field parameters, interelectronic repulsion parameter andbonding parameter.

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CHEMISTRY

DCC

Organic Chemistry – II

UNIT-I

Stereochemistry

- Elements of symmetry, Chirality, Molecules with more than one chiral center, DL, RS and EZ nomenclature, methods of resolution, Optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereo specific and stereo selective synthesis, optical activity in the absence of chiral carbon (biphenyl, allenes and spiranes), chirality due to helical shape. Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity.

Asymmetric Synthesis

- Inroduction to asymmetric synthesis, Cram's and Prelog's rules. Use of chiral auxiliaries, chiral catalyst (L-Proline based reaction), asymmetric hydrogenation, asymmetric epoxidation (Sharpless epoxidation), and asymmetric dihydroxylation, Enzyme catalyzed asymmetric reactions (Reduction and oxidations).

UNIT-II

Rearrangements

- General mechanistic considerations-nature of migration, migratory aptitude, memory effects.

- **A detailed study of the following rearrangements** - Pinacol-Pinacolone rearrangement, Wagner- Meerwin rearrangement, Demjanov rearrangement, Benzil - Benzilic acid rearrangement, Favorskii rearrangement, Wolff rearrangement, Neber rearrangement, Beckmann rearrangement, Hofmann

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rearrangement, Curtius rearrangement, Schmidt rearrangement, Lossen rearrangement, Bayer-Villiger rearrangement and Stevens rearrangement.

UNIT-III

- **Reagents in organic synthesis:** Use of the following reagents in organic synthesis and functional group transformation, Gilman's reagent, lithium dimethyl cuprate LDA, dichlorohexylcarbodiimide, trimethyl silyl iodide, tributyltin hydride, DDQ, Baker yeast, Petersons synthesis, Merrifield resins, 1,3-dithiane, selenium oxide, osmium tetroxide, use of N- heterocyclic carbene in organic synthesis.

Pericyclic reactions

- Introduction, classification of pericyclic reactions, molecular orbital symmetry, frontier orbitals of ethylene, 1,3 –butadiene, 1,3,5-hexatriene and allyl system. Woodward Hoffmann Correlation diagram, F.M.O. and PMO approach to cycloaddition and electrocyclic reactions. Electrocyclic reactions- Conrotatory and disrotatory motions, 4n and 4n+2. Cycloadditions- antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloaddition and cheleotropic reactions.
- Sigmatropic rearrangement-suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, Claisen, Cope and aza-Cope rearrangement. Fluxional tautomerism. Ene reaction.

Books Recommended :

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, JohnWiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum
3. Modern Organic Reactions, H.O. House, Benjamin
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic &Professional.
5. Reaction Mechanism in Organic Chemistry , S.M. Mukherji and S.P. Singh,Macmillan
6. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
7. Stereochemistry of Organic Compounds, P.S Kalsi, New age International.
8. Organic Reaction and Their Mechanisms, P.S. Kalsi, New Age International.
9. Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Parshar, New Age International.
10. Stereochemistry of Organic Compounds, E.L. Eliel.

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SEMESTER - II

Organic Chemistry Laboratory – II

1. Quantitative Analysis (minimum -2)

I. Determination of equivalent weight of an acid by silver salt method

II. Estimation of phenol/ aniline using Bromate-Bromide solution or by acetylation method

III. Estimation of glucose by titration using Fehling's solution/ Benedict solution

IV. Estimation of carbonyl group by using 2, 4-dinitrophenylhydrazine.

2. Analysis of oils and fats (minimum -2)

I. Determination of saponification value of oil.

II. Determination of iodine value of oil.

III. Determination of acid value of oil.

3. Chromatography of amino acids and carbohydrates:-

I. Separation of components by TLC

Separation of components by adsorption paper chromatography

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Semester II

CHEMISTRY

DCC

Physical Chemistry- II

UNIT -I

- **Classical thermodynamics:** Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies, partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance, determinations of these quantities.
- **Non-ideal systems:** Excess function for non-ideal solutions, activity, activity coefficient. Debye- Huckel theory for activity coefficient of electrolyte solutions, determination of activity and activity coefficients, ionic strength.
- **Statistical thermodynamics** - Concept of distribution, thermodynamic probability and most probable distribution, ensemble averaging, postulates of ensemble averaging, canonical, grand canonical, and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers)Partition function, translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions, applications of partition functions. Chemical equilibrium and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, Bose-Einstein statistics, distribution law.

UNIT-II

- **Non-equilibrium thermodynamics** –Meaning of Irreversible(Non-equilibrium) thermodynamics, Thermodynamic criteria for non-equilibrium states, phenomenological laws- linear laws, Gibbs equation, Onsager reciprocal relations, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g. heat flow, chemical reaction etc.) Prigogines principal of maximum entropy production, transformations of the generalized fluxes and forces. Applications of non-equilibrium thermodynamics.

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- **Surface chemistry -** Surface tension, Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electrokinetic phenomenon), catalytic activity atsurfaces. Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro- emulsion, reverse micelles.

UNIT III

- **Electrochemistry:** Debye-Huckel-Onsager treatment and its extension, ion-solvent interactions, Debye-Huckel-Jerum mode, derivation of electro-capillarity, Lippmann equations (surface excess), methods of determination, structure of electrified interfaces, Guoy-Chapman, Stern, Graham-Devanathan-Mottwatts, Tobin, Bockris, Devanathan models, over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot, semiconductor interfaces,theory of double layer at semiconductor, electrolyte - solution interfaces, structure of soluble layer interfaces, effect of light at semiconductor solution interface.

Book Recommended:

1. Modem Electrochemistry Vol. I and Vol.II, J.O.M. Bockris and A.K.N. Reddy, Plenum
2. Silbey, R. J., Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed. Wiley
3. McQuarrie, D. A. Statistical Mechanics Viva Books Pvt. Ltd.: New Delhi (2003).
4. Nash, L. K. Elements of Statistical Thermodynamics 2nd Ed., Addison Wesley (1974).
5. Physical Chemistry, P.W Atkins, ELBS
6. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum

SEMESTER-II

Physical Chemistry Laboratory – II

1. Distribution law

I. Complex formation between copper sulphate and ammonia.

II. Equilibrium constant of the reaction between iodine and potassium iodide.

III. Study the distribution of benzoic acid in benzene and water to show the benzoic acid dimerise in benzene.

2. Conductometry – (minimum -4)

I. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.

II. Find out the equivalent conductance of strong electrolytes (NaCl, KCl, KNO_3, HCl etc.) atdifferent dilutions and verify Debye-Huckel-Onsager equation.

III. Determination of velocity constant and order of the reaction for saponification of ethyl acetate by sodium hydroxide conductometrically.

IV. Study the stepwise neutralization of a polybasic acid e.g. oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the plots.

V. Study the estimation of potassium sulphate solution by conductometric titration. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with Sodium hydroxide.

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Semester II

CHEMISTRY

DSE / GE

Environmental and Green Chemistry

UNIT I

- **Principle and concepts of Green Chemistry:-**Introduction, definition, principles, atom economy, atom economic and atom uneconomic reaction, reducing toxicity.
- **Waste- Production, Problems and Preventions:** Introduction, problem caused by waste, sourceof waste, cost of waste, waste minimization techniques, on-site waste treatment, design for degradation, polymer recycling. Introduction to catalysis, biocatalyst and phase transfer catalysis.

UNIT-II

- **Green Solvents:** Organic solvents, solvent-free systems, controlling of solvent-free reactions, supercritical fluids (H_2O and CO_2), fluorous biphase solvents.
- **Green Reagents:** Introduction, methods of designing safer chemicals, avoidance of toxic functional groups, examples of greener reagents including replacement of phosgene, methylations using dimethyl carbonates and other polymer supported reagents, solid state polymerization, alternative nitrile synthesis.
- **Green Synthesis:** Design for energy efficiency, classification and applications of Green Synthesis including Microwave Assisted Synthesis green synthesis of polycarbonates, paracetamol, ibuprofen, citral, urethane, adipic acid, styrene, α, β-unsaturated nitroalkenes.

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UNIT-III

- **Environmental chemistry: Atmosphere** –chemical and photochemical reactions in the atmosphere, oxygen and ozone Chemistry, greenhouse gases and effect, hydrosphere-physical chemistry of sea water, eutrophication, sewage treatment, lithosphere and chemistry involved, smoke formation acid rains. A brief idea of toxicological effects of arsenic, lead, cadmium, mercury, ozone PAN, cyanide and pesticides. Oxide of nitrogen, sulphur and carbon, carcinogens.
- **Analysis of pollution:** Sampling and monitoring of air and water, determination of total dissolved solids, conductivity , acidity, alkalinity, harmness, chloride, sulphate, fluoride phosphate and different forms of nitrogen phenols, pesticides, surfactants DO, BOD, COD and microorganism. Catalysts of aquatic chemical reactions water pollution laws and standards.

Books Recommended:

1. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of Chemicals, Cambridge.
2. Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes, Edited by Paul T.Anastas & Tracy C. Williamson, Oxford University Press.
3. Green Chemical Syntheses and Processes: Edited by Paul T. Anastas, Lauren G. Heine & Tracy C. Williamson, ACS Symposium Series.
4. Green Chemistry: Environment Friendly Alternatives, Edited by Rashmi Sanghi, M. M. Srivastava, Narosa Publishing House, New Delhi.
5. Green Chemistry: Microwave Synthesis, K. R. Desai, Himalaya Publishing House.
6. Green Chemistry: A Teaching Resource, Dorothy Warren, Royal Society of Chemicals, 2001.
7. Green Chemistry: Williams, Charlotte.
8. Environmental Chemistry, S. E. Manahan, Lewis Publishers.
9. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
10. Environmental Chemistry, A. K. De, Wiley Eastern.
11. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern
12. Standard Method of Chemical Analysis, F.J. Welcher Vol. Ill, Van Nostrand Reinhold Co.
13. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
14. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordonand Breach Science Publication.
15. Environmental Chemistry, C. Baird, W. H. Freeman.

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Semester II

CHEMISTRY

DSE / GE

Supramolecular Chemistry

UNIT – I

Introduction to Supramolecular Chemistry

- General Introduction, History, Objectives of the course, Brief summary of the course.Introduction to the Principles of Molecular Recognition
- Non-covalent interactions: Ion pairing, Ion-Dipole Interactions, Dipole-Dipole interactions, Dipole-Induced Dipole and Ion-Induced Dipole interactions, vander Waals or Dispersion Interactions, Hydrogen bonding, Cation-π interactions, Anion–π interactions, π–π interactions, Closed shell interactions, Aromatic-Aromatic Interactions: Benzene Crystals, Edge-toface vs. π-π Stacking Interactions, N-H—π interactions, Sulfur-aromatic interactions, Benzene-Hexafluorobenzene π– stacking.
- Solvation and Binding: Hydrophobic Interactions, The Hansch Equation: Estimating the Hydrophobic Character of Small Functional Groups.

UNIT – II

- Principles of Cation Complexation Crown Ether Complexation: Structures, Nomenclature, Solvent dependence, Role of the Counterion, Cavity Size and Ion Radii, Complexation Enthalpy and Entropy, Nature of the Donor Atoms in the Crown, Complexation Kinetics.
- Cation Complexation by Cryptands: Structures of Cryptands and Their Complexes, X-Ray Crystal Structures of Cryptandes and Their Complexes, Stability in Solution, Kinetics of Cation Complexation by Cryptands.
- Cation Complexation by Spherands: Structures and Stabilities of Spherand Complexes.

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- The Lariat Ethers and Podands
- Complexation of Primary and Secondary Ammonium Ions: Complexes of Primary Ammonium Ions, Complexation of Secondary Ammonium Ions by Crown Ethers, The Ionic N+-HO bond.
- Synthesis: The High Dilution Rule, Templated Cyclizations, Crown Ether Synthesis, Cryptand Synthesis, Spherand and Hemipherand Synthesis

UNIT III

- Anion Complexation, Introduction: Scope, Challenges in Anion Receptor Chemistry.
- Halide Ion Receptors and Complex Stabilities, Protonation and Complexation Properties ofMacrocyclic Polyamines and Synthesis
- Anion Receptors, Applications of anion and cation complexation, Phase Transfer Catalysis and AnionActivation.
- Allosteric Effects Complexation of neutral molecules in aqueous solution
- Cyclophane Receptors: Electronic Effects in Cyclophane Complexes with Aromatic Substrates, Complexation of Polyaromatic Hydrocarbons, Combination of Apolar Binding and Ion Pairing, Water Soluble Cyclophane Receptors Molecular Self-Assembly
- Examples of Self-assembly in Nature, Biological Self-assembly
- Rotaxanes and Catenanes: From Cyclophanes to Catenanes, Properties of Catenanes, Rotaxanes, Switchable Catenanes and Rotaxanes Molecular Machines and Motors.

Reference Books:

1. Supramolecular Chemistry, J. W. Steed, J. L. Atwood (2009), 2nd Edition, John Wiley &Sons Inc.
2. Supramolecular Chemistry, J.–M. Lehn, (1995), 1st Edition, Wiley–VCH.
3. Macrocylic Chemistry, B. Dietrich, P. Viout, J. –M. Lehn, (1993), VCH.
4. The Weak Hydrogen Bond, G. Desiraju, T. Steiner, (2001), Oxford science publications.
5. Principles and Methods in Supramolecular Chemistry, H.–J. Schneider, A. Yatsimirsky,(2000), Wiley.
6. Crystal Engineering: A textbook, G. R. Desiraju, J. J. Vittal and A. Ramanan, (2011), WorldScientific Publishing Co. Pte Ltd.

Assessment method: Written (and if necessary – Seminar/Assignment/Viva).

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