Murshidabad Maharaja Krishnanath University

Berhampore, Murshidabad

Syllabus

Two Years M.Sc. in Chemistry

(NEP 2020)

DEPARTMENT OF CHEMISTRY

Murshidabad Maharaja Krishnanath University

Berhampore, Murshidabad

West Bengal, India,

Pin 742101

Semester – I

Course Code	Course Type	Course Name	Credit	Lectures / Week	Internal Assessment	End Semester	Total Marks
PG-CHE-101(T)	Theory	Inorganic Chemistry	4	4	20	60	80
PG–CHE-102 (T)	Theory	Physical Chemistry	4	4	20	60	80
PG–CHE-103(T)	Theory	Organic Chemistry	4	4	20	60	80
PG–CHE- 104(P)	Practical	Inorganic, Physical & Organic Chemistry Practical	4	8	20	60	80
PG-MDC-105(T)	Theory		4	4	20	60	80
Total			**20**	**24**	**100**	**300**	**400**

SEMESTER-I

Course Code	Course Title	Credit: 4
PG-CHE-101(T)	Inorganic Chemistry	F.M. = 80

1. Theories of Bonding: (15L)

Hydrogen molecule: Linear Combination of atomic orbitals (LCAO) method-normalizing constant, overlap integral. Bonding, non-bonding and anti-bonding orbitals. The variational principle-coulomb integral, resonance integral. Qualitative MO treatment to understand the bonding in polyatomic (triatomic, tetraatomic etc) systems. Qualitative MO energy level and orbital diagrams. Rationalization of structures.

2. Metal – ligand Equilibria in Solution (20L)

Stability of mononuclear, polynuclear and mixed ligand complexes in solution. Stepwise and overall formation constants and their relations. Trends in stepwise formation constants, factors affecting the stability of metal complexes with reference to the nature of the metal ions and ligands. Statistical and non-statistical factors influencing stability of complexes in solution.

3. **Bioinorganic Chemistry (25L)**

Essential elements of Life, Role of metal ions in living systems-a brief review, Na^+ ion pump and transport of Na^+ and K^+ across the cell membrane, Porphyrin and related ligands, ATP as energy source, oxidative phosphorylation and phosphorylation of glucose. Transport and storage of dioxygen: Structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin, Synthetic oxygen carriers. Active site structures and bio-functions of carboxy peptidase A, carbonic anhydrase B, cytochrome c and chlorophyll. Biological nitrogen fixation, toxic metals (Pb, Cd and Hg) and their effects. Wilson disease, chelation therapy, platinum and gold complexes as drugs (examples only).

Reference Books

1. F. A. Cotton, G. Wilkinson, C. M. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, 6th Edn, John Wiley & Sons, Inc, New York, 1999.

2. J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi, *Inorgnic Chemistry: Principles of Structures and Reactivity*, 4th Edn, Pearson, New Delhi, 2006.

3. K. L. Purcell, J. C. Kotz, *An Introduction to Inorganic Chemistry*, Cengage, 2010.

4. S. F. A. Kettle, *Physical Inorganic Chemistry: A Coordination Chemistry Approach*, 1996

5. G. Wilkinson, R. A. Gillard, J. A. Mc Cleverty (eds) *Comprehensive Coordination Chemistry*, Pargamon Press, 1987.

6. J. Ronald, Paul L. A. Gillespie, Popelier, *Chemical Bonding and Molecular Geometry. From Lewis to Electron*, Oxford University Press, 2001.

7. C.J. Balehausen, H. B. Gray, *Molecular Orbital Theory: An Introductory Lecture Note and Reprint Volume*, W.A. Benjamin INC., 1965.

8. J. N. Murrall, S. F. A. Kettle, S. Teddler, *Valence Theory,* John Wiley and Sons, 1965.

9. A. Williams, *Theoretical Approach to Inorganic Chemistry,* Springer–Verlag–Berlin–Heidelberg–GmbH, 2014.

10. D. F. Shriver, T. Overton, J. Rourke, M. Weller, F. Armstrong, *Inorganic Chemistry*, 5th Edn., Oxford University Press, 2010.

11. C. E. Housecraft and A. G. Sharpe, *Inorganic Chemistry*, 3rd Edn, Pearson Education Ltd, Essex, England, 2008.

12. R. W. Hay, *Bioinorganic Chemistry*. Ellis Horwood and Halsted Press, 1984.

13. D. R. Williams, *Introduction to Bioinorganic Chemistry*, Charles C. Thomas (Springfield, Illinois), 1976.

14. I. Bertini, H. B. Gray, S. J. Lippard, J. S. Valentine, *Bioinorganic Chemistry,* University Science Books, 1994.

15. Jeremy M Berg, Stephen J Lippard *Principles of Bioinorganic Chemistry*, Panima Publishing Corporation, 1997.

16. A. Das, A. K. Das, M. Das, *Bioinorganic Chemistry*, Books and Allied Private Limited, 2017.

17. W. Kaim, Schwederski, A. klein, *Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introduction and Guide,* Wiley, 2013.

18. Dieter Rehder, Ebbe Nordlander, *Bioinorganic Chemistry*, Oxford University Press; Illustrated edition, 2014.

19. Robert Crichton, *Biological Inorganic Chemistry: A New Introduction to Molecular Structure and Function*, 3rd Edition, Academic Press, 2018.

20. *Bioinorganic Chemistry: An Inorganic Perspective of Life*, Editors: Kessissoglou, D.P. (Ed.), Springer, 2012.

21. G. N. Mukherjee, A. Das, *Elements of Bioinorganic Chemistry*, U.N. Dhar & Sons Pvt. Ltd., 2012.

22. M. N. Hughes, *Inorganic Chemistry of Biological Process*, Wiley, 1972.

23. Dieter Rehder, Ebbe Nordlander, *Bioinorganic Chemistry*, Oxford University Press; Illustrated edition 2014.

24. K. H. Reddy, *Bio-Inorganic Chemistry*, New Age International Publisher, 2nd Edn., 2020.

Course Code	Course Title	Credit: 4
PG-CHE-102(T)	Physical Chemistry	F.M. = 80

1. Advanced Chemical Kinetics (14L)

Brief review of Collision Theory and Activated Complex Theory, ionic reaction, kinetic salt effect, steady-state kinetics, unimolecular reactions, chain reactions, fast reactions, relaxation techniques, flow method, stopped flow method.

2. Group Theory (13L)

Concepts of Symmetry, symmetry elements, operations,group, sub-group, class, point groups with examples.

3. Basic Molecular Spectroscopy of Diatomic Molecules (13L)

Rotational spectroscopy, vibrational spectroscopy, rotation-vibration spectroscopy and electronic spectroscopy of diatomic molecules.

4. Basic Concepts of Quantum Mechanics (20L)

Basic, concepts in Quantum chemistry, Heisenberg Uncertainty Principle. Beginning of Quantum Mechanics: Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof). Wave function: Schrodinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function.

Reference Books

1. Castellan, G.W. Physical Chemistry, 3rd Edn., Addison-Wesley Publishing Company, 1983.
2. Atkins, P.W. & Paula, J. de Atkins, *Physical Chemistry*, 8th Edn., Oxford University Press, 2006.
3. McQuarrie, D. A. & Simons, J. D., *Physical Chemistry: A Molecular Approach*, University Science Books, 1997.
4. Levine, I. N. Physical Chemistry, Tata McGraw-Hill.
5. Moore, W.J. Physical Chemistry, Orient Longman.
6. Mortimer, R. G. Physical Chemistry, Elsevier.
7. Engel, T. & Reid, P. Physical Chemistry, Pearson.
8. Levine, I. N. Quantum Chemistry, PHI.
9. Atkins, P. W. Molecular Quantum Mechanics, Oxford.
10. Engel, T. & Reid, P. Physical Chemistry, Pearson.
11. F. A Cotton, Chemical Applications of Group Theory.
12. Fundamentals of Molecular Spectroscopy, C. N. Banwell.
13. L. Stryer, J. M. Berg, J. M. Tymoczko, *Biochemistry*, 6th Edn. W.H. Freeman and Co., New York, 1995

Course Code	Course Title	Credit: 4
PG-CHE-103(T)	Organic Chemistry	F.M. = 80

1. Cyclic Stereochemistry: (10L)

Conformational analysis and reactivity of six membered, fused and bridged bicyclic compounds: consideration of steric and stereoelectronic requirements; elimination (E2, E1), nucleophilic substitution (SN^1, SN^2, SN^i, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolytic syn elimination and fragmentation.

2. The Logic of Organic Synthesis: (15L)

Retrosynthetic analysis: disconnections; synthons, donor and acceptor synthons; natural reactivity and umpolung; linear and convergent synthesis, latent polarity in bifunctional compounds: consonant and dissonant polarity; illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA); C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenated compounds), reconnection (1,6-dicarbonyl); protection-deprotection strategy (alcohol, amine, carbonyl, acid).

3. Pericyclic reactions: (10L)

Pericyclic Reaction: Introduction, classification and stereochemical modes, selection rules of electrocyclic reactions, 2-component cycloadditions (4π- and 6π-electrons) and sigmatropic rearrangements ([1,3]- and [1,5]-H shifts and [3,3]-shifts with reference to Claisen and Cope rearrangements). Rationalization based on 'aromatic transition state' and FMO approaches (4π- and 6π-electrons). Fluxional tautomerism.

4. NMR Spectroscopy: (15L)

Introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; elementary idea about non-first-order splitting; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange; interpretation of NMR spectra of simple compounds.

NMR phenomenon (CW and FT-NMR), 1H NMR: Chemical shift δ, inductive and anisotropic effects on δ, chemical and magnetic equivalent / non-equivalent protons, spin-spin coupling (hydrogen-hydrogen

and hydrogen with other spin active nuclei such as 13C, 19F), structural correlation to coupling constant J, First order patterns

5. Biomolecules: (10L)

Amino acids: synthesis with mechanistic details: Strecker, Gabriel, acetamido malonic ester, azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperazine; isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin West reaction; resolution of racemic amino acids. Peptides: peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: C-terminal and N-terminal unit determination (Edman, Sanger & 'dansyl' methods).

Reference Books:

1. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
2. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
3. Sengupta, Subrata. Basic Stereochemistry of Organic molecules.
4. Kalsi, P. S. Stereochemistry Conformation and Mechanism, Eighth edition, New Age International, 2014.
5. Eames, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003.
6. Robinson, M. J. T., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.
7. Fleming, I. Molecular Orbitals and Organic Chemical reactions, Reference/Student Edition, Wiley, 2009.
8. Fleming, I. Pericyclic Reactions, Oxford Chemistry Primer, Oxford University Press.
9. Gilchrist, T. L. & Storr, R. C. Organic Reactions and Orbital symmetry, Cambridge University Press.
10. Warren, S. Organic Synthesis the Disconnection Approach, John Wiley and Sons.
11. Warren, S., Designing Organic Synthesis, Wiley India, 2009.
12. Carruthers, W. Modern methods of Organic Synthesis, Cambridge University Press.
13. Willis, C. A., Wills, M., Organic Synthesis, Oxford Chemistry Primer, Oxford University Press. 14. Kemp, W. Organic Spectroscopy, Palgrave.
15. D. L. Pavia, et al. Introduction to Spectroscopy, 5th Ed. Cengage Learning India Ed. (2015).
16. J. Dyer, Application of Absorption Spectroscopy of Organic Compounds, PHI Private Limited.

Course Code	Course Title	Credit: 4
PG-CHE-104(P)	Inorganic, Physical and Organic Chemistry Practical	F.M. = 80

Inorganic Chemistry Practical

Inorganic Preparation:

i. Mohr's salt

ii. Potassiumtris(oxalato)chromate(III)trihydrate

iii. Tetraamminecarbonatocobalt(III)nitrate

iv. Potassiumbis(oxalato)cuprate(II)dihydrate

v. Tris(ethylenediamine)nickel(II)chloride

Physical Chemistry Practical

1. Determination of Ksp for AgCl by potentiometric titration of AgNO3 solution against standard KCl solution.
2. Determination of CMC from surface tension measurements.
3. Determination of molecular weight of a polymer by viscometry

Organic Chemistry Practical

1. Quantitative Analysis

i. Estimation of glucose by titration using Fehling's solution

ii. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method

2. Chromatographic Separations:

i. TLC separation of a mixture containing 2/3 amino acids

ii. TLC separation of a mixture of dyes (e.g. fluorescein and methylene blue)

Reference Books

Inorganic Chemistry Practical Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. University Hand Book of Undergraduate Chemistry Experiments, edited by G. N. Mukherjee, University of Calcutta, 2003.

3. S. C. Das, S. B. Chakraborty, Practical Chemistry.

4. K. S. Mukherjee, Text book on Practical Chemistry, New Oriental Book Agency.

5. Ghosal, Mahapatra & Nad, An Advanced course in practical Chemistry, New Central Book Agency, 2022.

Physical Chemistry Practical Books:

1. S.R. Palit, S. K. De, Practical Physical Chemistry, Science Book Agency.

2. University Hand Book of Undergraduate Chemistry Experiments, edited by G. N. Mukherjee, University of Calcutta, 2003.

3. Levitt, B. P. edited Findlay's Practical Physical Chemistry Longman Group Ltd.

4. K.L. Kapoor, A Textbook of Physical Chemistry: Experimental Aspects In Physical Chemistry (SI Units) Volume 7, 1st Edn., McGraw Hill Education, 2019

5. M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1999.

6. H.R. Allcock, F.W. Lampe & J.E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall 2003.

7. F.W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience 1984.

Organic Chemistry Practical Books:

1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003

2. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.

3. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Practical Organic Chemistry, 5th Ed., Pearson, 2012.

4. F.G. Mann, & B.C. Saunders, Practical Organic Chemistry, 1st Edn. Pearson Education, 2014.

Course Code	Course Title	Credit: 4
PG-CHE-105(T)	Multi-Disciplinary Course	F.M. = 80

1. Air pollution: [8 hours]

Primary pollutants and their origins, harmful effect of CO, NOx, SOx, hydrocarbon and other organic, photo physical smog, CFC, ozone hole, greenhouse effect, global warming, particulate matters, acid rain radioactive pollutants and their effects.

2. Water pollution: [7 hours]

Aquatic pollutants, chemical, radioactive and thermal pollutants, basic gaseous and coloured inorganic and organic pollutants, pollutants in industrial effluents and sewage, Fertilizer waste, agricultural runoff, pesticides and other pollutants in the soil. As-pollution, F^- , NO_3^- / NO_2^- , PO_4^{3-} pollutions.

3. Treatment of water [5 hours]

Water treatment, municipal and industrial water, drinking water from sea. Removal of hardness. Chemical and electrochemical methods, ion exchange, reverse osmosis.

4. Polymers [20 hours]

Introduction, types of polymers, classification of solvents; degree, extent and kinetics of polymerization; number and weight average molecular weights and their relation, determination of molecular weights by osmometry and viscometry, Advanced synthetic techniques for controlling molecular weight dispersity in synthetic polymers-Living polymerization (living ionic, living radical and living ring-opening polymerizations); block copolymers-synthesis, microstructure, and applications; Conjugated polymers and their electrical and opto-electronic properties.

5. Pesticides [10 hours]

Common pesticides: structures, production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin.

6. Drugs [10 hours]

Concept and necessity of drugs and pharmaceuticals; synthesis and uses: aspirin, paracetamol, sulphadiazine, quinine, chloroquine, phenobarbital, metronidazole.

Reference Books:

1. A. K. De and A.K. De, Environmental Chemistry, New Age International Publisher, 7th Edn., 2007
2. S. K. Garg, Ecology and Environmental Studies, Khanna Publishers, 2015.
3. V.R. Gowariker, Polymer Science, New Age International Publisher, 3rd Edn., 2019.
4. J. Ghosh, A Textbook Of Pharmaceutical Chemistry, S. Chand and Co., 2017.5.
5. A. Kar, Medicinal Chemistry, New Age International Publisher, 8th Edn., 2022.
6. B.S. Parmar, Pesticides Formulation: Theory and Practice, CBS Publishers and Distributors Pvt . Ltd., 2010.
7. F.W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience, 1984.
8. M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1999.