DEPARTMENT OF CHEMISTRY

Programme Outcomes

PO1: **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational and personal) from different perspectives.

PO2: **Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3: **Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4: **Effective Citizenship**: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5: **Ethics:** Recognize different value systems including your own, understand the moral dimensis of your decisions and accept responsibility for them.

M Sc CHEMISTRY
[2-year Regular Programme]
(For those who joined since 2019-20)

PSO 1: To make students capable of studying Chemistry in academic and industrial courses
PSO2: To promote understanding of basic facts and concepts in advance Chemistry
PSO3: To expose the students to different processes used in industries and their applications

Preamble

The following changes introduced in the curriculum for the candidates to be enrolled from june 2019-20 onwards

- Core papers for which syllabus has been modified are
  Inorganic Chemistry - I
  Physical Chemistry - I
  Physical Chemistry - II
  Inorganic Chemistry - III
  Physical Chemistry - III
- Elective papers for which syllabus has been modified are
  Green and Environmental Chemistry
- Alterations are done in core papers
  Organic Chemistry - I
  Organic Chemistry - II
  Organic Chemistry - III
  Inorganic Chemistry - II
- Alterations are done in Elective papers
  Applied Electrochemistry
  Polymer Chemistry
  Nanoscience and Nanotechnology
- Extra credit paper (Molecule Spectroscopy) is given as Forensic Chemistry
- Extra credit paper (Chromatographic Techniques) is given as Applied Chemistry
- Extra credit paper (Agricultural and Drugs Chemistry) is given as Agricultural Chemistry

M.Sc. Chemistry
(For those who joined since 2019-20)

Programme Structure

Sem	Subject Code	Course	Subject Title	Hrs/ wk	Credit	CIA	ESE	Total
I	GMCHC111	CORE –I	Organic Chemistry-I	6	5	40	60	100
	GMCHC121	CORE –II	Inorganic Chemistry-I	6	5	40	60	100
	GMCHC131	CORE –III	Physical Chemistry-I	6	5	40	60	100
	GMCHC14P	CORE –IV	Organic Chemistry Practical	6	5	40	60	100
	GMCHE1A1 / GMCHE1B1	Elective-I	a. Instrumental methods of analysis / b. Green and Environmental Chemistry	6	5	40	60	100
	GMCHX11/ GMCHX1O	Extra Credit	Forensic Chemistry / Online course	-	2	-	100	100
			Total	**30**	**25+2**	**200**	**300 + 100**	**500 + 100**
II	GMCHC211	CORE –V	Organic Chemistry-II	6	5	40	60	100
	GMCHC221	CORE –VI	Inorganic Chemistry-II	6	5	40	60	100
	GMCHC231	CORE –VII	Physical Chemistry-II	6	5	40	60	100
	GMCHC24P	CORE –VIII	Inorganic Chemistry Practical	6	5	40	60	100
	GMCHE2A1/ GMCHE2B1	Elective-II	a. Applied Electrochemistry / b. Polymer Chemistry	6	5	40	60	100
	GMCHX21/ GMCHX2O	Extra Credit	Applied Chemistry/ Online course	-	2	-	100	100
			Total	**30**	**25+2**	**200**	**300 + 100**	**500 + 100**
III	GMCHC311	CORE –IX	Organic Chemistry-III	6	5	40	60	100
	GMCHC321	CORE –X	Inorganic Chemistry-III	6	5	40	60	100
	GMCHC331	CORE –XI	Physical Chemistry-III	6	5	40	60	100
	GMCHC34P	CORE –XII	Physical Chemistry Practical	6	5	40	60	100
	GMCHE3A1/ GMCHE3B/s GMCHE3B1	Elective-III	a. Nanoscience and Nanotechnology / b. Material Chemistry	6	5	40	60	100
	GMCHX31/ GMCHX3O	Extra Credit	Agricultural Chemistry/ Online course	-	2	-	100	100
			Total	**30**	**25+2**	**200**	**300 + 100**	**500 + 100**
IV	GMCHC4PW	CORE –XIII	Project	30	15	100	100	200
	GMSED4	Extra credit	Skills for Employability Development	-	2	100	-	100
			Total	**30**	**15+2**	**100 + 100**	**100**	**200 + 100**
			Grand Total	**120**	**90 + 8**	**700 + 100**	**1000 + 300**	**1700 + 400**

Hrs/wk-Hours/Week CIA–Continuous Internal Assessment and ESE – End Semester Examination

*For online certification credit alone will be assigned on submission of certificate obtained through appearing for online examination from spoken tutorial, EDX, NPTEL or Coursera

CORE I – ORGANIC CHEMISTRY-I
(For those who joined from since 2019-20)

Semester: I **Hours/Week: 6**
Subject Code: GMCHC111 **Credits: 5**

CO1: To enable the students to learn the principles of reaction mechanism and modern reagents used for various reactions
CO2: Mechanistic aspects in nucleophilic and electrophilic substitution
CO3: Understood the principles and reaction mechanism involving aliphatic and aromatic nucleophilic substitution reactions
CO4: To acquire basic knowledge about the aliphatic and aromatic electrophilic substitution reactions
CO5: Mechanisms of addition reactions of C=C and C=O bonds and elimination reactions
CO6: Learnt about the oxidation and reduction reaction

Unit I **(18 Hours)**

Nature of Bonding in Organic Molecules: Delocalized chemical bonding – Conjugation, Cross conjugation, Resonance, Hyperconjugation, Tautomerism, Aromaticity, Alternant and non-alternant hydrocarbons, Huckel's rule, Craig's rule, Energy level of π-molecular orbitals, Annulenes, Antiaromaticity, Homo-aromaticity, Bonds weaker than covalent, Addition compounds, Non-covalent bonding and inclusion complexes

Unit II **(18 Hours)**

Aliphatic and Aromatic Nucleophilic Substitution Reactions: Bonding – Structure and reactivity of acids and bases (hard and soft acid base theory), Methods of determination and the study of reaction mechanisms, S_N^1, S_N^2, S_N^i and neighbouring group participation, Hydrolysis of esters – Wurtz reaction, Claisen and Dieckmann condensation, Williamson reactions, Different mechanisms of aromatic nucleophilic substitution – Chichibabin reaction, Cine substitution, Diazonium group as leaving group –Benzyne mechanism

Unit III **(18 Hours)**

Aliphatic and Aromatic Electrophilic Substitution Reactions: S_E^1 and S_E^2 reactions – mechanisms and reactivity, Typical reactions involving migration of double bond – Keto-enol tautomerism, Halogenation of carbonyl compounds, Stork enamine reactions, Aromatic electrophilic substitution (Ortho and Para ratio) – Reactivity, orientation and mechanisms – Nitration, Halogenation and Sulphonation, Friedel Crafts alkylation and arylation (Scholl reaction) Formylation with (i) Disubstituted formamides (Vilsmeyer- Haack reaction) (ii) Gatterman reaction (iii) Chloroform (Reimer - Tiemann reaction)

Unit IV **(18 Hours)**

Addition and elimination reactions: Addition to C-C and C-O multiple bonds – Electrophilic, Nucleophilic and Free-radical additions, Additions to conjugated systems Orientation, Birch reduction, Michael addition, 1,3 dipolar additions, Carbene addition to double bonds – Mannich reaction, Meerwein-Pondorf reduction, Grignard reactions, Aldol, Stobbe, Wittig, Cannizarro reaction Elimination reactions – E^1 and E^2 Mechanisms, Orientations, Hofmann and Saytzeff rules, Elimination versus substitution – Chaugav reaction, Bredt's rule, Dehydration of alcohols, Dehydrohalogenation – Mechanisms and orientation in pyrolytic elimination

Unit V **(18 Hours)**

Oxidation and Reduction: Formation of C=C, C-C bonds by dehydrogenation, Allylic oxidation, Oxidation of alcohols, Glycols, Halides and Amines to aldehydes and ketones, Ozonolysis, Oxidation of olefinic double bonds and Unsaturated carbonyl compounds, Sommelet reaction and selectivity in reduction, Metal hydride reduction, Metal alkoxide reduction, Reduction by dissolving metals, Reduction of nitro compounds and Carbenes and Nitrenes – structure and generation, Addition reaction with alkenes and insertion reactions

Text Book:

1. J. Clayden, N. Greeves, S. Warren and P. Wothers, **Organic Chemistry,** Oxford University Press, UK, 2nd Edition, 2012.

Reference Books:

2. J. March and M. B. Smith, **March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure,** Wiley, New York, 7th Edition, 2013.
3. F. A. Carey and R. J. Sundberg, **Advanced Organic Chemistry: Parts A and B,** 5th Edition, Springer, Germany, 2007.
4. O. P. Aggarwal, **Organic Chemistry Reactions and Reagents,** Krishna Prakashan Media, 47th Edition, 2011.
5. Peter. A Sykes, **Guide Book to Mechanism in Organic Chemistry,** Longman, 6th Edition, 1989.
6. R. T. Morrison and R. N. Boyd, **Organic Chemistry,** Pearson, New Delhi, 7th Edition, 2011.
7. R. K. Bansal, **Organic Reaction Mechanisms,** Tata McGraw Hill, Noida, 11th Edition, 2006.
8. V. K. Ahluwalia and R. K. Parashar, **Organic Reaction Mechanisms,** Narosa Publishing House, New Delhi, 3rd Edition, 2009.
9. W. Carruthers, **Modern Methods of Organic Synthesis,** 3rd Edition, Cambridge University Press, UK, 2004.
10. T. H. Lowry and K. S. Richardson, **Mechanism and Theory in Organic Chemistry,** ELBS, New Delhi, 1995.

CORE II – INORGANIC CHEMISTRY-I
(For those who joined from since 2019-20)

Semester: I **Hours/Week: 6**
Subject Code: GMCHC121 **Credits: 5**

CO 1: To understand the role of various elements in the periodic properties
CO 2: To acquire basic knowledge about the acid-base systems and non-aqueous solvents
CO 3: To get an insight on the use of several inorganic rings, cages and clusters
CO 4: Learnt about the various methods involved in nuclear and radiation chemistry
CO 5: To understand the basic concepts of solid state chemistry

UNIT I **(18 Hours)**

Acid-base systems and Non-aqueous solvents: Concepts of acids and bases **–** Bronsted-Lowry, Lewis, Lux-Flood concepts, Steric effects and solvation effects, Measures of acid-base strength, Factors affecting the strength of acids and bases, Common ion effect and Henderson's equation, Hard and soft acids and bases – symbiosis, theoretical basis of hardness and softness
Classification of solvents – properties of ionizing solvents, Typical reactions in non-aqueous solvents – liquid HF, hydrogen cyanide, sulphuric acid and acetic acid

UNIT II **(18 Hours)**

Nuclear Chemistry: Different types of nuclear reaction, nuclear fission and fusion, theories of fission-fissile and fertile isotopes characteristics of nuclear fission and fusion, Chemical effects of

nuclear transformations, Positron annihilation and autoradiography, Synthesis of transuranic elements such as neptunium, plutonium, curium, berkelium, einsteinium, mendelevium, nobelium, lawrencium Nuclear forces – Liquid drop model and shell model, Nuclear reactors – classification of nuclear reactors, breeder reactor, Applications of radioactive isotopes in chemical investigations, age determination, medicinal and agricultural field

UNIT III **(18 Hours)**

Radiation Chemistry : Interaction of radiation with matter – range of alpha, beta and gamma radiations, neutron through matter, Analytical applications of radioisotopes – Radiometric titrations, Kinetics of exchange reactions, Measurement of physical constants including diffusion constants, Radioanalysis – Neutron activation analysis, Prompt gama neutron activation analysis and Neutron absorptiometry, Applications of radioisotopes – industry, medicine, autoradiography, radiopharmacology, radiation safety precaution, Nuclear waste disposal, radiation chemistry of water and aqueous solutions

UNIT IV **(18 Hours)**

Inorganic Rings, Cages and Metal Clusters: Inorganic Rings – P-N compounds, cyclophosphazanes and cyclophosphazenes, S-N compounds – S_2N_2, S_4N_4, $(SN)_x$, polythiazyl S_xN_4 compounds, S-P compounds – molecular sulphides such as P_4S_3, P_4S_7, P_4S_9 and P_4S_{10}

Cages – Borane and Carboranes – Nomenclature, synthesis, properties, structure and bonding in diborane and tetraborane, Wades rule, Styx numbers, synthesis, properties and structure of ferrocene

Metal clusters – Polyacids – Classification of polyacids, synthesis, structure and bonding in polyanions and isopolyanions of phosphorous, molybdenum and tungsten

UNIT V **(18 Hours)**

Solid state chemistry: Defects in solids – point, line and plane defects, Stoichiometry and non-stoichiometry defects and effects of defects on physical properties, band theory and free electron theory, metals and insulators, Semiconductors – types of semi-conductors, semiconductors in solar energy conversion, hoping semiconductors rectifiers and transistors, bonding in metals, electronic specific heat, hall effect, Electrical and thermal conductivity of metals, Superconductors, Illustrative examples of ionic, covalent and hydrogen bonded solids – Perovskite, Iilmenite and Rutile, Spinel and Inverse Spinel

Text Book:

1. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, **Inorganic Chemistry,** Oxford University Press, UK, 5th Edition, 2013.

Reference Books:

2. F. Albert Cotton, Geoffrey, Wilkinson, Carlos A. Murillo, and Manfred Bochmann, **Advance Inorganic Chemistry,** Wiley Student Edition, John Wiley and Sons, INC, New York, 6th Edition, 2004.
3. G. L. Miessler and D. A. Tarr, **Inorganic Chemistry**, Pearson Education, 3rd Edition, 2004.
4. C. E. Housecroft and A. G. Sharpe, **Inorganic Chemistry**, Pearson Education Ltd., 2nd Edition, 2005
5. F. A. Cotton, G. Wilkinson and P. L. Gaus, John, **Basic Inorganic Chemistry**, Wiley and Sons, 3rd Edition, 2002.
6. J. E. Huheey, E. A. Keiter and R. L. Keiter, **Inorganic Chemistry**, Pearson Education, 4th Edition, (2002).
7. Satya Prakash, G. D. Tuli, S.K. Basu, and R. D. Madan, **Advanced Inorganic Chemistry, Volume-I,** S. Chand and Company, New Delhi, India, 2008.
8. B. R. Puri, L. R. Sharma and K. C Kalia, **Principles of Inorganic Chemistry (UGC Syllabus)**, Milestone Publishers, New Delhi, India, 2008.
9. James E. House, **Inorganic Chemistry,** First Indian Reprint, Academic Press, USA, 2010.

10. D. N. Singh, **Basic Concepts of Inorganic Chemistry,** Pearson Education, New Delhi, 2010.
11. H. J. Arnikar, **Elements of Nuclear Chemistry,** New Age Publishers, 4th edition, 2008.
12. **C**. N. R. Rao and J. Gopalakrishna, **New Directions in Solid State Chemistry,** Cambridge University Press, 1997.
13. Walter Loveland, David Morrissey and Glenn Seaborg, **Modern Nuclear Chemistry**, Wiley-Interscience, Hoboken, NJ, 2006.
14. H. J. Emelius and Sharpe, **Modern aspects of Inorganic chemistry**, Universal Book Stall, New Delhi, 1989.
15. H.V. Keer, **Principles of the Solid State,** Wiley Eastern Ltd., 1993.

CORE III – PHYSICAL CHEMISTRY-I
(For those who joined from since 2019-20)

Semester: I **Hours/Week: 6**
Subject Code: GMCHC131 **Credits: 5**

CO 1: To enable the learners to understand the significance of classical thermodynamics
CO 2: To know the details of statistical thermodynamics
CO 3: To enable the leaners to understand the principles of chemical kinetics
CO 4: To understand the principles of surface chemistry
CO 6: The students will acquire the knowledge of **c**hromatography and their applications

Unit I **(18 Hours)**

Classical Thermodynamics: Concepts involved in first, second and third law of thermodynamic, Thermodynamic equation of state, Maxwell relations, Free energy and entropy of mixing, Partial molar quantities, Gibbs-Duhem equation, Equilibrium constant, Temperature-dependence of equilibrium constant, Phase rule for one and two component system, Thermodynamic description of phase transitions, Experimental determinations of fugacity of real gases, activity, activity co-efficient and its determination

Unit II **(18 Hours)**

Statistical Thermodynamics: Combinatory rule, Probability theorem, Permutations and combinations, Concept of ensembles energy states and energy levels, Macro-states and micro-states, Maxwell-Boltzmann statistics, Thermodynamic probability, Sterling's approximation, Legrange's undetermined multiplier, Distribution functions

Partition function and thermodynamic functions – Molar partition function, Separation of partition function, Translational, rotational, vibrational and electronic partition functions, Combined partition function, Equilibrium constant and partition function

Quantum statistics – Fermi-Dirac and Bose-Einstein statistics, population inversion

Unit III **(18 Hours)**

Surface Chemistry: Different types of surfaces, thermodynamics of surfaces, Gibbs adsorption equation and its verification, surfactants and micelles, surface films

Adsorption – Introduction, adsorption of gases on solids, physisorption and chemisorptions, adsorption isotherms – Freundlich, Langmuir, BET, Temkin adsorption isotherms, adsorption on liquid surface, surface tension, surface area determination by electro-osmosis and electrophoresis.

Colloids – Zeta potential, sedimentation potential and streaming potential, Donnan membrane equilibrium

Unit IV **(18 Hours)**

Chemical Kinetics: Parallel, consecutive and reversible reactions, Determination of order of reaction, Arrhenius equation, energy of activation and its experimental determination, Simple collision

theory–mechanism of bimolecular reaction, Lindemann's theory, Activated complex theory of reaction rate, Kinetics of reactions in solution – Salt effects, effect of dielectric constant (single sphere and double sphere model), Homogeneous catalysis – Acid-base catalysis, Enzyme catalysis – Derivations of Michaelis & Menton equation, Kinetics of heterogeneous reactions – unimolecular and bimolecular surface reactions, Advanced unimolecular theory – Marcus theory or Rice, Ramspergcr, Kassel and Marcus (RRKM) theory

Unit V (18 Hours)

Chromatography: Partition Chromatography – Paper chromatography, Thin Layer Chromatography, R_f value, chromatogram, Ascending and descending chromatography, Applications of partition chromatography

Adsorption Chromatography – Principle, classification of column chromatography, column efficiency, preparation of column

Ion Exchange Chromatography – Structure of ion exchanger, types of cation and anion exchanger, mechanism of ion exchange chromatography, Ion exchange resins, Ion exchange capacity, Factors affecting separations, applications of IEC

Exclusion or Gel Chromatography – Technique in gel Chromatography, gel preparation, packing of column, Theory and application of gel chromatography

HPLC– Principle, instrumentation, advantages of HPLC, Effect of temperature in HPLC and HPTLC

Gas Chromatography– Principle, GC columns, Instrumentation, Methodology, GC-MS, Applications of GC

Text Book:

1. Peter Atkins, **Atkins' Physical Chemistry**, Osford University Press, New York, 8th Edition, 2010.

Reference Books:

2. K. J. Laidler, **Chemical Kinetics**, Pearson Education Pvt. Ltd., New Delhi, 3rd Edition, 2004.
3. D. A. McQuarrie and J. D. Simon, **Molecular Thermodynamics,** University Science Books, California 2004.
4. D. A. McQuarrie, **Statistical Mechanics,** University Science Books, California 2005.
5. E. Thomas and R. Philip, **Thermodynamics: Statistical Thermodynamics and Kinetics,** Pearson Education, 1st edition, 2007.
6. R. J. Silbey, R.A. Alberty and M.G. Bawendi, **Physical Chemistry,** Wiley-Interscience Publication, 4th edition, 2013.
7. A. Peter and J. de. Paula, **Physical Chemistry,** Oxford University Press, 9th edition, 2011.
8. M. Mortimer and P. G. Taylor, **Chemical Kinetics and Mechanism**, Royal Society of Chemistry, UK, 1st Edition, 2002.
9. J. Rajaram and J. C. Kuriacose, **Thermodynamics for Students of Chemistry - Classical, Statistical and Irreversible**, Pearson Education, New Delhi, 2013.
10. D. A. Skoog, F.J. Holler, and S.R. Crouch, **Principles of Instrumental Analysis, Thomson Learning**, 2007.
11. H. H. Willard, Jr. L. Merritt, J.A. Dean and F.A. Settle, **Instrumental Methods of Analysis,** CBS Publishers, 7th Edition, 2007.
12. A. Braithwaite and J. F. Smith, **Chromatographic Methods**, Springer, Germany, 5th Edition, 1995.
13. V. K. Srivastava and K. K. Srivastava, **Introduction to Chromatography,** 2nd Edition Holden Day, New York, 1985.
14. V. K. Srivatsan and K.K. Srivatsan, **Introduction to Chromatography- Theory and Practice,** S. Chand Company Ltd., 4th Edition, 1991.
15. Lloyd R. Snyder and Joseph J. Kirkland, **Introduction to Modern Liquid Chromatography Hardcover**, Wiley, 3rd Edition, 2009.

16. J. Rajaraman, and J. Kuriacose, **Kinetics and Mechanism of Chemical Transformations**, McMillan, 2008.
17. B.R. Puri, L.R. Sharma, & M. S. Pathania, **Elements of Physical Chemistry**, New Delhi, Vishal Publishing Co., 2014.
18. A. W. Adamson, **Physical chemistry of surfaces**, John Wiley & sons, New York, 5th Edition, 1990.

CORE IV – ORGANIC CHEMISTRY PRACTICAL
(For those who joined from since 2019-20)

Semester: I **Hours/Week: 6**
Subject Code: GMCHC14P **Credits: 5**

CO 1: The students to understand the basic principles of lab techniques adopted in organic laboratories
CO 2: Learnt about the quantitative and qualitative analyses
CO 3: Learnt the preparation of organic compounds
CO 4: Preparation and purification of different organic compounds

PART-I (30 Hours)

1. Qualitative analysis:
Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their solid derivatives
Phenols, Carbonyl compounds (Aldehydes & Ketones), Acids, Nitro compounds, Amines, Amides and Carbohydrates. (2 compounds are to be given for analysis with preparation of one solid derivative for each).
Examination: One experiment or a part of it has to be carried out and the product has to be purified by recrystallisation. The yield of the crude product and the melting point of the recrystallized product are to be noted. Both crude and recrystallised products are to be submitted.

PART-II (30 Hours)

2. Quantitative analysis:
Estimation of phenol, aniline, ketone and reducing sugars - estimation of functional groups like hydroxyl, methoxyl, carbonyl and nitro groups

PART-III (30 Hours)

Preparation of organic compounds (Double stage)
1. p-bromo acetanilide from aniline (acetylation and bromination)
2. benzillic acid from benzoin (rearrangement)
3. p-amino benzoic acid from p-nitro toluene (oxidation and reduction)
4. p-bromoaniline from acetanilide (bromination and hydrolysis)
5. 1, 2, 4-triacetoxy benzene from hydroquinone (oxidation and acylation)

Reference Books:

1. V. K. Ahluwalia, P. Bhagat, and R. Agarwal, **Laboratory Techniques in Organic Chemistry**, I. K. International, 2005.
2. A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford and P. W. G. Smith, **Vogel's Textbook of Practical Organic Chemistry**, 5th Edition, Prentice Hall, 1989.
3. S.P. Bhutani and A. Chhikara, **Practical Organic Chemistry: Qualitative Analysis,** ANE books-new Delhi, 1st Edition, 2009
4. Brian S. Furniss, **Vogel's Textbook of Practical Organic Chemistry**, Pearson India, 5th Edition, 2005.

5. F.G. Mann and B.C Saunders, **Practical Organic Chemistry**, Pearson India, 4th Edition, 2009.
6. Renu Aggarwal and V. K. Ahluwalia, **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,** Universities press, India, 2001
7. Arun Sethi**, Systematic Laboratory Experiments in Organic Chemistry**, New Age International, 2003.
8. V. K. Ahluwalia and Sunitha Dhingra, **Comprehensive Practical Organic Chemistry: Qualitative Analysis,** Orient Longman, 1st Edition, 2004.
9. N. K. Vishnoi, **Advanced Practical Organic Chemistry,** Vikas Publishing House Pvt. Ltd, 2nd Edition, 1996.

ELECTIVE I (A) – INSTRUMENTAL METHODS OF ANALYSIS
(For those who joined from since 2018-19)

Semester: I **Hours/Week: 6**
Subject Code: GMCHE1A1/ GMCHE1A **Credits: 5**

CO 1: Learnt about the various methods involved in analytical techniques
CO 2: Learnt about the various methods involved in electroanalytical techniques
CO 3: Learnt about the various methods involved in thermoanalytical techniques
CO 4: Learnt about the various methods involved in spectroanalytical techniques
CO 5: Learnt about the error analysis of sample
CO 6: Learnt about the precipitation techniques of solution

Unit I **(18 Hours)**

Error analysis: Classification of errors, accuracy and precision, minimization of errors, significant figures, significant figures in computation, statistical treatment of data – mean, median, standard deviations, variance, relative standard deviation – spread, errors – standard deviation of computed results, students t-test, F-test, comparison of the means of two samples, correlation and regression– linear regression (least square analysis)

Unit II **(18 Hours)**

Precipitation Techniques: Introduction, properties of precipitates and precipitating reagents, colloidal precipitates, co-precipitation, post precipitation, precipitates from homogeneous solution, surface adsorption, drying and ignition of precipitates, application of gravimetric methods

Unit III **(18 Hours)**

Electroanalytical techniques: Electrogravimetry, theory of electrogravimetric analysis, electrolytic separation and determination of metal ions, Coulometry – electrolytic cell, working electrodes, auxiliary electrode and reference electrode, coulometric titrations, Voltammetry – stripping voltammetry, chronopoteniometry, Amperometry– Amperometric titrations

Unit IV **(18 Hours)**

Thermoanalytical Methods: Thermal analysis, theory and principles of DTA and TGA, factors affecting the position of DT and TG traces, application of DTA and TGA to the thermal behavior of the following compounds, crystalline copper sulphate, calcium oxalate monohydrate, calcium acetate monohydrate, zinc hexafluorosilicate, complementary nature of DTA and TGA , principle and application of DSC, determination of degree of conversion of high alumina cement, purity determination phase transition study in forensic laboratory

Unit V **(18 Hours)**

Spectroanalytical Methods: Colorimetry – Beer and Lambert's law, terminology – condition for a satisfactory colorimetric analysis, method of colour measurement or comparison, principles of

colorimetric determinations of NH_3, Cr, Cu, Fe, Mn, simultaneous spectrophotometer determination of Cr and Mn - Nephelometry and turbidimetry – principle, determination of sulphate and phosphate, Fluorimetry– principle, application of fluorimetry in the determination of Cd, Ca and Zn and determination of codeine and morphine in a mixture, Flame spectrometry –theory, interferences, AAS – applications in the determination of Mg^{+2} and Ca^{+2} in tap water, V in lubricating oil, trace lead in a ferrous alloy and trace elements in contaminated soil

Text Book:

1. D.A. Skoog, E.J. Holler, S.R. Crouch, **Instrumental Analysis,** Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, 11th Edition 2012.

Reference Books:

2. J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, **Vogel's Textbook of Quantitative Chemical Analysis,** Pearson Education, New Delhi, India, 6th Edition, 2012.
3. H. H. Williard, L. L. Merritt and J. A. Dean, **Instrumental Methods of Analysis,** East-West press, New Delhi, 1988.
4. D.A. Skoog, E.J. Holler and T.A. Nieman, **Principles of Instrumental Analysis,** Thomson Aisa Pvt. Ltd., Singapore, 5th Edition, 2004.
5. J. Basset et al., **Vogel's text book of Qualitative Inorganic Analysis**, Longman, 5th Edition, ELBS, Essex, 1989.
6. Daniel C. Harris, **Quantitative Chemical Analysis**, W.H. Freeman and Company, New York, USA, 6th Edition, 2003.
7. J. G. Dick, **Analytical Chemistry**, Tata – Mc-Graw Hill, 1973.
8. D.A. Skoog, D.M. West, E.J. Holler and S.R. Crouch, **Fundamentals of Analytical Chemistry,** Thomson Aisa Pvt. Ltd., Singapore, 8th Edition, 2004.

ELECTIVE III (B) – GREEN AND ENVIRONMENTAL CHEMISTRY
(For those who joined from since 2019-20)

Semester: I **Hours/Week: 6**
Subject Code: GMCHE1B1 **Credits: 5**

CO 1: To teach the importance of various types of green synthesis and their applications
CO 2: To create awareness on environmental pollution
CO 3: Concepts and applications of green chemistry
CO 4: To impart the knowledge on the chemistry of atmosphere and their crucial applications

Unit I **(18 Hours)**

Introduction of Green Chemistry: Principles of green chemistry, Need for green chemistry – sustainability and cleaner production, Ecoefficiency, Environmental protection laws, Challenges ahead for a chemist – Education on Green chemistry, Dreaming green chemistry –Innovations for a cleaner world, Pollution-a price tag of modern society, Pollution control to pollution prevention, Green chemistry – Need of the day, Green methods, Green products, Recycling of waste

Unit II **(18 Hours)**

Designing Green Synthesis: Green Synthesis – Designing, Choice of starting materials, choice of reagents, choice of solvents, choice of catalyst

Organic synthesis in water – Reactions in water-Claisen rearrangement, Knoevenagel reaction, Pinacol coupling, Benzoin condensation and Strecker synthesis

Ionic liquids – Types of ionic liquids, synthesis of ionic liquids, Reaction in ionic liquids-Suzuki coupling, Claisen-Schimidt condensation and Waker-type oxidation reactions

Super critical Fluids – Introduction, Supercritical CO_2 – super critical polymerization, Kolbes-Schmitt synthesis and Friedel-Craft reaction

Unit III (18 Hours)

Solvent-Free organic synthesis: Microwave assisted synthesis–microwave activation, microwave heating, Advantages of microwave exposure and specific effects of microwaves

Microwave assisted synthesis in water – Hoffmann elimination, Hydrolysis of benzamide and Oxidation of toluene

Ultrasound assisted organic synthesis– Introduction, Types of sonochemical reactions, Homogeneous sonochemical reactions – Curtius rearrangement, Heterogeneous Liquid-Liquid reactions – esterification, Heterogeneous Solid-Liquid reactions – Hydroboration

Phase Transfer Catalysts– Advantage, types and application in conversion of nitriles from akyl and aryl halides

Biocatalyst– Microbial oxidation and enzymatic hydrolysis, polymer supported catalysts

Unit IV (18 Hours)

Air pollution, Water pollution and Soil pollution: Air pollution– Pollution by C, CO, NO_X, SO_X, HC, acid rain, smog, particulates, greenhouse effect/global warming, ozone layer depletion, effects & control of air pollutants

Water pollution– Source and Classification – organic, inorganic and radioactive pollutants

Soil pollution– Chemical composition, Micro and macro nutrients in soil, Pollution by fertilizers, pesticides, plastics and heavy metal compounds, plant as indication of soil pollution

Unit V (18 Hours)

Industrial Pollution, Radiation pollution & Environmental toxicology: Introduction, Causes of industrial pollution, Thermal power plants, Nuclear power reactors, Fertilizers and Chemical industry-Pulp and Paper industries, Agro based industries, Cement industry

Classification & effects of radiation, Effects of ionizing radiation on man, Effects of non-ionizing radiation on life, Radioactivity and nuclear fallout, Protection and control from radiation

Toxic chemicals in the environment–biochemical effects of arsenic, cadmium, lead, mercury and cyanide, Bio-ware agents, Chemical solutions to environmental problems biodegradability, Principles of decomposition better industrial processes, Bhopal gas tragedy, Chernobyl, Three mile island, Sewozo and Minamata disasters

Text Book:

1. V. K. Ahluwalia, **Green Chemistry**, Ane Books Pvt Ltd., New Delhi, 2nd Edition, 2016.

Reference Books:

2. V. K. Ahluwalia and M. Kidwai, **New Trends in Green Chemistry**, Anamaya Publishers, 2004.
3. P. T. Anastas and J. C. Warner, **Green chemistry Theory and Practice**, Oxford University Press, New York, 2005.
4. R. A. Sheldon, I. Arends, and U. Hannefed**, Green Chemistry and Catalysis**, Wiley-VCH Verlag GmbH and Co., 2007.
5. P. Anastas and T. C. Williamson, **Green Chemistry Frontiers in Benign Chemical Synthesis and Processe**s, Oxford University Press, 1999.
6. G.W. Van-Loon and S. J. Duffy **Environmental Chemistry**, Oxford University Press 3rd Edition, 2005.
7. C.S. Rao, **Environmental Pollution Control Engineering**, New Age International Publishers, New Delhi, 2nd Edition, 2006.
8. P. S. Sindhu, **Environmental Chemistry**, New Age International Publishers, 2nd Edition, 2002.
9. A. K. De, **Environmental Chemistry**, New Age International Publishers, 6th Edition, 2008.
10. Shweta Sharma and Pooja Sharma, **Environmental Chemistry**, Narosa Publishing House Pvt. Ltd., New Delhi, 2014.
11. Rashmi Sanghi & M. M. Shrivastav, **Green Chemistry, Environment Friendly Alternatives,** Narosa Publishing House Pvt. Ltd., New Delhi, 2012.

12. A. K. De, **Environmental Chemistry**, Wiley Eastern Ltd, 3rd Edition, 1994
13. B. K. Sharma, **Environmental Chemistry**, Goel Publishers, 2001.
14. M.S. Sethi, **Environmental Chemistry**, Sri Sai Printographers, 1994.
15. C. D. Tyagi and M. Mehra, **Text book of Environmental Chemistry,** Anmol Publishers,1996.
16. V. Kumar, **An Introduction to Green Chemistry,** Vishal Publishing Co., Jalandhar, 2007.

EXTRA CREDIT I – FORENSIC CHEMISTRY
(For those who joined from since 2019-20)

Semester: I **Credits: 2**
Subject Code: GMCHX11

CO 1: To give the students the importance of forensic chemistry and an exposure to find, Analyse and find a suitable method to detect the crime

Unit I
Introduction of Forensic Chemistry: Basic principles and its significance, History & development of forensic science, Nature and scope of forensic science, Organizational structure of Forensic Science Laboratories at central & State level, Ethics in Forensic science, Method of analysis in forensic science – spectrometry and microscopy

Unit II
Scene of crime: Types, protection of scene of crime, preservation (recording) of scene of crime-photography and sketching methods
Physical evidence: Meaning, Types, search methods, collection and preservation, Forwarding, Chain of custody, Collection, preservation, packing and forwarding of blood, semen and other biological stains, firearm exhibits, documents, fingerprint, viscera, hair & fiber, glass, soil and dust, petroleum products, drugs and poisons, etc.

Unit II
Crime: Definition, theories of causation of crime – Pre-classical and Neo-classical, constitutional, geographical, economic, psychological, sociological, multiple causation approach.

Unit IV
Indian Penal Code: Introduction, General exceptions, Offences against person, Offences against property, Attempt to suicide, Sexual offences
Criminal Procedure Code: Introduction and general idea of sections – 291-93, 154, 155, 156, 157, 158, 159, 160, 161, 162, 172, 173, 174, 175, and 176
Indian Evidence Act: Introduction and general idea of sections – 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, and 159

Unit V:
Forensic Medicine: Definition of Forensic Medicine and Medical Jurisprudence, Dying declaration, Death – definition, types, somatic, sudden natural and unnatural deaths, Medical aspects aids – Misuse of scheduled drugs, burns and their treatment by plastic surgery
Forgery: Detecting forgery in bank cheques / drafts and educational records (mark lists, certificates), using UV-light, Hand writing comparison – genuine and forged writing, collection of samples, detection
Transportaion: Drunken driving – breath analyzer for ethanol, Incendiary and timed bombs in road and railway tracks, Defusing live bombs, Accidental explosions during manufacture of matches and fire-works (as in Sivakasi)

Text Book:

1. Saferstein, Richard and Criminalistics, **An Introduction to Forensic Science,** Prentice Hall, Fifth edition.

Reference Books:

2. Ichael Grieve, **Forensic Examination of Fibres**, Kindle Edition-Kindle eBook, Second Edition, 2007.
3. Kleiner, Munay, **Handbook of Polygraph testing**, Academic Press, 2002.
4. Noon, **Forensic Engineering Investigation**, 2000.
5. Krishan Vij, **Text book of Forensic Medicine**, B.I. Churchill Livingstone Pvt. Ltd., 2001.
6. John. G Clement and David. L. Ranso, **Craniofacial Identification in forensic Medicine,** Oxiford University Press, 1998.
7. C.G.G. Aitken and D.A. Stoney, **The use of statistics in Forensic Science**, Ellis Harwood Limited, England, 1991.
8. S.H. James and J.J. Nordby, **Forensic Science: an Introduction to Scientific and Investigative Techniques,** CRC Press, USA, 2003.
9. J Deed Reckoning Mordby, **The Art of Forensic science Detection,** CRC Press LLC, Boca Raton FL, CRC Press, 2000.

CORE V – ORGANIC CHEMISTRY-II
(For those who joined from since 2019-20)

Semester: II **Hours/Week: 6**
Subject Code: GMCHC211 **Credits: 5**

CO 1: Mechanistic pathway of organic reactions
CO 2: Stereochemistry approach to planning organic syntheses
CO 3: Conversion of different functional group *via* rearrangement reaction
CO 4: To enable the students to learn the synthesis and the isolation of amino acids, proteins, enzymes and nucleic acids
CO 5: Learnt the knowledge of pericyclic reactions
CO 6: To impart the knowledge on photochemistry reactions

Unit I **(18 Hours)**

Molecular rearrangements and reactions: Types of organic rearrangements – Anionic, Free radical, Carbene, Nitrene and Long-range rearrangements, Mechanism of Wagner- Meerwein, Hofmann, Curtius, Schmidt, Lossen, Beckmann, Wolf, Fries, Hofmann-Martius, Orton, Smiles, Favorskii, Stevens, Wittig, Sommelet, Hauser, Bayer-Villiger, Neber, Zimmermann, Chapman, Hydroperoxide and borane rearrangements

Unit II **(18 Hours)**

Stereochemistry and Conformation analysis: Stereochemistry – Elements of symmetry, Chirality, R-S nomenclature, Diastereoisomerism in Acyclic and Cyclic systems, E-Z isomerisms, Interconversion of Fischer, Newman and Sawhorse projections, Molecules with more than one chiral center, Threo and erythro isomers, Methods of resolution, Optical purity, Enantiotopic and diastereotopic atoms, Groups and faces, Asymmetric synthesis – Cram's rule, Prelog's rule
Conformational Analysis – Acyclic Compounds – Conformation of Monosubstituted and Disubstituted Cyclohexanes

Unit III **(18 Hours)**

Pericyclic Reactions: Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5- hexatriene and allyl systems, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams, FMO and PMO approach - Electrocyclic reactions – conrotatory and disrotatory

motions, 4n, 4n+2 and allyl systems Cycloaddditions – antarafacial and suprafacial additions, 4n and 4n+2 systems, 1,3 dipolar cycloadditions and cheleotropic reactions - Sigmatropic rearrangements – suprafacial and antarafacial shifts of H, 3,3- and 5,5- sigmatropic rearrangements, Claisen, Cope and Aza-Cope rearrangements, Fluxional tautomerism, Ene reaction (with selected examples)

Unit IV **(18 Hours)**

Organic Photochemistry: Introduction, Photochemistry of alkenes– Intramolecular reactions of the olefinic bond, Geometrical isomerism, Photochemistry of carbonyl compounds– Intramolecular reactions of carbonyl compounds, saturated, cyclic and acyclic (Norrish type I) and Norrish type –II reactions, Photochemistry of aromatic compounds– isomerisations, additions and substitutions, Photo-Fries rearrangement. Barton reaction, singlet molecular oxygen reactions– Paterno - Buchi reaction

Unit V **(18 Hours)**

Bioorganic Chemistry: Amino Acids – Structure, classification, synthesis and properties of amino acids - Proteins – Classification and properties (denaturation, isoelectric point and electrophoresis), primary, secondary, tertiary and quaternary structures of proteins, Enzymes – Typical enzyme mechanisms (Chymotrypsin) - Nucleic Acids – Nucleotides and Nucleosides, DNA – Primary and secondary structure, replication of DNA, RNA and Protein synthesis – Messenger RNA synthesis, transcription ribosomes-rRNA, Transfer RNA

Text Book:

1. J. Clayden, N. Greeves, S. Warren, and P. Wothers, **Organic Chemistry,** Oxford University Press, UK, 2nd Edition, 2012.

Reference Books:

2. E. L. Eliel, and S. H. Wilen, **Stereochemistry of Organic Compounds**, John Wiley, New York, 1994.
3. E. L. Eliel, Stereochemistry **of Carbon Compounds**, Tata-McGraw Hill Publishing Company, New Delhi 1998.
4. D. Nasipuri, **Stereochemistry of Organic Compounds – Principles and applications,** New Age International Pvt. Ltd., New Delhi, Revised 2nd Edition, 2009.
5. J. D. Coyle, **Organic Photochemistry,** Wiley, New York, 1998.
6. J. M. Coxon, and B. Halton, **Organic Photochemistry,** Cambridge, University Press, UK, 2nd Edition, 1987.
7. J. Singh and J. Singh, **Photochemistry and Pericyclic Reactions,** New Age International (P) Ltd., 2nd Edition, 2005.
8. J. Singh and L. D. S. Yadav, **Organic Synthesis – Design, Reagents, Reactions and Rearrangements,** Pragathi Prakashan, Meerut, India, 1st Edition, 2009.
9. S. N. Sanyal, **Reactions, Rearrangements & Reagents,** Bharati Bhavan, 2004.
10. K. K. Rohatgi-Mukherjee, **Fundamentals of Photochemistry**, 2nd Revised Edition, New Age international Publishers, 2006.
11. Mukhergji and S. P. Singh, **Reactions mechanisms in organic chemistry,** Mc Millan 2015.
12. F.A. Carey and R.J. Sundberg, **Advanced Organic Chemistry Part A and Part B,** Plenum Press, New York, 4th Edition, 2001.
13. P.S. Kalsi, **Stereochemistry – Conformation and Mechanism,** New Age International Publishers, New Delhi, India, 7th Edition, 2008.
14. W. Carruthers, **Some Modern Methods of Organic Synthesis**, Cambridge University Press, London, 4th Edition, 2004.

CORE VI– INORGANIC CHEMISTRY-II

(For those who joined from since 2019-20)

Semester: II **Hours/Week: 6**
Subject Code: GMCHC221 **Credits: 5**

CO 1: Learnt the detailed study of synthetic inorganic complexes owing to the preparation as well as their reactivity and application which is very useful in the modern era

CO 2: To make the students to understand different reactions leads to the formation of various inorganic complexes and the mechanism involved

CO 3**:** To enable the student to understand about coordination chemistry

CO 4: To know the details of bioinorganic chemistry and inorganic photochemistry

Unit I (18 Hours)

Theory of Coordination Chemistry: Nomenclature of coordination complexes, labile and inert complexes, stability constants of complexes, stepwise and overall stability constant, their determination-Jobs continuous variation method and spectrophotometric method, factors affecting the stability constants, Valence bond theory – explanation with examples, drawbacks of VBT

Metal–ligand bonding –Overview of crystal field and ligand field theories of 4-, 5- and 6- coordinated complexes, d-orbitals splitting in linear, trigonal, octahedral, square planar, tetrahedral, trigonal-bipyramidal and cubic complexes, Measurement of CFSE (d_1 to d_{10}) in weak and strong ligand fields, Jahn-Teller distortion, Nephelauxetic series, variation of lattice energy, ionic radii and heat of hydration across 1^{st} row transition metal ions

Unit II (18 Hours)

Reaction Mechanism of Coordination chemistry: Substitution reactions – square planar substitution reactions – Factors affecting reactivity of square planar complexes, Trans effect – theories of Trans effect, substitution reactions in octahedral complexes, (SN_1,SN_2,SN_iCB) – reactions of coordinated ligands, acid hydrolysis – anation reactions and base hydrolysis

Mechanism of electron transfer reactions – Outer sphere, inner sphere electron transfer reactions, Synthesis of coordination compounds using electron transfer and substitution reaction, Applications of coordination compounds

Magnetic properties in coordination compounds– Diamagnetic, paramagnetic, ferromagnetic antiferromagnetic and ferromagnetic behaviour of transition metal complex compounds

Unit III (18 Hours)

Lanthanides and Actinides: Lanthanides – Occurrence, separation techniques (precipitation, ion-exchange, solvent-extraction and selective reduction and oxidation), electronic configuration and oxidation states, lanthanide contraction, spectral and magnetic properties, uses of lanthanides and their compounds, position in the periodic table

Actinides **–** Extraction of Th, U and Pu from fission products, electronic configuration and oxidation states, spectral and magnetic properties, position in the periodic table

Unit IV (18 Hours)

Inorganic Photochemistry: Electronic transitions in metal complexes, Metal-centered and charge-transfer transitions, Various photophysical and photochemical processes of coordination compounds, Unimolecular charge-transfer photochemistry of cobalt (III) complexes, Ligand-field photochemistry of chromium(III) complexes, Adamson's rules, Photoactive excited states, V-C Model, Photophysics and photochemistry Of ruthenium, Polypyridine complexes, Photochemistry Of organometallic compounds, Metal Carbonyl compounds

Unit V (18 Hours)

Bioinorganic Chemistry: Reversible oxygenation in life process O_2-uptake proteins – myoglobin, hemoglobin, hemeerythrin, hemocyanin and model systems, Electron transport proteins – Fe-S proteins, ferridoxin, rubredoxin and model systems, Respiratory electron transport chains– cytochromes, photosynthetic electron transport chain (PS-I and PS-II) chlorophyll, biological nitrogen fixation (nitrogenase) and abiological nitrogen fixation, Metal dependent diseases Wilsons, Alzheimer, Vitamin B_{12} -enzyme, metal complexes in therapeutic use of chelated and non-chelated compounds, Chelation therapy

Text Book:

1. F. Albert Cotton, Geoffrey, Wilkinson, Carlos A. Murillo, and Manfred Bochmann, **Advance Inorganic Chemistry,** Wiley Student Edition, John Wiley and Sons, INC, New York, 6th Edition, 2014.

Reference Books:

1. James E. Huheey, Ellen A. Keiter, Richard L. Keiter and Okhil K. Medhi, **Inorganic Chemistry – Principles of Structure and Reactivity**, Pearson Education, Indian Edition, New Delhi, India, 4th Edition, 2013.
2. J.D. Lee, **Concise Inorganic Chemistry,** Blackwell Science Ltd., London, 5th Edition, 2003.
3. Stephen J. Lippard and Jeremy Berg, **Principles of Bioinorganic Chemistry**, Panima Publishing Corporation, New Delhi, India, 2005.
4. Bertini, Gray, Lippard and Valentine**, Bioinorganic Chemistry,** Viva Books, Pvt., Ltd. 2004.
5. Asim K. Das, **Bioinorganic Chemistry**, Books and Allied (P) Ltd, Kolkota, 2010
6. W. Kaim and B. Schewederski, **Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life**, John Wiley and Sons, New York, USA, 2nd Edition, 2013.
7. A. W. Adamson and P. D. Fleischauer, **Concepts of Inorganic Photochemistry**, R. E. Krieger Pubs, Florida, 1984.
8. J. Ferraudi, **Elements of Inorganic Photochemistry**, Wiley, New York, 1988.
9. D. Banerjea, **Coordination Chemistry**, Asian Books Private Limited, 2nd Edition, 2007.
10. J.A. McCleverty and T.J. Meyer, **Comprehensive Coordination Chemistry II**, Elsevier, 2004.
11. S. F. A Kettle, **Coordination Chemistry – Ari Approach**, Spectrum Academic publishers Oxford, 1996.
12. I. Bertini et al., **Bioinorganic Chemistry**, Viva Books private Ltd, Chennai, 1998.

CORE VII – PHYSICAL CHEMISTRY-II
(For those who joined from since 2019-20)

Semester: III **Hours/Week: 6**
Subject Code: GMCHC231 **Credits: 5**

CO 1: Learnt about the various principles involved in group theory.
CO 2: Learnt the principles involved in molecular spectroscopy.
CO 3: Characterization by physical and spectroscopic techniques.
CO 4: To teach the students to understand the basic principles group theory and molecular spectroscopy
CO 5: Learnt the knowledge of electrochemistry.
CO 6: Versatile knowledge about the photochemistry, nuclear quadruple resonance and electron spin resonance spectroscopy

Unit I **(18 Hours)**

Photochemistry: Fundamentals of photochemistry, Unimolecular photochemical processes, Jablonski diagram, quantum yield, chemical actinometry, excimers, exciplexes, E-type and P-type fluorescence, short range and long range energy transfer, quenching and sensitization, Kinetics of photochemical processes, Stern-Volmer equation, Photochemical techniques– flash photolysis, radiation chemistry - pulse radiolysis, Solar energy conversion and storage, solar cell and its working, Photochemistry of environment – ozone layer in the stratosphere**,** greenhouse effect and photochromism

Unit II **(18 Hours)**

Electrochemistry-I: Mean ion activity and activity coefficient of electrolytes in solution, ion association, ionic strength, Debye-Huckel theory and Debye-Huckel limiting law – Its validity and limitations, strong and weak electrolytes, Debye theory of electrolytic conductance, Debye-Hückel-

Onsager equation - verification and limitations, electrochemical cells and applications of standard redox potentials

Unit III (18 Hours)

Electrochemistry-II: The electrical double layer, polarizable and non-polarizable interfaces, structure of electrical double layer, Double layer models–Helmholtz, Guoy-Chapman and Stern models, Kinetics of electrode processes, Current-potential curve, Butler-Volmer relation and its approximations, Symmetry factor and transfer coefficient, Tafel equation, Charge transfer resistance, Nernst equation from Butler-Volmer equation, Primary and secondary batteries, Fuel cells

Unit IV (18 Hours)

Nuclear Magnetic Resonance: Nuclear Magnetic Resonance Spectroscopy – Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin- spin interactions, factors including coupling constant 'J', classification (ABX, AMX, ABC, A_2B_2, etc), spin decoupling, basic ideas about instruments, FT NMR, advantages of FT NMR, use of NMR in medical diagnostics**,** Carbon-13 NMR Spectroscopy, Two dimension NMR Spectroscopy– COSY, NOESY, DEPT, INEPT, APT and INADEQUATE Techiniques

Unit V (18 Hours)

Nuclear Quadruple Resonance and Electron Spin Resonance: Nuclear quadruple resonance spectroscopy – quadruple nuclei, quadruple moments, electric field gradient, coupling constant, splitting, applications - Electron spin resonance spectroscopy – Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value, isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, applications

Text Book:

1. Peter Atkins, **Atkins' Physical Chemistry**, Oxford University Press, New York, 8th Edition, 2010.

Reference Books:

2. Colin N. Banwell and Elaine M. McCash, **Fundamentals of Molecular Spectroscopy**, Tata McGraw-Hill Publishing Company Limited, New Delhi, 4th Edition, 2008.
3. Samuel Glasstone, **An Introduction to Electrochemistry**, Litton Educational Publishing, Inc., New York, 2008.
4. B.K. Sharma, **Electrochemistry,** Krishna Prakashan Media (p) Ltd, 1998.
5. K. Veera Reddy, **Symmetry and spectroscopy of molecules,** 2nd Edition, New Age International Publication, 2009.
6. F. A. Cotton, **Chemical Applications of Group Theory**, 3rd Edition, John Wiley and Sons, Singapore, 2003.
7. R. L. Flurry, **Symmetry Groups: Theory and Chemical Applications**, Prentice Hall, New Jersy, 1980.
8. S. F. A. Kettle, **Symmetry and Structure,** 2nd Edition, John Wiley and Sons, Chichester, 1995.
9. J. H. Simpson, **Organic Structure Determination using 2D NMR Spectroscopy**, Academic Press, Elsevier, 2008.
10. D.L. Pavia, G. M. Lampman and G.S. Kriz, **Introduction to Spectroscopy**, Brooks/Cole Cengage Learning 4th Edition, 2008.
11. R.M. Silverstein and F.X. Webster, **Spectrometric Identification of Organic Compounds,** John Wiley & Sons, Inc., 7th Edition, 2005.
12. M.L. Martin, J.J. Delpeuch and G.J. Mirtin, **Practical NMR Spectroscopy**, Heyden 1980.
13. R.V. Parish, **NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry**, Ellis Harwood, 1991.

14. H. Windawi, and F.L.H. Floyd, **Applied Electron Spectroscopy** for Chemical Analysis (Chemical Analysis Vol. 63), John Wiley 1982.
15. K.L. Kapoor, **A Text Book of Physical Chemistry,** Macmillan, India, 2nd Edition, Vol. 3, 2005.
16. B.R. Puri, L.R. Sharma, & M. S. Pathania, **Elements of Physical Chemistry**, New Delhi, Vishal Publishing Co., 2014.
17. K. K. Rohatgi-Mukherjee, **Fundamentals of Photochemistry,** New Age International Pvt. Ltd., New Delhi, 3rd Edition, 2014.

CORE VIII – INORGANIC CHEMISTRY PRACTICAL
(For those who joined from since 2019-20)

Semester: II **Hours/Week: 6**
Subject Code: GMCHC24P **Credits: 5**

CO 1: The students to understand the basic principles of lab techniques adopted in inorganic laboratories
CO 2: Learnt about the quantitative and qualitative analyses
CO3: To enable the learners to apply the principle in the semi-micro analysis of an inorganic salt mixture
CO 4: Preparation and purification of different inorganic complexes

PART-I (90 Hours)

1. Qualitative analysis:
Semi – micro qualitative analysis: Analysis of mixtures containing one familiar and one less familiar cations from the following W, Pb, Se, Te, Mo, Cu, Cd, As, Sb, Ce, Th, Zr, Ti, V, Cr, Mn, U, Ni, Co, Zn, Ca, Ba, Sr, Li, Mr (insoluble and interfering anion may be avoided)

2. Titrimetry:
Complexometric titrations involving estimations of calcium, magnesium, nickel, zinc and hardness of water

3. Quantitative analysis:
Quantitative analysis involving volumetric and gravimetric estimations of at least four mixtures of cations.

4. Preparation of inorganic complexes:
About five preparations involving different techniques selected from the following.
(i) Potassium tris (oxalato)aluminate
(ii) Nickel ammonium sulphate
(iii) Tris(thiourea) copper(I) chloride
(iv) Potassium tris(oxalato)ferrate
(v) Hexammine cobalt(III) chloride
(vi) Ammonium hexachloro stannate(IV)
(vii) Tetrammine copper(II) sulphate
(viii) Cis and trans bis(glycinate) copper

Reference Books:

1. J. Mendham, R.C. Denney, J.D. Barnes, and M. J.K. Thomas, **Vogel's Textbook of Quantitative Analysis**, Pearson Education, 3rd Edition, 2007.
2. V.V. Ramanujam, **Inorganic Semi-micro Qualitative Analysis**, National Publishing Company, Madras, 3rd Edition, l990.
3. G. Svehla and B. Sivasankar, **Vogel's Qualitative Inorganic Analysis** (revised), Pearson, 7th Edition, 1996.
4. A. I. Vogel, **Text Book of Quantitative Inorganic Analysis**, Longman, New Delhi, 6th Edition, 2000.

ELECTIVE II (A) – APPLIED ELECTROCHEMISTRY
(For those who joined from since 2019-20)

Semester: II **Hours/Week: 6**
Subject Code: GMCHE2A1 **Credits: 5**

CO 1: To impart the knowledge on the chemistry of green inhibitors and their crucial applications
CO 2: To teach the importance of various types of battery and their applications
CO 3: Detailed knowledge about the electrochemical energy storage
CO 4: To create awareness on conversion and storage of electrochemical energy
CO 5: To teach the chemistry of coulometry
CO 6: To teach methodologies involved in voltammetry

Unit I **(18 Hours)**

Conversion and Storage of Electrochemical Energy: History of fuel cells, Direct energy conversion by electrochemical means, Electrochemical Generators (fuel cells) – Hydrogen oxygen cells, Hydrocarbon air cell, Alkaline fuel cell and Phosphoric fuel cell, Applications of fuel cells

Unit II **(18 Hours)**

Electrochemical Energy Storage: Properties of electrochemical energy stores – Measure of battery performance, charging and discharging of a battery, storage density, energy density, Classical batteries – (i) Lead acid (ii) Nickel-cadmium, (iii) Zinc manganese dioxide, Modern batteries – (i) Zinc-air (iii) Lithium battery

Unit III **(18 Hours)**

Corrosion and Stability of Metals: Civilization and surface mechanism of the corrosion of the metals–thermodynamics and the stability of metals, Potential - pH (or Pourbaix) diaphragms, uses and abuses, corrosion current and corrosion potential -Evans diagrams, Measurement of corrosion rate – (i) Weight loss method, (ii) Electrochemical method, Inhibiting corrosion– cathodic and anodic protection, organic inhibitors, Passivation – structure of passivation films, mechanism of passivation

UNIT IV **(18 Hours)**

Kinetic of Electrode Process: Methods of determining kinetic parameters for quasi-reversible and irreversible waves – Koutecky's methods, Meits Israel Method, Gellings method, Electrocatalysis – Chemical catalysts and electrochemical catalysts with special reference to porphyrin oxides of rare earths, electrocatalysis in simple redox reactions, in reaction involving adsorbed species, Influence of various parameters

UNIT V **(18 Hours)**

Potential Sweep Methods: Cyclic Voltammetry – theory and applications, diagnostic criteria of Cyclic voltammetry, Chronopotentiometry – theory and applications, Bulk electrolysis methods – Controlled potential coulometry, Controlled coulometry, Stripping analysis – anodic and cathodic modes, Bioelectrochemistry – bioelectrodics, membrane Potentials, simplistic theory and modern theory

Text Book:

1. J'OM Bockris and A. K. N. Reddy, **Modern Electrochemistry,** Plenum Publication, New York, Vol. I, IIA, Vol. IIB, 2005.

Reference Books:

2. Samuel Glasstone, **An Introduction to Electrochemistry**, Litton Educational Publishing, Inc., New York, 2008.

3. D. Pletcher and F.C. Walsh, **Industrial Electrochemistry**, Chapman and Hall, 2nd Edition, 1984.
4. F. C. Walsh and D. Pletcher, **Industrial Electrochemistry**, Kluwer Academic Pub, 2nd Edition, 1990.
5. L. Antropov, **Theoretical Electrochemistry**, University Press of the Pacific, USA, 2001.
6. Basil H. Vessor & W. Galen, **Electroaalytical Chemistry**, Wiley Interscience.
7. S. K. Rangrajan, **Topics in pure and Applied Chemistry,** SAEST Publication, Karaikudi (India).

ELECTIVE II (B) – POLYMER CHEMISTRY
(For those who joined from since 2019-20)

Semester: II **Hours/Week: 6**
Subject Code: GMCHE2B1 **Credits: 5**

CO 1: To teach the students the essential role of polymer in industries
CO 2: To teach the importance of various types of polymers and their applications
CO 3: To create awareness on polymer processing
CO 4: Different mechanisms of polymerization
CO 5: To impart the knowledge on the chemistry of polymers and their crucial applications

Unit I **(18 Hours)**

Introduction: Concept of macromolecules, Monomer structure and polymerizability Nomenclature of polymers, Different ways in classification of polymers depending on – a) The origin (natural, semisynthetic, synthetic etc.) b) The structure (linear, branched, network, hyper branched, dendrimer) c) The type of atom in the main chain (homochain, heterochain) d) The formation (condensation, addition)

Unit II **(18 Hours)**

Kinetics and mechanism of chain polymerization processes: Chain reaction (addition) polymerization, Free radical addition polymerization mechanism of vinyl polymerization, generation of free radicals, initiation, propagation, termination, chain transfer inhibition of retardation, configuration of monomer units in vinyl polymer chains, kinetics of free radical addition polymerization, Ionic and coordination chain (addition) polymerization – Common features of two types of ionic polymerization, mechanism of cationic and anionic polymerization

Unit III **(18 Hours)**

Condensation polymerization: Step reaction (condensation) polymerization – Mechanism of step reaction polymerization, kinetics of step reaction polymerization, reactivity and molecular size, kinetic expressions for polymerization in absence and in presence of a catalyst, hyper-branched polymers, dandled with highlighting their methods of synthesis and properties, preparation, properties and application of the following – polyamides , Nylon 6, Nylon 66, Nylon 610 etc., polyesters

Unit IV **(18 Hours)**

Analytical Chemistry of polymers: Instruments and specimen, elucidation of structure – Proton NMR and C^{13} NMR phenomenon, broad line spectra, Analysis of molecular structure of simple polymers, Thermogravimetric analysis, Differential thermal analysis and DSC – introduction, instrumentation and application, determination of kinetic parameters, thermal degradation behaviour of some polymer by TGA methods

Unit V **(18 Hours)**

Polymer processing: Compounding of plastics, rubber and fibres (plasticizers, colorants, flame retardants), Polymer processing - Compression, blow and injection mouldings, film extrusion and

calendaring, die casting and rotational casting, thermo foaming, reinforcing, biopolymers, Biomedical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells

Text Book:

1. Fred W. Billmayer, **Textbook of Polymer Science**, John Wiley & Sons Pvt. Ltd., Singapore, Indian Edition, 3rd Edition, 2007.

Reference Books:

2. C. E. Carraher, **Polymer chemistry**, Marcel Dekker, New York, 6th Edition, 2003.
3. P.J. Flory, **Principles of Polymer Chemistry,** Asian Book Private Ltd., 1st edition, 2006.
4. V. K. Ahluwalia and Anuradha Mishra, **Polymer Science – A Textbook**, Ane Books India, Noida, 2008.
5. V. R. Gowariker, N.V. Viswanathan and Jayadev Sreedhar, **Polymer Science**, 5th Edition, New Age International Publishers, New Delhi, 2005.
6. Malcolm P. Stevans, **Polymer Chemistry,** Oxford University Press, New York, First Indian Edition, 2008.
7. P. Bahadur and N.V. Sastry, Principles **of Polymer Science**, 2nd edition, Narosa Publishing house, Chennai, 2005.
8. T. R. Crompton**, Analysis of Polymers- an Introduction**, pergaman pres, 1989.
9. E.A. Turi, **Thermal Characterization of Polymeric Materials**, Academic press Inc.
10. W. J., D. Bavaporwala, **Plastic Technology**, Bombay.
11. L.M. Dekkar Naturaman, **Polymer Plastics Technology and Engineering,** 1979.
12. G. S. Mistra, **Introductory Polymer Chemistry,** New Age International Publication, New Delhi, 2005.
13. B. K. Sharma, **Polymer Chemistry**, Goel Publication, House, Meerut, 2009.

EXTRA CREDIT II – APPLIED CHEMISTRY
(For those who joined from since 2019-20)

Semester: II **Credits: 2**
Subject Code: GMCHX21

CO 1: To enable the learners to understand the water
CO 2: To know cement and glass chemicals
CO 3: To understand the basic concept of lubricants and protective coatings

Unit I

Water: Methods of treatment of water for domestic supply – Sedimentation, coagulation, filtration, sterilization, break point chlorination, Hardness – Different types of hardness, determination of hardness of water–Demineralization of water by ion exchange process, zeolite process and reverse osmosis process

Unit II

Cement: Manufacture of cement – Dry and wet process, important process parameters for manufacturing a good cement clinker, setting mechanism of cement, Different types of cement – special Cement, white Cement

Unit III

Glass: Composition of Glass – Raw materials for manufacture of glass, Manufacturing of glass – composition and uses of optical glass, colored glasses, lead glass and neutron absorbing glass

Unit IV

Lubricants: Functions of lubricant, mechanism of lubrication, classification of lubricants, Lubricating oil – Greases, properties of lubricating oil and greases, solid lubricants (graphite and

molybdenum) – fluid or hydrodynamic lubrication, thin film or boundary lubrication & extreme pressure lubrication

Unit V

Paints: Constituents, functions & mechanism of drying, varnishes and lacquers, surface preparation for metallic coatings, electroplating (gold) and electrodeless plating (Nickel), anodizing, phosphate coating, powder coating & antifouling coating

Text Book:

1. B.K. Sharma, **Industrial Chemistry,** New Delhi, Goel publishing, 15th Edition, 2006.

Reference Books:

2. S.S. Dara & S.S. Umare, **A Text Book of Engineering Chemistry,** New Delhi, S. Chand & Company Ltd., 2013.
3. P.C. Jain, **Engineering Chemistry**, Dhanpat Rai Publishing Company Ltd., New Delhi, 2010.
4. S. S. Dara, **A text book of Engineering Chemistry**, S. Chand & Co., New Delhi 2010.
5. P.C. Jain, & Monica Jain, **Engineering Chemistry,** Dhanpat Rai Publishing Company, New Delhi, 2009.
6. A. Ravikrishnan, **Engineering Chemistry,** Sir Krishna publication, Chennai, 2008.

CORE IX – ORGANIC CHEMISTRY-III
(For those who joined from since 2019-20)

Semester: III **Hours/Week: 6**
Subject Code: GMCHC311 **Credits: 5**

CO 1: To study the detailed aspects of analytical techniques like Infrared, Ultraviolet and Visible, Nuclear Magnetic Resonance and Mass Spectrometry
CO 2: Learnt the principles involved in small ring heterocycles
CO 3: Learnt about the various principles involved in terepenoids, alkaloids, flavonoids, steroids, porphyrins and prostaglandins

Unit I **(18 Hours)**

Ultraviolet and Visible & Infrared Spectroscopy: Ultraviolet and Visible Spectroscopy – Introduction, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, Fieser – woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds, steric effect in biphenyls (problem to be discuss), Calculating of λ_{max}

Infrared Spectroscopy – Introduction, Factors influencing group frequencies, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines, detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides and conjugated carbonyl compounds)

Unit II **(18 Hours)**

Nuclear Magnetic Resonance & Carbon-13 NMR Spectroscopy: ^{1}H –Chemical shift, spin-spin coupling, coupling constant, first order and second order spin-spin splitting, Influence of stereo chemical factors on chemical shift of protons, simplification of complex spectra, spin decoupling, Double resonance – Shift reagents, CIDNP

Carbon-13 NMR Spectroscopy – Basic principle of FT technique, relaxation time, assignment of the signals, Off-resonance decoupling – 2D NMR, Structural problems based on all the above techniques – correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic alkyne, aromatic, hetero aromatic and carbonyl carbon) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto)

Unit III (18 Hours)

Mass Spectrometry: Introduction, principle, Type of ions – Base peak, parent ion, metastable ion and isotopic ions, fragmentation, general rules, pattern of fragmentation for various classes of organic compounds – Mc Lafferety rearrangement, Retro diels and Alder reaction, Nitrogen rule, High resolution mass spectrometery, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination

Unit IV (18 Hours)

Small Ring Heterocycles: Three-membered and four-membered heterocycles – synthesis and reactions of azirodines, oxiranes, thiranes, azetidines, oxetanes and thietanes

Benzo-fused five-membered heterocycles – synthesis and reactions including medicinal applications of benzopyrroles, bezofurans and benzothiophenes

Unit V (18 Hours)

Chemistry of Natural Products: Stereochemistry, reaction and synthesis of terpenoids and carotenoids – zingiberine and α- cadinene - Stereochemistry, reactions and synthesis of alkaloids – camptothecin - Structure, synthesis and reactions of flavonoids – coumarins

Structure, synthesis and reactions of steroids – cholesterol (without synthesis), bile acid, testosterone, estrone, progesterone - Structure and synthesis of prostaglandins: PGE_2

Text Book:

1. P. M. Silverstein and F. X. Western, **Spectroscopic Identification of Organic Compounds**, John Wiley, New York, 8th Edition, 2014.

Reference Books:

2. I. L. Finar, **Organic Chemistry**, Pearson Education Pvt. Ltd, Vol 2, 6th Edition, 2002.
3. C. N. Banwell and E. M. McCash, **Fundamentals of Molecular Spectroscopy,** Tata McGraw Hill, 1994.
4. S. Chandra, **Molecular Spectroscopy**, Narosa Pvt. Ltd, 2009.
5. William Kemp, **Organic Spectroscopy**, Palgrave, New York, USA, 3rd Edition, 2004.
6. J. R. Dyer, **Applications of Absorption Spectroscopy of Organic Compounds,** PHI Learning, New Delhi, 2009.
7. Y. R. Sharma, **Elementary Organic Spectroscopy – Principles and Chemical applications,** S. Chand, New Delhi, 1992.
8. P. S. Kalsi, **Spectroscopy of Organic Compounds**, 6th Edition, New Age International Publishers, New Delhi, 2004.
9. Silverstein, **Spectrometric Identification of Organic Compounds**, Tata McGraw Hill, 7th Edition, 2005.
10. J. A. Joule and K. Mills, **Heterocyclic Chemistry,** Blackwell Publishing, Wiley India Pvt. Ltd., New Delhi, 4th Edition, 2009.
11. O. P. Agarwal, **Organic Chemistry – Natural Products,** GOEL Publishing House, Meerut, India, Vol. I, 2003.
12. O. P. Agarwal, **Organic Chemistry – Natural Products,** GOEL Publishing House, Meerut, India, Vol. II, 2004.
11. Raj K, Bansal, **Heterocyclic Chemistry**, New Age International Publishers, New Delhi, India, 4th Edition, 2009.
12. I. Howe, D.H. Williams and R.D. Bowen, **Mass Spectrometry, Principles and Applications**, McGraw Hill, New Delhi, 2nd Edition, 1981.

COREX– INORGANIC CHEMISTRY-III

(For those who joined from since 2019-20)

Semester: III **Hours/Week: 6**

Subject Code: GMCHC321 **Credits: 5**

CO1: To enable the student to learn the organometallic chemistry- I and II
CO2: To enable the students in-depth study of spectral applications to the structural elucidation of inorganic compounds
CO 3: Detailed knowledge about the supramolecular chemistry
CO 4: Learnt the principles involved in medicinal bioinorganic chemistry

Unit I (18 Hours)

Organometallic Chemistry-I: The 18- electron rule for organometallic compounds of transition metals, Classification based on 18-electron rule, Complexes of two, three, four, five six, seven, eight-electron π-ligands, Nomenclature, Exceptions to 18 electron rule, the 16-electron rule, isolobal and isoelectronic relationship of complexes, agostic interaction, metal-carbon-bonded compounds (compounds of the sigma electron ligands), metal-alkyl, -allyl, -carbene, -carbonyl, -carbide and cyclopentadienyl complexes, Structure and bonding in η^2- ethylene and η^3- allylic compounds with typical examples, Structure and bonding in metallocenes

Unit II (18 Hours)

Organometallic Chemistry-II: Organometallic reactions – ligand association and dissociation, oxidative addition and reductive elimination, insertion reactions, Catalytic mechanism in the following reactions – hydrogenation of olefins (Willkinson catalyst), Tolman catalytic loops hydroformylation (Oxoprocess) – acetic acid from methanol, oxidation of alkenes to aldehydes and ketones (Wacker process) – synthesis gas and their applications using organometallic compounds as catalyst, olefin polymerization (Ziegler-Natta), Cyclo oligomerisation of acetylenes (Reppe's or Wilke's catalysts), Synthetic gasoline (Fischer Tropsch process and mobile process), Photodehydrogenation catalyst (Platinum POP)

Unit III (18 Hours)

Application of IR, Raman and Mossbauer Spectroscopy to the Study of Inorganic Compounds: IR and Raman Spectroscopy – Application of IR and Raman spectra in the study of coordination compounds, application to metal carbonyls, nitrosyls and sulphate, geometrical and linkage isomerism, detection of inter and intramolecular hydrogen bonding

Mossbauer spectroscopy – Mossbauer effect, resonance absorption, doppler effect, doppler velocity, isomer shift, magnetic hyperfine splitting, application of Mossbauer spectroscopy in the study of iron and tin complexes

Unit IV (18 Hours)

Electronic Spectra and NMR Spectroscopy of Inorganic Compounds:

Electronic Spectra Spectroscopy – d-d transition, charge transfer transition, selection rules, mechanism of beak down of selection rules, bandwidths and shapes, Jahn Teller effect, Orgel diagram - evaluation of $10D_q$ and β for octahedral and tetrahedral complexes

NMR Spectroscopy – ^{31}P and ^{19}F NMR spectroscopy– Introduction, application in structural problem, evaluation of rate constants, monitoring the course of reaction, NMR of fluxional molecules, NMR of paramagnetic molecules, contact shifts and shift reagents

Unit V (18 Hours)

Supramolecular and Medicinal Bioinorganic Chemistry: Supramolecular Chemistry – Definition, nature of supramolecular interactions, supramolecular host-guest compounds, supramolecular devices and sensors, various types of supramolecular devices – supramolecular photochemistry, molecular and supramolecular photonic devices – light conversion and energy transfer devices, role of supramolecular chemistry in the development of nanoscience and technology

Medicinal Bioinorganic Chemistry – Chemotherapy with compounds of certain non-essential elements, Platinum complexes in cancer therapy, Cisplatin and its mode of action, Cytotoxic compounds of other metals, Gold containing drugs as anti-rheumatic agents and their mode of action, Lithium in pschycopharmocological drugs, radiopharmaceuticals technetium

Text Book:

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, **Inorganic Chemistry Principles of Structure and Reactivity,** Harper Collins College Publishers, 4th Edition, 2006.

Reference Books:

2. John F. Hartwig, **Organotransition Metal Chemistry: From Bonding to Catalysis**, University Science Books, 2009.
3. Ch. Elshebroicn and A. Salzer, **Organometallics: A concise Introduction,** VCH, 2006.
4. B. E. Douglas, D. H. McDaniel and J. J. Alexander, **Concepts and Models of Inorganic Chemistry,** Wiley-India, 3rd Edition, 2007.
5. B. D. Guptha and A. J. Elias, **Basic Organometallic Chemistry,** Universities Press, 2010.
6. H. J. Schneider and A. Yatsimirsky, **Principles and Methods in Supramolecular Chemistry,** Wiley, New York, 2000.
7. J.W. Steed and J.L. Atwood, **Supramolecular Chemistry,** John Wiley &Sons, Chichester, 2009.
8. R. H. Crabtree, **The Organometallic Chemistry of the Transition Metals**, 3rd Edition, John Wiley and Sons, New York, 2001.
9. Stephen J. Lippard and Jeremy Berg, **Principles of Bioinorganic Chemistry**, Panima Publishing Corporation, New Delhi, India, 2005.
10. Bertini, Gray, Lippard and Valentine**, Bioinorganic Chemistry,** Viva Books, Pvt., Ltd. 2004.
11. Asim K. Das, **Bioinorganic Chemistry**, Books and Allied (P) Ltd, Kolkota, 2010.
12. W. Kaim and B. Schewederski, **Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life**, John Wiley and Sons, New York, USA, 2nd Edition, 2013.
13. Raymond Chang, **Basic principles of Spectroscopy,** Mc Graw Hill, New Delhi, 1971.
14. Kazuo Nakamoto, **Infrared and Raman Spectra of Inorganic and coordination compounds,** John Wiley and Sons, New York, 4th Edition, 1986.
15. W. Kemp, **Organic Spectroscopy**, Palgrave, New York, 3rd Edition, 2011.
16. R.S. Drago, Physical Methods in Inorganic Chemistry, East-West press Pvt. Ltd., New Delhi, 2012.

CORE XI – PHYSICAL CHEMISTRY-III
(For those who joined from since 2019-20)

Semester: II **Hours/Week: 6**
Subject Code: GMCHC331 **Credits: 5**

CO 1: To understand the principles of quantum chemistry
CO 2: To enable the learners to acquire knowledge in corrosion chemistry
CO 3: Concept of computer applications in chemistry and their stability for many practical uses
CO 4: To understand the basic concept of group theory

Unit I **(18 Hours)**

Basics of quantum chemistry: Introduction of quantum chemistry, operators, postulates of quantum chemistry, eigen value and eigen function, normalization and orthogonality, Schrodinger wave equation

Application of quantum chemistry to simple systems

Translational motion – Particle in one dimensional box, particle in three dimensional box-rectangular and cubical box , particle with finite potential barrier, One finite potential barrier, two finite potential barrier

Vibrational motion – Hooke's law, harmonic oscillator, the quantum mechanical derivation for a harmonic oscillator model of a diatomic molecule

Rotational motion – Rigid rotator, derivation of energy and wave function of rigid rotator, rotation in one plane, rotation in space

Hydrogen and Hydrogen like atoms – Spherically symmetric potential and the hamiltonian, spherical coordinates, schrodinger wave equation in terms of r, θ, Φ, radial eigen functions

Unit II (18 Hours)

Approximate methods: Variation principle-linear and non-linear variation theory, Perturbation theory-Ist, Application of variation and perturbation theory to He atom

Theory of angular momentum **–** Angular momentum, quantum mechanical operator for angular momentum, ladder operator, eigen function and eigen values of angular momentum using ladder operator

Molecular orbital theory (MOT) – LCAO approximation, the H^{2+} ion, the LCAO-MO wave fuction of H^{2+} ion, electron density and bonding in H^{2+}, physical representation, Huckel MOT of conjugated systems, Huckel rule of aromaticity, Applications of Huckel MOT to ethylene, butadiene, Elementary idea of extended Huckel theory

Unit III (18 Hours)

Corrosion Chemistry: Basic aspects of corrosion – Classification of corrosion – Dry corrosion and electrochemical corrosion, Difference between chemical and electrochemical corrosion, Corrosion control methods**–** Protective Coatings - Metallic coating, non - metallic coating and organic coating, pre-treatment of the surface, Metallic coatings **–** Hot dipping, spraying, cladding, cementation, electroplating – process, types of electroplating, factors affecting electroplating, applications of electroplating, Inorganic non-metallic coating – Chromate coating, phosphate coating and oxide coating, Organic coating – Paints, requirements of good paint

Unit IV (18 Hours)

Computer Applications in Chemistry: Introduction to computers and computing - Block diagram of a PC and the functions of the various units of computer, High and low level languages, Introduction to networking - LAN, WAN, Internet and Intranet, World Wide Web, Chem Web, E-journals– search engines for chemistry

Introduction to C language - Structure of C program, control statements, loops -recursion.

Examples of simple chemistry programmes:

1. Calculation of pH
2. Determination on first order rate constant for the given reaction
3. Calculation of normality, molarity and molality of a given solution
4. Converting kelvin to celsius temperature and vice versa
5. Determination of enthalpy of a given solution
6. Evaluation of cell constant

Unit V (18 Hours)

Group Theory: Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup, conjugacy relation and classes, point symmetry group, schonflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh}), character of a representation

Character Table and their uses **–** The great orthogonality theorem and its importance, construction of character tables, reducible and irreducible representations, group theory and quantum mechanics, projection operator, using projection operator to construct symmetry adopted linear combinations (SALCs)

Text Book:

1. R.K. Prasad, **Quantum Chemistry**, New Age International Publishers, New Delhi, 4th Edition, 2010.

Reference Books:

1. N. I. Levine, **Quantum Chemistry**, Prentice Hall, 5th ed., 2008.
2. A.K. Chandra, **Introduction to Quantum Chemistry**, Tata McGraw Hill, 4th ed., 2004.
3. P. Atkins and R. Friedman, **Molecular Quantum Mechanics**, Oxford University Press, 4th ed., 2005.
4. Donald A. McQuarrie, and John D. Simon, **Physical Chemistry – A Molecular Approach**, Viva Books Pvt. Ltd., New Delhi, 3rd Edition, 2011.
5. Peter Atkins, **Atkins' Physical Chemistry**, Osford University Press, New York, 8th Edition, 2010.
6. Ira N. Levine, **Quantum Chemistry**, Pearson Education Pvt. Ltd., New Delhi, 5th Edition, 2004.
7. David O. Hayward, **Quantum Mechanics for Chemists**, The Royal Society of Chemistry, UK, 2002.
8. John P. Lowe and Kirk A. Peterson, **Quantum Chemistry**, Academic Press, London, UK, 3rd Edition, 2009.
9. B.K. Sharma, **Industrial Chemistry,** New Delhi, Goel publishing, 15th Edition, 2006.
10. S.S. Dara & S.S. Umare, **A Text Book of Engineering Chemistry,** New Delhi, S. Chand & Company Ltd., 2013.
11. P.C. Jain, **Engineering Chemistry**, Dhanpat Rai Publishing Company Ltd., New Delhi, 2010.
12. S. S. Dara, **A text book of Engineering Chemistry**, S. Chand & Co., New Delhi 2010.
13. P.C. Jain, & Monica Jain, **Engineering Chemistry,** Dhanpat Rai Publishing Company, New Delhi, 2009.
14. A. Ravikrishnan, **Engineering Chemistry,** Sir Krishna publication, Chennai, 2008.
15. Raman K.V., **Group Theory and Its Applications to Chemistry**, Tata McGraw-Hill, 1990.
16. N.N. Dass, **Symmetry and Group Theory for Chemists**, Asian Books Pvt. Ltd 2004.
17. M.S. Gopinathan, and V. Ramakrishnan, **Group Theory in Chemistry**, Vishal Publishers, 2006.
18. K. V. Raman , **Computers in Chemistry**, Tata McGraw- Hill Publishing Company Ltd., New Delhi, 3rd Edn., 1993.
19. K. Arora, **Computer Applications in Chemistry**, Anmol Publications Pvt. Ltd. 2004.
20. R. Kumari, **Computers and their Applications to Chemistry**, Narosa Publishing House Pvt. Ltd, Second Edition 2005.
21. Brian W. Kernighan & Dennis M. Ritchie, **The C Programming Language**, Prentice Hall of India Private Limited, New Delhi, 2nd Edn., 2001.
22. Byron S. Gottfried, **Programming with C,** Tata McGraw- Hill Publishing Company Ltd., New Delhi, 2nd Edn., 2001.
23. R. Rajaram, **C Programming Made Easy,** Scitech Publications, Chennai, 1999.

CORE XII – PHYSICAL CHEMISTRY PRACTICAL
(For those who joined from since 2019-20)

Semester: III **Hours/Week: 6**
Subject Code: GMCHC34P **Credits: 5**

CO1: The students to understand the basic principles of lab techniques adopted in physical laboratories
CO 2: To know about the practical applications of conductometry, potentiometry and p^H metry
CO 3: Measurement of various physical and chemical properties
CO 4: Applying related experiments for their research work
CO 5: To get in-depth knowledge in adsorption, thermochemistry, chemical kinetics surface tension and distribution law experiments

PART-I **(90 Hours)**

1. Conductometry:

(i) Determination of cell constant
(ii) NaOH vs. HCl titration
(iii) NaOH vs. Oxalic acid titration
(iv) NaOH vs. CH_3COOH titration
(v) $AgNO_3$ vs. KCl titration
(vi) Ba $(NO_3)_2$ vs. Na_2SO_4 titration

2. Potentiometry:

(i) NaOH vs. HCl titration
(ii) NaOH vs. Oxalic acid titration
(iii) NaOH vs. CH_3COOH titration
(iv) $AgNO_3$ vs. KCl titration
(v) $KMnO_4$ vs. Mohr's Salt/ $FeSO_4$ titrations

3. pH metry:

(i) NaOH vs. HCl titration
(ii) NaOH vs. Oxalic acid titration
(iii) NaOH vs. CH_3COOH titration
(iv) Determination of first, second and third dissociation constants of phosphoric acid

4. Thermochemistry:

(a) Determination of heat of neutralisation
(i) NaOH vs. HCl
(ii) NaOH vs. CH_3COOH
(iii) NaOH vs. Oxalic acid
(b) Determination of Heat of solution and Heat of hydration of $BaCl_2$ and $CuSO_4$

5. Chemical Kinetics

(i) To study kinetics of hydrolysis of an ester in the presence of acid
(ii) To compare the relative strength of acids (HCl and H_2SO_4)
(iii) To determine the temperature coefficient for the I^{st} order reaction
(iv) Perdisulphate and iodide ion reaction: study of Primary salt effect and determination of concentration of given KNO_3

6. Surface tension

To determine interfacial tension of two immiscible liquids

7. Adsorption

To study the adsorption of Oxalic acid and Acetic acid on charcoal

8. Distribution Law

(i) To determine partition coefficient of benzoic acid between benzene and water
(ii) To determine partition coefficient of Iodine between Carbon tetrachloride and water
(iii) Determination of Equilibrium constant for $I_2 + I^- = I_3$

Reference Books:

1. B.D. Khosla, V.C. Garg, and A.R. Gulati **Senior Practical Physical Chemistry**, S. Chand, 2007.
2. J.B. Yadav, **Advanced Practical Physical Chemistry**, Krishna Prakasan Media, 2008.
3. D. P. Shoemaker, **Experimental Physical Chemistry,** Mc. Growhill, 7th Edition, 2003.
4. B.P. Levitt, **Findlay's Practical Physical Chemistry**, Longman Group Ltd., 9th Edition, 1985.

5. Matthews, G. Peter, **Experimental Physical Chemistry,** Oxford University Press, 1st Edition, 1985.
6. R.C. Das, and B. Behra, **Experimental Physical Chemistry**, Tata McGraw, 1983.

ELECTIVE I (A) – NANOSCIENCE AND NANOTECHNOLOGY
(For those who joined from since 2019-20)

Semester: III **Hours/Week: 6**
Subject Code: GMCHE3A1 **Credits: 5**

CO 1: To understand the concept of self-assembly and its applications to various Nano structures
CO 2: To understand the role of various methods of preparation of Nanomaterials
CO 3: To learn characterization of Nano materials
CO 4: Learnt about the various theories of Nanoscience and Nanotechnology
CO 5: Studied the recent development in Nanomedicine

Unit I **(18 Hours)**

Introduction to Nanoscience and Nanotechnology: Background to Nanotechnology scientific revolution, Types of Nanostructures, Definition of a Nano system, Types of Nanocrystals – one Dimensional (1D), two Dimensional (2D), three Dimensional (3D) Nanostructured materials, Quantum dots, Quantum wire - Core/Shell structures, Nanomaterials and properties –Carbon Nanotubes (CNT), metals (Au, Ag), metal oxides (TiO_2, CeO_2, ZnO), semiconductors (Si, Ge, CdS, ZnSe), Applications of Nanomaterials

Unit II **(18 Hours)**

Synthesis of Nanomaterials: Bulk synthesis of bulk Nanostructured materials, Sol-gel processing, Mechanical alloying and milling, Inert gas condensation technique, bulk and Nano composite materials, grinding, High energy ball milling physical and chemical approaches self-assembly–Self-Assembled Monolayers (SAM), Vapour Liquid Solid (VLS) approach- Chemical Vapour Deposition (CVD), Introduction to vacuum technology, Physical Vapour Deposition techniques

Unit III **(18 Hours)**

Characterization Techniques for Nanomaterials: Electron Microscopy– Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning Probe Microscopic Techqnics, Atomic force Microscopy (AFM) and Scanning Tunneling Microscopy, Particle size Analyser (Dynamic light scattering), X-ray Differaction (XRD), Auger Emission Spectroscopy, Electron Spectroscopy for Chemical analysis (ESCA)

Unit IV **(18 Hours)**

Carbon Clusters, Inorganic and organic nanomaterials: Nature of carbon bond − New carbon structures, Carbon clusters- Discovery of C_{60}, Alkali doped C_{60}, Superconductivity in C_{60}, Larger and smaller fullerenes
Inorganic nanomaterials − nano TiO_2 / ZnO/CdO/CdS,
Organic nanomaterialss – Rotaxanes and Catenanes

Unit V **(18 Hours)**

Nanomedicine and Nanodevices – DNA as a nanomaterial, DNA – knots and junctions, DNA-nanomechanical device, Force measurements in simple protein molecules and polymerase – DNA complexes, Molecular recognition and DNA based sensor. Protein nano array, nanopipettes, molecular diodes, self-assembled nano transistors, nanoparticle mediated transfection, Molecular Nanotechnology – MEMS, NEMS, Nano fluidics and micro fluidics, self-assembly of Nanoparticles for biomedical applications, Nanomolecular diagnostics and Biosensor Nanodiagnostics

Text Book:

1. G.Cao, **Nanostructures and Nanomaterials: Synthesis, Properties and Applications,** Imperical College Press, 2004.

Reference Books:

2. M. Wilson, K. Kannangara, G Smith, M. Simmons and B. Raguse, **Nanotechnology: Basic Science and Emerging Technologies,** Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
3. C.N.R. Rao, A. Muller and A. K. Cheetham (Eds), **The Chemistry of Nanomaterials: Synthesis, Properties and Applications,** Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.
4. Kenneth J. Klabunde (Eds), **Nanoscale Materials Science**, John Wiley & Sons, Inc, 2001.
5. C.S.S.R. Kumar, J. Hormes and C. Leuschner, **Nanofabrication towards biomedical applications,** Wiley –VCH Verlag GmbH & Co, Weinheim, 2004.
6. W. Rainer, **Nano Electronics and information Technology**, Wiley, 2003.
7. K. E. Drexler, **Nano systems**, Wiley, 1992.
8. C. P. Poole and F. J. Owens, **Introduction to Nanotechnology**, Wiley Interscience, New Jersey, 2003.
9. K. J. Klabunde (Ed), **Nanoscale Materials in Chemistry**, Wiley-Interscience, New York, 2nd Edition, 2009.
10. T. Pradeep, **Nano: The Essentials in Understanding Nanoscience and Nanotechnology**, 1st Edition, Tata McGraw Hill, New York, 2007.
11. H. Fujita (Ed.), **Micromachines as Tools in Nanotechnology**, Springer-Verlag, Berlin, 2003.
12. T. Tang and P. Sheng (Eds), **Nanoscience and Technology, Novel Structures and Phenomena**, Taylor and Francis, New York, 2003.
13. A. Nabok, **Organic and Inorganic Nanostructures**, Artech House, Boston, 2005.
14. E. A. Rietman, **Molecular Engineering of Nanosystems**, Springer-Verlag, New York, 2001.
15. C.M. Niemeyer and C.A. Mirkin, **Nanobiotechnology, Concepts, Applications and perspectives,** WILEY-VCH, Verlag Gmb H&Co, 2004.
16. Edward A. Rietman, **Molecular engineering of Nanosystems,** Springer- Verlag, New York, 2001.
17. G. Ozin and A. Arsenaut, **Nanochemistry: A Chemical Approach to Nanomaterials,** Royal Society of Chemistry, London, 2005
18. C.N.R. Rao, A. Muller and A.K. Cheetham, **The Chemistry of Nanomaterials,** WileyVCH, Germany, 2004.

ELECTIVE III (B) – MATERIAL CHEMISTRY
(For those who joined from since 2019-20)

Semester: III **Hours/Week: 6**
Subject Code: GMCHE3B1 / GMCHE3B **Credits: 5**

CO 1: To understand the basic concept of structure of matter and their various properties
CO 2: Experimental techniques for controlling the chemical reactions
CO 3: Measurement of various physical and chemical properties
CO 4: Applying related experiments for their research work
CO 5: Mechanism for chemical reactions for optimizing the experimental conditions
CO 6: Physical and chemical characterization of catalysts and catalytic reaction

Unit I **(18 Hours)**

Structure of Matter: Atomic structure: Wave mechanical model, electronic configurations, ionic, covalent, metallic and secondary bond. Space lattices and crystalographic systems. influence of radius ratio on coronation, structure of common metallic, semi conducting, ionic, polymeric and ceramic materials

Use of X-ray diffraction for determination of simple structures, point, line and surface defects, geometry of edge and screw dislocations, Burger's vector, grain and twin boundaries

Unit II (18 Hours)

Diffusion Behaviour: Mechanism of diffusion Fick's laws, solution to Fick's second law, surface and grain boundary diffusion, experimental determination of diffusion coefficient

Phase behavior **–** Solid Solutions, Intermediate phases and intermetallic compounds, phase rule, binary phase diagrams like Cu-Ni, Pb-Sn, Cu-Zn and Fe-C, transformation in steels, Nucleation and growth phenomena, solidification including directional solidification, crystal growth, zone melting and purification

Mechanical properties **–** Elastic, anelastic and viscoelastic behaviours of materials, atomic model of elastic behaviours, rubber – like elasticity, relaxation processes, displacement model for viscoelasticity, plastic deformation, slip systems in crystals, critical resolved shear stress, work hardening, strengthening mechamism, ductile and brittle fracture, Griffith's criterion, failure of materials due to creep and fatigues, deformation behaviours of polymers and ceramics

Unit III (18 Hours)

Electrical Properties: Electrical / Electronic behaviours of materials, electronic and ionic conductivity, free electron and band theory of solids, intrinsic and extrinsic semiconductors, conduction mechanisms, junctions and devices, viz-diodes, rectifiers, transistors and solar cells, super conductivity

Dielectric behaviours of materials – Polarization phenomena, polarizability, frequency and temperature dependence of dielectric constant

Unit IV (18 Hours)

Magnetic properties: Magnetic behaviours of materials– dia, para, ferro and ferri magnetisms, soft and hard magnetic materials including ceramic magnets

Optical Properties **–** Optical properties of materials, elementary ideas about absorption, transmissions and reflection refractive index, lasers and their application, optoelectronic devices

Thermal properties **–** Thermal properties of materials, specific heat, thermal conductivity and thermal expansions

Unit V (18 Hours)

Thin film deposition techniques: Introduction – CVD, PVD, Spray pyrolysis, Sputtering, Molecular beam epitaxy Electroplating and Electroless plates methods

Materials characterization techniques – Materials characterization techniques such as XRD, ESC A, XPS, AES, FTIR and Laser Raman spectroscopy, Microscopic techniques – SEM, AFM and TEM, Thermal analysis – TG/DTA and DSC

Text Books:

1. V. Raghavan, **A First course in Materials science and Engineering**, Prentice-Hall of India Private Ltd., New Delhi.

Reference Books:

2. A**.** G. Guy, **Elements of Materials Science**, Mc Graw Hill.
3. A. L. Ruoff, **Introduction to Materials Science**, Prentice-Hall.
4. M. F. Ashby and D. R. H, Jones, **Engineering Materials**, Pregamon
5. O. P. Khana, **A Text book of Material Science and Metallurgy**, Damphat Rai &Sons, New Delhi.
6. C. M. Srivastava & C. S rinivasan, **Science of Engineering Materials**, New Age International (P) Ltd., New Delhi.
7. C. Kittd, **Solid State Physics**, Wiley Eastern Ltd., 1995.
8. B. S. Saxena R. C. Gupta and P. M. Saxena, **Fundamentals of Solid State Physics**, Pragati Prakasham Educational Publishers, Meerat
9. K.L Chopra and I.Kaur, **Thin Film Devices and their Applications**, Plenum Press, New York, 1983.

10. K. S. V. Santhanam and M. Sharon, **Photoelectrochemical Solar Cell**, Elsevier Science Publishers, New York, 1988.
11. A. F. Fahrenbruch and R.H. Bube, **Fundamentals of Solar Cells**, Academic Press, London.

EXTRA CREDIT III – AGRICULTURAL CHEMISTRY
(For those who joined from since 2018-19)

Semester: III **Credits: 2**
Subject Code: GMCHX31

CO 1: Concepts and applications of soil chemistry
CO 2: The students will acquire the knowledge of soil fertility and soil productivity
CO 3: Mode of action of Soil and fertilizer phosphorus

Unit I
Soil Chemistry: Chemical (elemental) composition of the earth's crust and soils, Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics, Soil organic matter– Classification, fractionation of soil organic matter and different fractions, genesis and nature of soil organic matter and humus formation, humus decomposition, separation of humus from soil particles, clay-organic interactions

Unit II
Soil fertility and soil productivity: Nutrient sources – fertilizers and manures, Essential plant nutrients - functions and deficiency symptoms, Law of soil fertility soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification, biological nitrogen fixation, nitrogenous fertilizers and their fate in soils, management of nitrogenous fertilizers

Unit III
Soil and fertilizer phosphorus: Forms, immobilization, mineralization, reactions in acid and alkali soils, factors affecting on availability in soils, Phosphatic fertilizers - behavior in soils and management under field conditions, Potassium - forms, equilibrium in soils and its significance, mechanism of potassium fixation, management of potassium fertilizers under field conditions

Unit IV
Sulphur, Calcium and Magnesium: Source, forms, fertilizers and their behavior in soils, factors affecting their availability in soils, management of fertilizers, Micronutrients – critical limits in soils and plants, factors affecting their availability and correction of their deficiencies in plants, role of chelates in nutrient availability

Unit V
Chemistry of acid soils: Active and potential acidity, lime potential, sub-soil acidity, Chemistry of salt-affected soils and amendments, soil pH, ECe, ESP, SAR and important relations, soil management and amendments, Chemistry and electrochemistry of waterlogged soils

Text Book:
1. J.S. Kanwar, **Theory and Practice of Soil Fertility**, ICAR Pub., 1985.

Reference Books:
2. K. Mengel & E. A. Kirkby, **Principles of Plant Nutrition**, International Potash Institute, Switzerland, 1982.
3. J.J. Mortvedt, L. M. Shuman, F. R. Cox & R. M. Welch, **Micronutrients in Agriculture,** SSSA, Madison, 2nd Ed., 1991.

4. G. M. Pierzinsky, T. J. Sims & J. F. Vance, **Soils and Environmental Quality,** CRC Press, 2nd Ed., 2002.
5. F. J. Stevenson & M. A. Cole, **Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients,** John Wiley & Sons, 1999.
6. S. L. Tisdale, S. L. Nelson, J. D. Beaton & J. L. Havlin, **Soil Fertility and Fertilizers,** Prentice Hall of India, 5th Ed., 1999.
7. F. R. Troeh & L. M. Thompson, **Soils and Soil Fertility,** Blackwell, 2005.
8. S. Chand, **Integrated Nutrient Management for Sustainable Crop Production and Soil**, 2008.
9. Health, International Book Distributing Co., Lucknow, UP
10. Tolanur, Shivanandan, **Soil Chemistry,** International Book Distributing Co., Lucknow, 2006.
11. K.H. Tan, **Principles of Soil Chemistry,** John Wiley & Sons, 1988.

CORE XIII– PROJECT
(For those who joined from since 2019-20)

Semester: IV **Hours/Week: 30**
Subject Code: GMCHC4PW **Credits: 15**

CO 1: To enable students to understand the basic concepts in chemistry project
CO 2: Experimental techniques for controlling the chemical reactions
CO 3: Measurement of various physical and chemical properties
CO 4: Applying related experiments for their research work
CO 5: To gain the hands on experience of different instruments and will give the exposure of research potential
CO6: To learn principles and procedures employed in thesis writing of chemistry and develop practical

The program encourages the students to experience the research in the field of chemistry. A Project work to be done individually by the students either in the department laboratory or in a chemical industry or in institutions like CECRI, Agricultural Research Station, Water testing centres, Pharmaceutical laboratories etc. The Project work should help the students to create research attitude and apply theory they have learnt throughout the course.
Project internal is evaluated on the basis of presentation of the project such as, for review 75 marks, dissertation (record) 20 marks and 5marks for attendance.
The external 100 marks is distributed as follows, for dissertation (record) 40 marks, for presentation 30 marks and for viva- voce 30 marks.