Ramakrishna Mission
Vivekananda Centenary College, Rahara

DEPARTMENT OF CHEMISTRY

SYLLABUS FOR
M.Sc. IN CHEMISTRY

CHOICE BASED CREDIT SYSTEM
(CBCS)

2018

Head of the Department of Chemistry
(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

PROGRAMME OUTCOMES (POs)

PO No.	PROGRAMME OUTCOMES	Cognitive Level
PO 1:	Outline and demonstrate the basic concepts by acquiring a comprehensiveknowledge in the newer emerging field of knowledge.	R, U
PO 2:	Perform experiments, analyse & interpret the obtained accurate results and thusgain the ability to solve problems.	Ap, An, E
PO 3:	Apply and evaluate the basic ideas to their thoughts, actions, and interventionsfor the societal benefits through the development of entrepreneurships.	Ap, E
PO 4:	Develop the ability to involve in critical, independent, and inventive thinking forthe engagement in research and development on the emerging topics.	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PO No.	PROGRAMME SPECIFIC OUTCOMES	Cognitive Level
PSO 1:	Recall the fundamental concepts and understand the advanced concepts of organic inorganic and physical chemistry	R, U
PSO 2:	Apply the concepts of chemistry in carrying out different laboratory-based experiments	Ap
PSO 3:	Apply the theoretical and practical knowledge gained in entrepreneurship, research and development and different eras of society	Ap
PSO 4:	Build their own career in good academic as well as industrial position and crack different examination like NET, GATE, SET etc.	C
PSO 5:	Design new methodologies to develop novel materials in their future research in academia, agriculture and industry for the betterment of society	C

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COURSE STRUCTURE

(MSC CHEMISTRY)

COURSE TYPE	TOTAL PAPERS	CREDIT	TOTAL CREDIT
MCT	9	05	45
MCP	9	03	27
SCC	1	04	04
OE#	1	04	04
ME	2	04	08
OT	2	06+02	08
SOC	4	01	04

#Students can also achieve the credit from SWAYAM online courses (https://swayam.gov.in/) as per order by UGC.

ABBREVIATIONS USED:

MCT: Main Course Theory

MCP: Main Course Practical

SCC: Special Core Course

OE: Open Elective

ME: Major Elective

OT: Others

SOC: Skill Oriented Course

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SEMESTERWISE DISTRIBUTION OF COURSES

Semester	Course Code	Course Title	Credit	Class (hr)/Week
Semester-1	PGCHEMMCT01	Inorganic Chemistry -1	05	05
	PGCHEMMCT02	Organic Chemistry- 1	05	05
	PGCHEMMCT03	Physical Chemistry-1	05	05
	PGCHEMMCP01	Inorganic Chemistry Practical -1	03	03
	PGCHEMMCP02	Organic Chemistry Practical- 1	03	03
	PGCHEMMCP03	Physical Chemistry Practical-1	03	03
	PGSOC01	Yoga	01	01
Semester-2	PGCHEMMCT04	Inorganic Chemistry-2	05	05
	PGCHEMMCT05	Organic Chemistry -2	05	05
	PGCHEMMCT06	Physical Chemistry-2	05	05
	PGCHEMMCP04	Inorganic Chemistry Practical -2	03	03
	PGCHEMMCP05	Organic Chemistry Practical- 2	03	03
	PGCHEMMCP06	Physical Chemistry Practical-2	03	03
	PGSOC02	Communicative English	01	01
Semester-3	PGCHEMMCT07	Inorganic Chemistry -3	05	05
	PGCHEMMCT08	Organic Chemistry- 3	05	05
	PGCHEMMCP07	Inorganic Chemistry Practical -3	03	03
	PGCHEMMCP08	Organic Chemistry Practical- 3	03	03
	PGCHEMSCC	Interdisciplinary Adv. Chemistry	04	04
	PGCHEMOE01/ PGCHEMOE02	Open Elective 01/ Open Elective 02	04	04
	PGSOC03	VECC	01	01
Semester-4	PGCHEMMCT09	Physical Chemistry-3	05	05
	PGCHEMMCP09	Physical Chemistry Practical-3	03	03
	PGCHEMME01/ PGCHEMME03/ PGCHEMME05	Advanced Organic Chemistry-1/ Advanced Inorganic Chemistry-1/ Advanced Physical Chemistry-1	04	04
	PGCHEMME02/ PGCHEMME04/ PGCHEMME06	Advanced Organic Chemistry-2/ Advanced Inorganic Chemistry-2/ Advanced Physical Chemistry-2	04	04
	PGSOC04	Computer for Chemists	01	01
	PGCHEMOT01	Project & Presentation	06	-
	PGCHEMOT02	Grand Viva and Seminar	02	-

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SEMESTER – 1	
CHEMISTRY -MCT01: INORGANIC CHEMISTRY-1	
PGCHEMMCT01	Credits: 5
Number of lectures required: 60	
MCT01: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Understanding different symmetry elements and symmetry operations
2. Applying the concept of group theory in different aspects of molecules
3. The advanced concepts on crystal field theory
4. The colour, magnetic properties and chemical potentials of coordination compounds of transition metals
5. Basic principle of inorganic analysis and different instrumentation techniques

Unit-1. Symmetry and Bonding: 18M: (16-20L)

Symmetry in nature, symmetry elements and symmetry operations. Symmetry properties of atomic orbitals. Elements of group theory, multiplication tables, point groups and their stereographic projections.

Born-Oppenheimer approximation, LCAO-MO and VB treatments on H_2^+, H_2; application to homo- and hetero- nuclear diatomic molecules/ ions of second period elements, electron density, forces and their role in chemical bonding. Hybridization and valences, MOs of H_2O, NH_3, CH_4; Huckel – pi – electron theory and its applications to ethylene, butadiene and benzene, idea of self-consistent field. Concept of resonance.

Unit-2. Coordination Chemistry:16M: (16-20L)

Crystal Field Theory: Spitting of *d* orbitals in crystal fields of different symmetry for similar and dissimilar ligands, crystal field stabilization energies (CFSE) in weak and strong crystal fields, spectrochemical series, octahedral site preference energy (OSPE) and their applications. Tetragonal distortion (John-Teller effect). Thermodynamic aspects of crystal field splitting (variation of ionic radii, lattice energy, hydration enthalpy and stability constants of complexes – Irving Williams order). Kinetic aspects of crystal field stabilization: crystal field activation energy, labile and inert complexes.

Electronic spectra of transition metal complexes: Microstates, ground and excited state terms of d^n ions; splitting of d^n terms in octahedral and tetrahedral fields, Orgel diagrams (qualitative approach), hole formalism, inversion and equivalence reactions; selection rules for spectral transitions, *d-d* spectra of d^n ions and crystal field parameters, nephelauxetic series. Metal-ligand bonding (pictorial MO approach): sigma and pi-bonding in complexes, CT transitions.

Magnetic properties of transition metal compounds: Spin and orbital moments, spin-orbit coupling, quenching of orbital moment, spin only formula, temperature dependence of magnetic moment, spin cross over.

Unit-3. Inorganic Analysis: 16M (16-20L)

Basic principle, instrumentation, special features and applications in inorganic analysis qualitative/ quantitative as applicable) of the following techniques.

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Electro analytical methods: Polarography: Ilkovic equation, half wave potential and its significance; amperometric, titrations, coulometry, cyclic voltametry, ion-selective electrode.

Thermo analytical methods: TGA, DTA and DSC, thermometric titrations.

Flame photometric techniques: AAS, AES, and atomic fluorescence methods, ICP techniques, Fluorimetric analysis.

UV-VIS-spectrophotometric methods: Photometric titration, derivative spectrophotometry, simultaneous determination of two components in a mixture.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Evaluate symmetry properties of different molecules	PO 3	PSO 1	E
CO 2:	Apply the knowledge of crystal field theory and its related aspects to discuss the chemistry of coordination compounds	PO 1	PSO 3	Ap, C
CO 3:	Apply the concepts on crystal field theory to explain colour, magnetic properties and chemical potentials of coordination compounds of transition metals	PO 1	PSO 4	Ap, E
CO 4:	Basic principle of inorganic analysis and different instrumentation techniques	PO 3	PSO 3	An, Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

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REFERENCE BOOKS FOR MCT01

- Advanced Inorganic Chemistry- F. A. Cotton & G. Wilkinson, John Wiley
- Inorganic Chemistry- J.E. Huheey, E.A. Keiter & R. L. Keiter, Harper & Row
- Chemistry of Elements- N. N. Greenwood & A. Earnshaw
- Concept and Models of Inorganic Chemistry-Douglass, McDaniel & Alexander
- Coordination Chemistry- S. F. A. Kettle
- Theoretical Approach to Inorganic Chemistry-A. F. Willams
- Inorganic Chemistry-D. F. Shriver, P. W. Atkins & C. H. Langford
- Chemical Applications of Group theory- F. A. Cotton
- Molecular Symmetry & Group Theory- R. L. Carter
- Introduction to Ligand Fields- B. N. Figgis
- Introduction to Ligand Field Theory- C. J. Ballahausen

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SEMESTER – 1	
CHEMISTRY -MCT02: ORGANIC CHEMISTRY-1	
PGCHEMMCT02	Credits: 5
Number of lectures required: 60	
MCT02: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Different organic synthetic strategies based on retrosynthetic approach
2. Reactivity of different organometallic compounds
3. Conformational analysis of cyclohexane and related compounds
4. Synthesis and structure elucidation of different terpenoids

Unit-1. Synthetic Strategy and Methodology: 18M: (16-20L)

Synthetic strategy: Retrosynthetic analysis, disconnection, functional group inter conversions (typical examples). Organoboron- Chemistry of organoboron compounds, carboranes, hydroboration, reactions of organoboranes, unsaturated hydrocarbon synthesis, allyl boranes, boron enolates. Organophosphorus- Chemistry' of organophosphorus compounds, Phosphorus ylides and chiral phosphines.

Organosulphur- Chemistry of organosulphur compounds, sulphur stabilized anions and cations, sulphonium salts, sulphonium and sulphoxonium ylides, chiral sulphoxides, Ramberg Backlund rearrangement, Julia olefination reaction. Organosilicon – silyl ethers, silyl enolethers, TMSI, TMSCN, Brook rearrangement, Peterson olefination, Vinylsilane, Acylsilane.

Unit-2. Stereochemistry and Conformational Analysis: 16M: (16-20L)

symmetry; point groups; Correlation of axial dissymmetry and centrodissymmetry, Nomenclature of compounds involving axial and planar chirality. Winstein-Holness equation, Curtin Hammett principle; Conformational analysis of cyclohexane, cyclohexene, decalins and their derivatives; Effects of conformation on reactivity in acyclic compounds and cyclohexanes. Stereochemistry of organo nitrogen-, sulfur- and phosphorus- compounds, conformation of sugars.

Unit-3. Chemistry of Natural Products 2 :16M:(16-20L)

Terpenoids:Isoprene rule, Structure elucidation (by chemical and spectroscopical methods), Synthesis, Biogenesis and Biosynthesis of representative examples of acyclic, monocyclic and bicyclic monoterpenes.

Alkaloids: Familiarity with methods of structure elucidation (chemical & spectroscopical method), biosynthesis, synthesis and biological activity of alkaloids (Ephedrine/nicotine/atropine/ coniine / papaverine).

New Addition: 0%	Modifications: 100%	Total change = 100 %

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Explain the conformation of new sugar molecules utilizing the concepts of stereochemistry for cyclic compounds	PO 1	PSO 2	E
CO 2:	Apply the reactivity of organometallic compounds in different reactions	PO 3	PSO 3	Ap
CO 3:	Evaluate structure of different natural products	PO 2	PSO 2	E
CO 4:	Design new molecules via retrosynthetic approach	PO 4	PSO 5	C

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Question Pattern for End Semester Examination

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UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR MCT02

- Organic Chemistry- I. L. Finer, Vols. 1 & 2, ELBS
- Adv. Organic Chemistry: Reaction, Mechanism- Jerry March
- Adv. Organic Chemistry-F. A. Carey & R. J. Sundberg
- Organic Chemistry (3rd. edn) -Hendrikson, Cram, Hammond
- Organic Chemistry- Clayden, Greeves, Warren & Wolthers
- Organic Chemistry- R. T. Morrison & R. N. Boyd
- Organic Reaction Mechanics- A. Gallego, M. Gomer & M. A. Sierra
- A Guide Book to Mechanism of Organic Reactions-Peter Sykes
- Reaction Mechanism in Organic Chemistry- S. M. Mukherjee & S. P. Singh
- Structure and Mechanism in Organic Chemistry- C. K. Ingold

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SEMESTER – 1	
CHEMISTRY -MCT03: PHYSICAL CHEMISTRY-1	
PGCHEMMCT03	Credits: 5
Number of lectures required: 60	
MCT03: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Understanding thermodynamic principles for a system performing mechanical work and applying the laws of thermodynamics
2. Analysing how fast a chemical reaction can occur under certain physical conditions
3. Rates and mechanisms of photochemical, chain and oscillatory reactions
4. Different models related to structure of atom

Unit-1. Thermodynamics :18M: (16-20L)

Classical Thermodynamics

Brief resume of the first-, second- and third- law of thermodynamics, of concepts of enthalpy, free energy, chemical potential and entropies. Gibbs- Helmholtz equation. Chemical equilibrium: free energy and entropy of mixing. Partial molar properties: partial molar free energy, partial molar volume, partial molar heat content and their significances. Gibbs-Duhem equation. Equilibrium constant and its temperature dependence., phase diagram of one- and two- component systems, the phase rule.

Statistical Thermodynamics

Thermodynamic probability and entropy, Maxwell-Boltzman-, Bose-Einstein- and Fermi-Dirac statistics. Partition function: rotational-, translational, vibrational- and electronic partition functions of diatomic molecules, calculation of thermodynamic functions and equilibrium constants. Theories of heat capacities of solids.

Unit-2. Chemical Kinetics & Reaction Dynamics: 16M (16-20L)

Reaction Kinetics: Methods of determining rate laws, collision theory of reaction rates; steric factor, treatment of unimolecular reactions. Theory of absolute reaction rates, Eyring and Arrhenius equations. Ionic reactions: salt effect. Homogeneous and heterogeneous catalysis, autocatalysis; Enzyme catalysis: Michaelis –Menten kinetics. *Fast Ractions:* Luminescence and energy transfer processes. Study of kinetics by stopped –flow and relaxation methods, flash photolysis and magnetic resonance method.

Reaction Dynamics: Rates and mechanisms of photochemical, chain and oscillatory reactions (hydrogen-bromine, hydrogen – chlorine reactions, pyrolysis of acetaldehyde, decomposition of ethane and Belousov- Zhabotinsky reaction as examples), dynamics of barrier less chemical reactions in solutions, dynamics of uni molecular reactions (Lindemann-Hinselwood and Rice-Ramsperger-Kasel-Marcus [RRKM] theories).

Unit-3. Atomic Structure (16-20L)

Motion under central force: Conservation of angular momentum and its consequence. Wilson – Sommerfeld quantization rule, principal and azimuthal quantum numbers, relativistic correction. Normal Zeeman effect, magnetic quantum number. Motion of angular momentum vector under magnetic field. Larmor precession. Stern – Gerlach experiment, spin quantum number, spin- orbit

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interaction, conservation of total angular momentum. Vector atom model: anomalous Zeeman effect, Paschen- Beck effect. Multielectron systems: Pauli exclusion principle and Hund's rules. Russel-Saunders coupling schemes, Slater-Condon parameters, terms arising from p^n and d^n configurations; magnetic effects: spin – orbit coupling, magnetic moment and Lande's g factor.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Recall the thermodynamic principles and applying the laws of thermodynamics in different chemical reactions	PO 1	PSO 2	R, Ap
CO 2:	Analyse how fast a chemical reaction can occur under certain physical conditions	PO 2	PSO 3	An
CO 3:	Explain rates and mechanisms of photochemical, chain and oscillatory reactions	PO 3	PSO 3	E
CO 4:	Apply the classical and quantum mechanical ideas to analyze different numerical problems	PO 2	PSO 3	Ap, An

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Question Pattern for End Semester Examination

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UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR MCT03

- Physical Chemistry: A Molecular Approach-D. A. McQuarrie & J. D. Simon
- Physical Chemistry- R. S. Berry, S. A. Rice & J. Ross
- Introduction to Quantum mechanics- L. Pauling & E. B. Wilson
- Quantum Mechanics J. L. Powel & B. Crasemann
- Elementary Quantum Chemistry-F. L. Pilar
- Quantum Chemistry- I. N. Levine

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Vivekananda Centenary College
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- Chemical Kinetics-K. J. Laidler
- Fundamentals of Chemical Kinetics-S. W. Benson
- Theoretical Chemistry- S. Glasstone
- The Principles of Chemical Equilibrium-K. Denbigh
- The Physical Chemistry of Surfaces- N. K. Adams
- Physical Chemistry of Surfaces- A. W. Adamson

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SEMESTER – 1	
CHEMISTRY -MCP01: INORGANIC CHEMISTRY PRACTICAL-I	
PGCHEMMCP01	Credits: 5
Number of lectures required: 60	
MCP01: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Quantitative estimation of metal ion spectrophotometrically
2. Spectrophotometric estimation of metal ion in a binary mixture
3. Estimations based on ion-exchange separation, acid-base, complexometric and argentometric titrations
4. Analysis of ternary and quaternary mixture

MCP 01: Inorganic Chemistry Practical-1: **Quantitative Inorganic Analysis**

Quantitative estimations based on spectrophotometry, ion-exchange separation, acid-base, complexometric and argentometric titrations.

Model Experiments:

1. Spectrophotometric Estimations:
   (a) Estimation of single components: (at least two)
      (i) Fe^{III} as $[Fe^{III}(SCN)^{2+}]$ complex
      (ii) Mn as MnO_4^-
      (iii) Phosphate as phosphomolybdate blue complex
      (iv) (Ti^{IV}/V^{v}) as H_2O_2 complex.

   (b) Estimation of two components in binary mixtures: (at least one)
      (i) Fe^{III} and Fe^{II} in mixture as $[Fe^{II}(1,10\text{-phenanthroline})_3^{2+}]$ complex
      (ii) $Cr_2O_7^{2-}$ and MnO_4^- in mixture
      (iii) Ti^{IV} and V^{v} in mixture as their H_2O_2 complexes
      (iv) Cu^{II} and Zn^{II} as their PAR complexes.
2. Estimations based on ion-exchange separation, acid-base, complexometric and argentometric titrations.
   (a) Estimation of two components in binary mixtures: (at least two)
      (i) $Co^{II} + Ni^{II}$
      (ii). $Zn^{II} + Cd^{II}$
      (iii). $Zn^{II} + Mg^{II}$
      (iv). $Cl^- + Br^-$.
   (b) Analysis of ternary / quaternary mixtures: (at least one)
      (i). K^+: H^+: SO_4^{2-} ratio in $KHSO_4$
      (ii). H^+, Na^+, Mg^{2+} and Zn^{2+} in mixture
      (iii). Al^{3+}, Fe^{3+}, Co^{2+} and Ni^{2+} in mixture.

New Addition: 0% Modifications: 100% Total change = 100 %

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Estimate metal ion quantitatively based on spectrophotometry	PO 2	PSO 2	C
CO 2:	Estimate metal ions in a binary mixture spectrophotometrically	PO 3	PSO 5	C
CO 3:	Estimate metal ions based on ion-exchange separation, acid-base, complexometric and argentometric titrations	PO 3	PSO 5	C
CO 4:	Analyse ternary and quaternary mixture to estimate each component present in the mixture	PO 3	PSO 5	An, C

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Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP01

- Physical Methods in Inorganic Chemistry-R. S. Drago
- Instrumental Methods in Chemical Analysis- Willrd, Meritt and Dean
- Instrumental Methods in Chemical Analysis- G. W. Ewing
- Vogel`s Text Book of Quantitative Chemical Analysis, G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denny
- Advanced Experiments in Inorganic Chemistry-G. N. Mukherjee (U. N. Dhur)
- Macro and Semi-micro Qualitative Inorganic Analysis- A. I. Vogel
- Semi-Micro Qualitative Inorganic Analysis- G. N. Mukherjee (C.U.Press)
- Quantitative Chemical Analysis- Kolthoff, Sandel, Meehan & Bruckenstein
- Synthesis and Characterizations if inorganic Compounds-W. L. Jolly

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SEMESTER – 1	
CHEMISTRY -MCP02: ORGANIC CHEMISTRY PRACTICAL-I	
PGCHEMMCP02	Credits: 5
Number of lectures required: 60	
MCP02: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Identification of unknown organic compound (solid and liquid) by qualitative tests
2. Application of chromatographic and or spectroscopic techniques in the identification of single organic compound
3. Separation, purification and identification of organic compounds in binary mixtures (two solids, one solid + one liquid)
4. Proper utilization of TLC, PC, column chromatography, chemical tests, UV-, IR- spectral measurements in the identification, separation and purification of organic compounds

MCP 02: Organic Chemistry Practical-1: **Qualitative Organic Analysis**

Identification of organic compounds (solid and liquid) by qualitative tests and chromatography and or spectroscopy (as applicable).

Experiment-1: Identification of single organic compounds.

Experiment-2: Separation, purification and identification of organic compounds in binary mixtures (two solids, one solid + one liquid) using TLC, PC, column chromatography, chemical tests, UV-, IR- spectral measurements as required.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Identify unknown organic compound (solid and liquid) by qualitative tests	PO 2	PSO 2	Ap
CO 2:	Apply chromatographic and or spectroscopic techniques to analyze single organic compound	PO 3	PSO 3	Ap, An
CO 3:	Predict, separate, and purify organic compounds in binary mixtures (two solids, one solid + one liquid)	PO 4	PSO 5	C

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CO 4:	Analyze organic compounds by proper application of TLC, PC, column chromatography, chemical tests.	PO 2	PSO 2	An, Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP02

- Experimental Organic Chemistry: Principles & Practice-L. M. Harwood & C. J. Roodey
- Experiments and Techniques in organic Chemistry-Pasto, Johnson & Miller
- Spectrometric Identification of Organic Compounds-(6th. edn)-Silverstein & Webster
- An Introduction to Experimental Organic Chemistry- Robert, Gilbert, Rodewaid & Wingrove
- Systematic Qualitative Organic Analysis-H. Middleton
- Hand Book of Organic Analysis- H. T. Clarke
- Text Book of Practical Organic Chemistry-A.I. Vogel

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SEMESTER – 1	
CHEMISTRY -MCP03: PHYSICAL CHEMISTRY PRACTICAL-I	
PGCHEMMCP03	Credits: 3
Number of lectures required: 60	
MCP03: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Determination of critical solution temperature of two component systems
2. Construction of phase diagram of three component systems
3. Surface adsorption behaviour of heterogeneous systems
4. Kinetics of chemical reactions of different orders
5. Determination of rate laws of different chemical reactions

MCP 03: Physical Chemistry Practical-1:
(At least one experiment of each type (total not less than six) should be carried out during the lab. session)

Model Experiments
(a) Phase-rule

1. Determination of critical solution temperature (system: phenol-water)
2. To construct the phase diagram of a three component system:
   (i).Chloroform-acetic acid-water
   (ii). Benzene-acetic acid-water
   (iii). Nitrobenzene-acetic acid-water

(b) Adsorption
3. To study the surface tension – concentration relationship of solutions (Gibbs equation)

(c) Kinetics
4. Determination of rate constant of reactions:
   (i). Iodination of acetone (zero order)
   (ii). Decomposition of H_2O_2 (first order)
   (iii). Oxidation of iodide ion by bromate ion (second order)

5. Determination of rate constant of oxidation of iodide by H_2O_2 and to study the kinetics of iodine-clock reaction

(d) Thermodynamics & Equlibrium
6. Determination of exchange capacities of ion-exchange resins and studies on ion-exchange equilibria.

7. Determination of solubility and solubility product of salts (systems: PbI_2, Potassium hydrogen tartarate)

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Vivekananda Centenary College
Rahara, Kolkata – 700 118

8. Determination of partition coefficients of a solute between two immiscible solvents (systems: benzoic acid between benzene and water)

9. Determination of composition of complexes formed in solution (systems: Cu^{2+} - NH_3, Ag^{+}- NH_3)

10. Determination of equilibrium constant of hydrolysis of an ester

11. Determination of isoelectric point by viscosity measurement

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Determine of critical solution temperature of two component systems	PO 2	PSO 2	E
CO 2:	Construct phase diagram of three component systems	PO 2	PSO 5	C
CO 3:	Analyze surface adsorption behaviour of heterogeneous systems	PO 2	PSO 3	An
CO 4:	Measure kinetics of chemical reactions of different orders	PO 2	PSO 3	E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP03

- Practical Physical Chemistry- A. M. James & F. F. Prichard
- Findlay's Practical Physical Chemistry- B. P. Levit
- Experimental Physical Chemistry- Shoemaker & Garland
- Introduction to Magnetic Resonance-A. Carrington & A. D. McLachlan
- NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry- R. V. Parish

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(with Post-Graduate Section)
Ramakrishna Mission
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Rahara, Kolkata – 700 118

SEMESTER – 1	
SOC 1: Yoga	
PGSOC01	Credits: 1
Number of lectures required: 20	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Attainment of general awareness about health
2. Management life style of students' life
3. Increase of concentration
4. Improvement the decision-making capacity
5. Build up confidence in their life

SOC 1: Yoga **Class: 15hrs**

PART I

Unit – I: INTRODUCTION TO YOGA AND YOGA PRACTICES. 2 class.

- Introduction to Yoga: Its meaning, definitions, aim, objective and misconceptions.
- Schools of Yoga and their relevance in modern social life.
- Yogic Practices and Principles for healthy living, Practice simple asana

Unit – II: BASIC PRINCIPLES AND PHYSIOLOGY OF YOGIC PRACTICES 2 class.

- Basic principles and physiology of Shat-karma
- Basic principles and physiology of Yogasana
- Basic principles and physiology of Pranayama and Dhyana
- Some complex asana

Unit – III: DIET, HEALTH AND HYGIENE 2 class.

- Introduction to Diet and Nutrition: Yogic Concept of Diet
- Health and Disease: Role of Yoga in prevention of disease and promotion of Health.
- Role and importance of Swasthavrita, Dinacharya, Ritucharya and Sadvrita in Health andHygiene
- Practice of different Pranayama

Unit – IV: YOGA FOR WELLNESS 2 class.

- Concept of Wellness: Ashtanga Yoga of Patanjali for Wellness
- Yogic attitudes (Maitri, Karuna, Mudita and Upeksha) and practices for Mental Wellbeing
- Psycho-social environment: Its role and importance for wellness
- Some demonstrations of Bandha & Mudra

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(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

PART-II: PRACTICAL TRAINING IN YOGA 7
class

UNIT – I: Lecture cum demonstration of Yoga for Wellness

UNIT – II: Loosening practices, Selected Yogic Sukshma Vyayama OR Yogic Surya Namaskara

UNIT – III: Yogic Shatkarma / Yogic cleaning practices:3.1 Kapalabhati

UNIT – IV YogasanaSukhasana, Padamasana, Vajrasana

- Tadasana, Urdhvahastottanasana, Katichakrasana
- Mandukasana, Kurmasana
- Vakrasana / Ardha
- Ustrasana, Gomukhasana
- Bhujangasana, Shalabhasana, Dhanurasana
- Ardha Halasana, Halasana
- Pavanamuktasana and its variations

UNIT – V Pranayama

- Mechanism of correct breathing, Yogic deep breathing, Concept of Puraka, Rechaka and Kumbhaka
- Nadi Shodhana Pranayama, Bhramari Pranayama (Without Kumbhaka)

UNIT – VI Concepts and demonstrations of Bandha & Mudra

- Bandha: Jalandhra Bandha, Uddiyana Bandha, Mula Bandha
- Mudra: Shanmukhi Mudra, Viparitakarani Mudra

UNIT – IV YogasanaSukhasana, Padamasana, Vajrasana

- Tadasana, Urdhvahastottanasana, Katichakrasana
- Mandukasana, Kurmasana
- Vakrasana / Ardha
- Ustrasana, Gomukhasana
- Bhujangasana, Shalabhasana, Dhanurasana
- Ardha Halasana, Halasana
- Pavanamuktasana and its variations

UNIT – V Pranayama

- Mechanism of correct breathing, Yogic deep breathing, Concept of Puraka, Rechaka and Kumbhaka
- Nadi Shodhana Pranayama, Bhramari Pranayama (Without Kumbhaka)

UNIT – VI Concepts and demonstrations of Bandha & Mudra

- **Bandha:** Jalandhra Bandha, Uddiyana Bandha, Mula Bandha
- **Mudra:** Shanmukhi Mudra, Viparitakarani Mudra

New Addition: 100%	Modifications: 0%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Attainment of general awareness about health	PO 1	PSO 1	R, U, Ap
CO 2:	Management life style of students' life	PO 3	PSO 3	R, Ap
CO 3:	Increase of concentration	PO 3	PSO 3	An, Ap
CO 4:	Improvement the decision-making capacity	PO 3	PSO 3	U, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

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Vivekananda Centenary College
Rahara, Kolkata – 700 118

SEMESTER – 2	
CHEMISTRY -MCT04: INORGANIC CHEMISTRY -2	
PGCHEMMCT04	Credits: 5
Number of lectures required: 60	
MCT04: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Structure elucidation of boranes, metal clusters and metal carbonyl clusters employing Wade's rule and related theories
2. Supramolecular ligands and their applications in coordination chemistry
3. Electronic configuration, oxidation states, aqueous, redox and complex chemistry, spectral and magnetic properties of compounds of d and f block elements
4. Structure, bonding and reactions of different organometallic complexes
5. Structure elucidation of organometallic clusters employing Wade's rule and TVE count

Unit-1. Chemistry of Elements-1 (Special Features): 16M: (16-20L)

Polymorphism of C, P and S.

Structure and bonding in higher boranes and borohydrides- Lipscomb's topological models, Wade`s rules, carboranes and metallocenecarboranes

Alkali metal complexes with crown ethers, cryptands, spherands and ionophores, Aqueous chemistry of Be^{II} and Al^{III}, basic beryllium compounds.

Dioxygen and dinitrogen compounds of transition metals (synthesis, structure and bonding, properties and reactions). Isopoly and heteropoly metallates derived from V, Mo and W (synthesis, reactions, structures, applications).

Unit-2. Chemistry of Elements-2 (Comparative Aspects): 16M: (16-20L)

(i). d-Block Elements

Electronic configuration, oxidation states; aqueous, redox and complex chemistry, spectral and magnetic properties of compounds in different oxidation states, horizontal and vertical trends in respect of 3d,4d, and 5d elements with references to Ti-Zr- Hf, Cr- Mo- W, Mn-Tc-Re and Pt group metals. Occurrence and isolation in respect of Mo, W, Re, Pt. Synthesis, properties, reactions, structure and bonding as applicable in respect of: Mo-blue, W-blue, Pt-blue, W-bronze, Ru-red, Creutz- Traube complexes, Vaska`s complexes.

(ii). f – Block Elements: Lanthanide and Actinide Elements

Nuclear stability, terrestrial abundance and distribution, relativistic effect, electronic configuration, oxidation states, aqueous-, redox- and complex- chemistry; electronic spectra and magnetic properties. Lanthanide and actinide contractions and their consequences, separation of lanthanides and actinides and their applications (examples).

Unit-3. Organometallic & Cluster Compounds (*Structure & Bonding*) :18M: (16-20L)

Main group organometallics: Classification, synthesis, reactions, structure and bonding and applications with typical examples.

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(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

Application of 18- electron and 16- electron rules to transition metal organometallics, structure, bonding (pictorial MO-approach) and reactions of of η^2-ethylinic, η^3-allylic and η^5-cyclopentadineyl compounds: K [Pt (η^2-C_2H_4)Cl_3], [(η^3-C_3H_5) Pd Cl]$_2$, (η^5- C_5H_5)$_2$ Fe]; carbene and carbyne complexes. Stereochemical non-rigidity and fluxional behavior of organometallic compounds with typical examples.

Metal-metal single and multiple bonding (pictorial mo – approach)., bond orders, bonding in direhnium compounds. Low and high nuclearity (M_3- M_{10}) carbonyl clusters: skeletal electron counting, Wade- Mingos- Louher rules, isolobal and isoelectronic relationships, capping rules; carbide and nitride clusters.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply Wade's rule and related theories to determine structure of boranes, metal clusters and metal carbonyl clusters	PO 1	PSO 1	Ap, E
CO 2:	Classify supramolecular ligands and discuss their applications in coordination chemistry	PO 1	PSO 3	An, C
CO 3:	Explain electronic configuration, oxidation states, aqueous, redox and complex chemistry, spectral and magnetic properties of compounds of d and f block elements	PO 2	PSO 5	E
CO 4:	Design new organometallic complexes and evaluate their structure, bonding and reactions	PO 2	PSO 5	E, C

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

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(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

REFERENCE BOOKS FOR MCT04

- Kinetics and Mechanism of Reactions of Trans. Metal Complexes- R. G. Wilkins
- Determination and use of Stability Constants- A. E. Martell & R. J. Motekaitis
- An Introduction to Bioinorganic Chemistry-D. R. Williams
- Inorganic Chemistry of Biological Processes-M. N. Hughes
- Bioinorganic Chemistry-E. I. Ochiai
- Bioinorganic Chemistry- R. W. Hay
- Elements of Bioinorganic Chemistry- G. N. Mukherjee & A. Das
- Organometallic Chemistry of Transition Metals-R.H. Cabtree
- Organometallic Chemistry- R. C. Mehrotra & A. Singh
- Nuclear and Radio Chemistry-Friedlander, Kennedy & Miller
- Radioactiviry Applied to Chemistry- A. C. Wahl & N. A. Bonner
- Magnetochemistry- Selwood
- Intriduction to Magnetochemistry- Earnshaw
- Environmental Analysis- S. M. Khopkar

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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

SEMESTER – 2	
CHEMISTRY -MCT05: ORGANIC CHEMISTRY -2	
PGCHEMMCT05	Credits: 5
Number of lectures required: 60	
MCT05: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Qualitative M.O. approach and Huckel's theory to explain bonding in organic molecules
2. Application of heterocycles in organic synthesis
3. Understanding the basic principles of photochemistry
4. Understanding the mechanism, stereochemistry, regioselectivity in case of electrocyclic reactions, cycloaddition reactions and sigmatropic reactions.
5. Elementary idea about ene reactions, 1,3-dipolar cycloaddition and rearrangement in ylide systems through simple and illustrative example

Unit-1: Structure Activity Relationship: 16M: (16-20L)

Qualitative M.O. approach to bonding in organic molecules. Construction of m.o's of ethylene, butadiene , cyclopentadiene, cyclobutadiene using Huckel's rule. walsh orbital of cyclopropane and cyclobutane. Huckel's approach to conjugated systems, concept of aromaticity in benzenoid and nonbenzenoid systems, antiaromaticity, pseudoaromaticity, homoaromaticity-PMO approach.

Structure and bonding in fullerene(C60), Bonds weaker than covalent bond: addition compounds, Crown ether complexes and cryptands, Inclusion compounds, cyclodextrines, catenates and rotaxanes, stability of carbocations, pi-facial selectivities, Cieplak Model, strained organic molecules, Calculation of strain energies. The Hammet equation and linear free energy relationship, substituent and reaction constants. Taft equation

Unit-2. Heterocyclic chemistry-1 and Photochemistry 18M: (16-20L)

Application of heterocycles in organic synthesis: Furan, thiophene, pyrrole, pyridine, Quinoline, Indole.

***Photo Organic Chemistry*:**

Basic principles, Jablonski diagram, photochemistry of olifinic compounds: intra molecular reactions of the olefinic bond, cis-trans

isomerization, cyclization reactions, rearrangements of 1,4- 1nd 1,5- dienes. Paterno-Buchi reaction. Photochemistry of carbonyl compounds: intramolecular reactions of saturated-, cyclic- and acyclic- α, β- unsaturated- and β, γ-unsaturated- carbonyl compounds, cyclohexadienones. Intramolecular cycloaddition reactions- dimerisation and oxetane formation; Norrish Type-I and Type II reactions,

Photo-reduction of ketones, di-π methane rearrangement. Photochemistry of aromatic compounds: isomerization, addition and substitution reactions. Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides, Photo-Fries rearrangement, Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photo degradation of polymers. Photochemistry of vision. Photoreactions in solid state, synthetic applications; cyclization of

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(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

radicals.

Unit-3. Pericyclic Reactions:16M: (16-20L)

Classification of pericyclic reactions: Electrocyclic, cycloaddition, sigmatropic, cheletropic and ene reactions. Rationalisation of pericyclic processes in terms of orbital correlation diagram, FMO interactions and Dewar-Zimmermann approach. Electrocyclic reactions: conrotatory and disrotatory motions, 4n, 4n+2, allyl and pentadienyl systems. Cycloaddition reactions: antarafacial and suprafacial additions, 4n and 4n+2 systems.

Sigmatropic rearrangements: suprafacial and antarafacial shifts of hydrogen, [1,3], [2, 3], [1,5], [3,3] (including Carroll rearrangement) and [5,5] sigmatropic shifts involving carbon moieties, Cope and Claisen rearrangements. Elementary idea about ene reactions, 1,3-dipolar cycloaddition and rearrangement in ylide systems through simple and illustrative examples.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply qualitative M.O. approach and Huckel's theory to explain bonding in organic molecules	PO 1	PSO 1	Ap, E
CO 2:	Apply the principles of heterocycles in organic synthesis to design functional organic molecules	PO 2	PSO 5	Ap, C
CO 3:	Apply the principles of photochemistry to design new photochemical reaction	PO 2	PSO 5	Ap, C
CO 4:	Explain the mechanism, stereochemistry, regioselectivity in case of electrocyclic reactions, cycloaddition reactions and sigmatropic reactions.	PO 2	PSO 3	E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

Head of the Department of Chemistry
(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

REFERENCE BOOKS FOR MCT05

- Organic Chemistry- R. T. Morrison & R. N. Boyd
- Organic Reaction Mechanics- A. Gallego, M. Gomer & M. A. Sierra
- A Guide Book to Mechanism of Organic Reactions-Peter Sykes
- Reaction Mechanism in Organic Chemistry- S. M. Mukherjee & S. P. Singh
- Structure and Mechanism in Organic Chemistry- C. K. Ingold
- Physical Organic Chemistry-J. Hiine
- Physical Organic Chemistry-N. S. Isaacs
- Orbital Symmetry and Organic Reactions-T. L. Gilchrist & R. C. Storr
- Some Modern Methods in Organic Synthesis-W. Carruthers
- Principles of Organic Synthesis-Norman, Coxon & Blakie
- Current Trends in Organic Synthesis-C.Scolastico & F. Nicotra
- Fronties Orbitals and Organic Chemcal Reactions-I. Fleming
- Pericyclic Reactions- Gill & Willis
- Pericyclic Reactions- S. M. Mukherjee
- Steriochemistry-E. Eliel & S. H. Wilen
- Steriochemistry- D. Nasipuri
- Steriochemistry of Organic Compounds- P. Kalsi
- NMR in Chemistry-A Multinuclear approach—W. Kemp

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(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

SEMESTER – 2	
CHEMISTRY -MCT06: PHYSICAL CHEMISTRY -2	
PGCHEMMCT06	Credits: 5
Number of lectures required: 60	
MCT06: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Understanding the basic and fundamental concepts classical and quantum mechanics
2. Applying the theories of quantum mechanics in different quantum mechanical systems
3. Understanding the fundamental principles of rotational, vibrational, and Raman spectroscopy
4. Understanding the basic principles of electrochemistry and electrode reactions
5. Understanding electrode kinetics and electro-catalysis.

Unit-1. Quantum Mechanics: 16M: (16-20L)

Introduction: Photoelectric effect, Compton effect, wave particle duality, Heisenberg's microscope uncertainty principle. Genesis of Schrodinger wave equation, probability concept, continuity equation, concept of stationary state.

Linear operators in quantum mechanics, Eigen value equation. Hermitian operator, canonical commutation relation, expectation value, Ehrenfest's theorem.

Elementary applications: free particle, potential barrier problems particle in a box, simple harmonic oscillator (wave function and operator method), rigid rotor; the hydrogen atom: Schrodinger equation for hydrogen atom, separation of variables, shape of orbitals; FEMO model.

Elementary perturbation theory (first order and non-degenerate), variation method and their simple applications. Multielectron systems, antisymmetry and exclusion principle. Slater determinant-wave functions. Introduction to the methods of self-consistent field.

Unit-2. Spectroscopy: 18M: (16-20L)

Underlining Principles: Electromagnetic radiation and its interaction with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation, natural line width and natural line broadening; results of time dependent perturbation theory- transition probability, transition moment, selection rules, intensity of spectral lines; Born-Oppenheimer approximation: rotational, vibrational and electronic energy levels.

Infrared spectroscopy: Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, force constant and bond strengths; anharmonicity. Mores potential energy diagram, vibration-rotation spectroscopy, P, Q, R branches. Breakdown of Born-Oppenheimer approximation, vibration of polyatomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factor affecting the band positions and intensities, far IR region, metal-ligand vibrations. normal coordinate analysis.

R*aman spectroscopy:* Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle.

Molecular Spectroscopy: Energy levels of molecular orbitals, vibronic transitions, vibrational progressions and geometry of excited states, Frank-Condon principle, electronic

Head of the Department of Chemistry
(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

spectra of polyatomic molecules. Emission Spectra: radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge transfer spectra.

Microwave Spectroscopy: Classification of molecules, rigid rotor model, effect of isotopic substitution on transition frequencies, intensities, non-rigid rotor. Applications.

Unit-3. Electrochemistry: 16M: (16-20L)

Ideal and non-ideal solutions: excess functions, ion-solvent interactions, concept of hydration number, activities in electrolytic solutions, mean ionic activity coefficient, Debye-Huckel treatment of dilute electrolytic solutions. Debye-Huckel –Onsager treatment and its extention. Debye-Huckel-Jerum mode.

Thermodynamics of electrified interface, polarizable and non-polarizable electrodes, derivation of electro capillarity, Lippmann equations for surface excess, structure of electrified interfaces, electrical double layers (Guoy-Chapman, Stern, Graham-Devanathan-Mottwatts, Tobin, Bockris, Devanathan models).

Electrode kinetics: Rate equation for electrode processes, kinetic derivation of Nernst equation. Concept of overvoltage, Butler-Volmer equation, Tafel equation, exchange current density.

Electro catalysis- influence of various parameters, hydrogen electrode. Batteries: primary, secondary and tertiary fuel cells.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Recall the fundamental theories and equations of classical and quantum mechanics to apply in solving problems	PO 1	PSO 3	R, Ap, C
CO 2:	Apply the fundamental principles of rotational, vibrational, and Raman spectroscopy in molecular characterizations	PO 3	PSO 2	Ap
CO 3:	Apply the basic principles of electrochemistry to analyze different electrode reactions	PO 1	PSO 3	Ap
CO 4:	Develop new electrocatalysts and electrode materials for applications in energy related research	PO 2	PSO 5	C

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Head of the Department of Chemistry
(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR MCT06

- Physical Chemistry- R. S. Berry, S. A. Rice & J. Ross
- Introduction to Quantum mechanics- L. Pauling & E. B. Wilson
- Quantum Mechanics J. L. Powel & B. Crasemann
- Elementary Quantum Chemistry-F. L. Pilar
- Quantum Chemistry- I. N. Levine
- Chemical Kinetics-K. J. Laidler
- Fundamentals of Chemical Kinetics-S. W. Benson
- Theoretical Chemistry- S. Glasstone
- The Principles of Chemical Equilibrium-K. Denbigh
- Introduction to Molecular Spectroscopy-G. M. Barrow
- Fundamentals of Molecular Spectroscopy- C.W. Banwell
- Introduction to Quantum Mechanics- D. J. Griffith
- Group Theory and Chemistry—D. M. Bishop
- Thermodynamics and an Introduction to Thermostatistics- H. B. Callen
- Coulson`s Valence- R. McWeeny
- Modern Electrochemistry-J.O`M. Bockris & A. K. N. Reddy
- Principles of Physical Biochemistry- K. E. van Holde, C. Johnson & P. S. Ho

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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

SEMESTER – 2	
CHEMISTRY -MCP04: INORGANIC CHEMISTRY PRACTICAL -2	
PGCHEMMCP04	Credits: 5
Number of lectures required: 60	
MCP04: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Basic principles of Semi-Micro Qualitative Inorganic Analysis of Complex Inorganic Mixtures
2. Reactions of the different cations and anions in solutions
3. Group separations of metal ions based on solubility product principle
4. Treatment of aqua-regia insoluble residue

MCP04: Inorganic Chemistry Practical-2

Semi-Micro Qualitative Inorganic Analysis of Complex Inorganic Mixtures containing not more than six (6) inorganic radicals from the lists ***(a), (b), (c),*** and ***(d),***of which two (2) radicals must be derived from the rare elements ***(d)***, and the mixture should not contain more than one insoluble material from the lists ***(c),*** and ***(d),*** :

(a). Cation Radicals derived from:
Ag, Hg, Pb, Bi, Cd, Cu, As, Sb, Sn, Fe, Al, Cr, Co, Ni, Mn, Zn, Ba, Sr, Ca, Mg, Na, K and NH_4^+ ion.

(b). Anion Radicals:
F^-, Cl^-, Br^-, I^-, BrO_3^- , IO_3^-, SCN^-, S^{2-}, $S_2O_3^{2-}$, SO_3^{2-}, SO_4^{2-}, NO_2^-, NO_3^-, PO_4^{3-}, AsO_3^{3-}, AsO_4^{3-}, BO_3^{3-}, H_3BO_3, SiO^{2-}, CrO_4^{2-}, $Cr_2O_7^{2-}$, $[Fe(CN)_6^{4-}]$, $[Fe(CN)_6^{3-}]$.

(c). Insoluble Materials:
$PbSO_4$, $BaSO_4$, $SrSO_4$, $PbCrO_4$, CaF_2, SiO_2 and various silicates, SnO_2, Al_2O_3, Fe_2O_3, Cr_2O_3, AgCl, AgBr, AgI.

(d). Cation radicals, anion radicals and insoluble materials derived from the following rare Elements: V, Mo, W, U, Ti, Zr, Ce, Th and Be.

Experiment-1: Known tests for detection of radicals derived from rare elements.
Experiment-2: Treatment of known insoluble materials.
Experiment-3: Analysis of unknown inorganic mixtures containing six radicals including two radicals derived from the rare elements (at least 4-5 samples)

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Head of the Department of Chemistry
(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply basic principles of semi-micro qualitative inorganic analysis to analyze different industrial samples	PO 2	PSO 2	Ap, An
CO 2:	Apply the basic principles of semi-micro qualitative inorganic analysis to identify different rare elements in soil and industrial samples	PO 2	PSO 3	Ap, An
CO 3:	Develop new analytical methods of separation of metal ions from their mixture	PO 3	PSO 5	C
CO 4:	Analyze the presence of metal ions in different insoluble geochemical residue	PO 2	PSO 5	An

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP04

- Physical Methods in Inorganic Chemistry-R. S. Drago
- Instrumental Methods in Chemical Analysis- Willrd, Meritt and Dean
- Instrumental Methods in Chemical Analysis- G. W. Ewing
- Vogel`s Text Book of Quantitative Chemical Analysis G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denny
- Advanced Experiments in Inorganic Chemistry-G. N. Mukherjee (U. N. Dhur)
- Macro and Semi-micro Qualitative Inorganic Analysis- A. I. Vogel
- Semi-Micro Qualitative Inorganic Analysis- G. N. Mukherjee (C.U.Press)
- Quantitative Chemical Analysis- Kolthoff, Sandel, Meehan & Bruckenstein
- Synthesis and Characterizations if inorganic Compounds-W. L. Jolly

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SEMESTER – 2	
CHEMISTRY -MCP05: ORGANIC CHEMISTRY PRACTICAL -2	
PGCHEMMCP05	Credits: 5
Number of lectures required: 60	
MCP05: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Synthesis of organic compounds employing different types of organic reactions
2. Work-up procedure and purification of the reaction product
3. Determination of m.p. and b.p. of the reaction product
4. Characterization of the prepared compounds by different spectroscopic and chromatographic techniques

MCP05: Organic Chemistry Practical-2

Organic Synthesis

Preparation of organic compounds by typical organic reactions, purification and characterization of the product [by re-crystallization, TLC, PC, determination of R_f value as required, m.p / b.p. , UV, IR spectra (as applicable)].

Model Reactions

(At least 4 reactions are to be carried out during the lab. session)

1. *Oxidation:* Adipic acid from cyclohexanol (by chromic acid oxidation).
2. *Grignard reaction:* Triphenylcarbinol from benzoic acid.
3. *Aldol condensation:* Dibenzal acetone from acetone and benzaldehyde.
4. *Sandmeyer reaction: p*-Chlorotoluene from p- toluidine.
5. *Cannizzro reaction*: Using *p*-chlorobenzaldehyde as the substrate.
6. *Fridel-Craft reaction*: *β*-Benzoylpropeonic acid from succinic anhydride and benzene.
7. *Acetoacetic ester condensation*: Ethyl *n*-butylacetoacetate from ethylacetoacetate.
8. *Aromatic electrophilic substitution: p*-Nitroaniline from *p*-bromoaniline.
9. *Parkin reaction*: Cinnamic acid from benzalehyde and potassium acetate.

New Addition: 0% Modifications: 100% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Design new methodologies for synthesising new organic compounds	PO 2	PSO 3	C
CO 2:	Develop new techniques for work-up and purification of new organic compounds	PO 2	PSO 5	C
CO 3:	Elaborate the synthesis knowledge to develop novel drug molecules	PO 4	PSO 5	C
CO 4:	Apply the spectroscopic and chromatographic techniques for characterization	PO 3	PSO 3	Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP04

- Experimental Organic Chemistry: Principles & Practice-L. M. Harwood & C. J. Roodey
- Experiments and Techniques in organic Chemistry-Pasto, Johnson & Miller
- Spectrometric Identification of Organic Compounds-(6th. edn)-Silverstein & Webster
- An Introduction to Experimental Organic Chemistry- Robert, Gilbert, Rodewaid & Wingrove
- Systematic Qualitative Organic Analysis-H. Middleton
- Hand Book of Organic Analysis- H. T. Clarke
- Text Book of Practical Organic Chemistry-A.I. Vogel

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SEMESTER – 2	
CHEMISTRY -MCP06: PHYSICAL CHEMISTRY PRACTICAL -2	
PGCHEMMCP06	Credits: 5
Number of lectures required: 60	
MCP06: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Determination of physical parameters like, strength, concentration, CMC etc. by conductometry
2. Determination of physical parameters like, concentration, electrode potentials, pH etc. by potentiometry and pH-metry
3. Kinetic studies by colorimetric methods
4. Polarimetric determination of rate constant of reactions, like, inversion of sucrose mutarotation of glucose

MCP06: Physical Chemistry Practical-2

(At least two experiments of each type should be carried out during the lab. session)

Model Experiments

(a) Conductometry

1. Determination of strengths of strong and weak acids in a mixture conductometrically

2. Determination of strengths of halides in a mixture conductometrically by precipitation titrations

3. Determination of concentrations of halides and halogen acids in a mixture conductometrically by precipitation titrations (system: HCl + KCl mixture by titration with standard NaOH and standard $AgNO_3$ solutions

4. Verification of Ostwald's dilution law conductometrically

5. Determination of critical micelle concentration (CMC) of a surfactant by conductometric method

(b) Potentiometry / pH-metry

6. Determination of strengths of strong and weak acids in a mixture potentiometrically / pH-metrically (system: acetic acid + HCl)

7. Determination E° value of redox couples:
   (i) Quinhydrone electrode
   (ii) Ferricyanide- ferrocyanide couple

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(iii) Ag Cl/Ag electrode

8. Determination of strengths of halides in a mixture potentiometrically by precipitation titrations (0.02N KBr + 0.02N KI mixture with standard 0.1N $AgNO_3$)

9. Determination of concentration by potentiometric / pH-metric titrations:
   (i) Acid-base titration (standard oxalic acid vs. NaOH, acetic acid vs. NaOH)
   (ii) Determination of ferrocyanide ion using standard bromate solution
   (iii) Determination of iodide ion by differential redox titration using standard bromate solution
   (iv) Determination of composition of zinc-ferrocyanide complex by potntiometric titration

(c) Colourimetry

11. Determination of pK_a of an indicator by colourimetric method
   (Systems: methyl red, methyl orange, alizarin red –*S* in aqueous solution)

12. Kinetic studies on iodination of aniline

(d) Polarimetry

13. Determination of specific rotation and molar rotation of dextro-tartaric acid

14. Polarimetric determination of rate constant of reactions:
   (i). Inversion of sucrose
   (ii). Mutarotation of glucose
   (Determination catalytic coefficients: k_{H+} and k_{H2O})

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Determine physical parameters like, strength, concentration, CMC etc. by conductometric methods	PO 1	PSO 2	E
CO 2:	Determine physical parameters like, concentration, electrode potentials, pH etc. by potentiometry and pH-metry	PO 1	PSO 2	C
CO 3:	Apply the colorimetric methods to determine the rate constant of related reaction	PO 3	PSO 3	Ap

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CO 4:	Determine the rate constant of reactions, like, inversion of sucrose mutarotation of glucose by polarimeter	PO 2	PSO 2	E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP06

- Practical Physical Chemistry- A. M. James & F. E. Prichard
- Findlay's Practical Physical Chemistry- B. P. Levit
- Experimental Physical Chemistry- Shoemaker & Garland
- Introduction to Magnetic Resonance-A. Carrington & A. D. McLachlan
- NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry- R. V. Parish

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SEMESTER – 2	
PGSOC02: Communicative English	
SOC 2	Credits: 1
Number of lectures required: 60	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Demonstrate mastery of the discipline by detailing the development and current practices of Listening, Speaking, Reading and Writing as Language skills.
2. Conduct research that engages and responds to diverse audiences of scholars, students, and community members.
3. Demonstrate values and ethics in all activities

PGSOC 2: Communicative English Class: 15 hrs

Unit I: Introduction to Communication

- Process of Communication
- Levels of Communication
- Flow of Communication
- Verbal and Non-Verbal Communication
- Barriers to Communication

Unit II: Listening and Speaking Skills

- Introduction to English Phonetic Symbols: Consonants and Vowels with illustrations in use.
- Dialogue
- Group Discussion
- Presentation
- Interview Technique.

Unit III: Reading and Writing Skills

- Techniques of Reading
- Types of Reading
- Email Writing
- Report Writing

New Addition: 100%	Modifications: 0%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Enhance their English language proficiency in the aspects of reading, writing, listening and speaking.	PO 3	PSO 3	U, Ap
CO 2:	Develop academic literacy required for undergraduate learning, further studies and research	PO 3	PSO 3	C
CO 3:	Apply the requisite communicative skills and strategies to future careers	PO 3	PSO 3	Ap
CO 4:	Gain an insight into cultural literacy and cross-cultural awareness and engage in self-directed english language learning	PO 3	PSO 3	Ap, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- Vibrant English (New Delhi: Orient Black Swan)
- Speak Well (New Delhi: Orient Black Swan) a compulsory supplementary Work Book forexercises on Interactions, dialogue, presentation skills, Group discussions, debates and Interviews.

Recommended Readings for advanced learning:

- Advanced Skills in English. eds E Suresh Kumar et al.
- Practising Writing Skills, Work Book
- Enhancing English and Employability Skills
- Business Communication,
- English for Fluency
- English Language Practice
- Basics of Academic English- 1 and 2
- Practising English- all these are Orient Black Swan publications

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SEMESTER – 3	
CHEMISTRY -MCT07: INORGANIC CHEMISTRY-2	
PGCHEMMCT07	Credits: 5
Number of lectures required: 60	
MCT07: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Techniques of Chemical Separation based on chromatography, and solvent extraction methods
2. Understanding environmental parameters and their corelations
3. Causes of environmental pollution and remedies
4. Essential and trace elements in the biological systems, their roles and reactions
5. Biological processes of electron transfer, transport and storage of oxygen

Unit-1: Techniques of Chemical Separation: 16M: (16-20L)

Principles, classification (where applicable), experimental set up, special features, mechanism of separation (where applicable), procedures, advantages and disadvantages and applications (analytical and or industrial as applicable) of the following separation techniques:
(i). Chromatography: Fundamentals, dynamics, plate theory, resolution of mixtures. Adsorption chromatography-chemical constitution and chromatographic behaviour, affinity chromatography and chiral chromatography. Partition chromatography-liquid-liquid and reverse phase partition chromatography, paper chromatography, thin layer chromatography (TLC), and ion-pair chromatography.
(ii). Gas Chromatography (GC): Plate theory, gas-solid and gas-liquid chromatography, HPLC. Super critical fluid chromatography, gel permeation chromatography and molecular sieves. Hyphened technique: GC-MS and its applications.
(iii). Ion-exchange chromatography: Ion-exchange resins, ion-exchange equilibria, plate theory of ion exchange column, separation of cations and anions from mixtures, separation of lanthanides; liquid ion-exchangers, inorganic ion-exchangers. Ion chromatography (IC) by chelation, ion pairing and ion exclusion- analytical applications and environmental speciation. Hyphened techniques: GC-IC, IC-MS. *(iv). Electro chromatographic techniques:* Curtain electro chromatography, reverse osmosis and electro dialysis and their applications in desalination of water, separation bio molecules by electrophoresis, capillary electrophoresis
(v). Solvent extraction: Extraction equilibria, partition coefficient and extraction coefficient, extraction by chelation and solvation; separation of metals, extraction of ion pairs, solid-phase extraction (SPE), supramolecular extraction with crown ethers, cryptands and rotaxenes.

Unit-2: Environmental Chemistry & Environmental Analysis: 16M: (16-20L)

The Environment: Environmental segments, ecosystem; bio distribution of elements, bio geo chemical cycles of C, O, N, S, P.

The Atmosphere: Structure and chemical composition, chemical and photochemical reactions in the atmosphere, ozone layer and its importance. Air pollution by CO, CO_2, NO_x, SO_2,

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H_2S, O_3, hydrocarbons (HC), PAN, PAH CFC'S, suspended particulate matters (SPM) and their detection, estimation and monitoring; air quality standard. Greenhouse effect, photochemical smog, acid rain, ozone hole and their impacts on the environment. Air pollution control measures: cyclone separators, electrostatic precipitators, catalytic converters.

The Hydrosphere: Environmental role of water, hydrologic cycle, water quality parameters: DO, COD, BOD, TDS, TOC, hardness, acidity, alkalinity and their determination. Water pollutants and their sources. Thermal and radiochemical pollution. Water treatment: coagulation, reverse osmosis, electro dialysis; waste water treatment. Chemical speciation in respect of As, Hg, Pb, Cd, Cu, Fe, Se and Cr in water and their toxic effects.

The Lithosphere: Soil composition, micro and macro nutrients in soil, soil pollutants. Interactions of pesticide, insecticides, fertilizers, toxic (heavy) metals and industrial effluents with soil and their impacts on soil fertility. Corrosion of metal and alloys, corrosion monitoring and prevention methods.

Unit-3: Bioinorganic Chemistry: 18M: (16-20L)

Essential and trace elements in the biological systems, metal of life, basic reactions in the biological systems and the roles of metal ions in biological process.

Bioenergetics and ATP cycle: Phosphate transfer potentials, metal complexes in transmission of metabolic energy, glucose storage; Ion transport (active and passive) across biological membrane and its significance, mechanism of Na^+K^+ -ion pump, ionophores as models.

Transport and storage of dioxygen: Active site structures and bio functions of O_2-uptake proteins: hemoglobin, myoglobin, hemocyanin and hemerythrin; model synthetic dioxygen complexes.

Electron transfer in biology: Active site structures and functions of cytochromes, cytochrome *c*; iron-sulfur proteins (ferredoxines). Respiratory electron transport chain, cytochrome c oxidase. Photosynthesis and chlorophylls, photosystem-I and photosystem-II and their roles in cleavage of water. Model systems. Biological and abiological nitrogen fixing systems.

Toxic effects of metal ions, detoxification by chelation therapy, metal dependent diseases and metal complexes as drugs- Pt, Ru Rh and Au drugs.

New Addition: 0% Modifications: 100% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply the techniques of chromatography, and solvent extraction methods in the separation of organic compounds	PO 2	PSO 2	An
CO 2:	Analyze environmental parameters and identify their corelations	PO 2	PSO 3	Ap, An

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CO 3:	Evaluate the causes of different environmental pollution and design remedies to resolve it	PO 3	PSO 3	E, C
CO 4:	Interpret the importance of essential and trace elements in the biological systems, their roles and reactions	PO 1	PSO 5	E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR MCT07

- Kinetics and Mechanism of Reactions of Trans. Metal Complexes- R. G. Wilkins
- Determination and use of Stability Constants- A. E. Martell & R. J. Motekaitis
- An Introduction to Bioinorganic Chemistry-D. R. Williams
- Inorganic Chemistry of Biological Processes-M. N. Hughes
- Bioinorganic Chemistry-E. I. Ochiai
- Bioinorganic Chemistry- R. W. Hay
- Elements of Bioinorganic Chemistry- G. N. Mukherjee & A. Das
- Organometallic Chemistry of Transition Metals-R.H. Cabtree
- Organometallic Chemistry- R. C. Mehrotra & A. Singh
- Nuclear and Radio Chemistry-Friedlander, Kennedy & Miller
- Radioactiviry Applied to Chemistry- A. C. Wahl & N. A. Bonner
- Magnetochemistry- Selwood
- Intriduction to Magnetochemistry- Earnshaw
- Environmental Analysis- S. M. Khopkar

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SEMESTER – 3	
CHEMISTRY -MCT08: ORGANIC CHEMISTRY-2	
PGCHEMMCT08	Credits: 5
Number of lectures required: 60	
MCT08: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Structure and properties of different important biomolecules
2. Structure, reactivity and roles of different enzymes
3. Different organometallic reactions
4. Catalysis involving different organometallic complexes
6. Fundamental theories of green chemistry and combinatorial chemistry

MCT08: Organic Chemistry Theory-3

Unit-1: Bioorganic Chemistry: 16M: (16-20L)

Biomolecules: Purines and pyrimidine bases, nucleosides and nucleotides. Gene-the code of life, replication, transcription and translation of DNA, genetic information transfer and heredity. Carbohydrates and Lipids: Types of sugars, deoxy sugars, amino sugars and polysaccharides; biological and industrial importance of polysaccharides and lipids.

Enzymes: Chemical and biological catalysis, catalytic power of enzymes, specificity and regulation. Nomenclature and classification, extraction (large scale production) and purification of enzymes. Enzymic actions: ribonuclease, carboxipeptidase A; phosphate transfer-ATP cleavage, carboxylation and decarboxylation, isomerization and rearrangements. Immobilization of enzymes and its effect on enzyme activity. Enzyme Models: crown ethers, cryptates. cyclodextrins, cyclodextrin based enzyme models, calixarenes, ionophores, micelles, synthetic enzymes or synzymes.

Unit-2: Advanced Organometallic Chemistry (Catalysis) :18M: (16-20L)

Catalysis by organometallic compounds: Oxidative addition, reductive elimination, insertion and elimination, electrophillic and nucleophilic reactions substitution, of organometallic compounds of transition metals.

Hydrogenation of olefins, Wilkinson's catalyst, Tolman catalytic loop; synthesis gas, water-gas shift reaction; Hydroformylation (oxo process), Monsanto acetic acid process, Wacker process; synthetic gasoline: Fischer-Tropsch process and Mobile process, polymerization, oligomerization and metathesis reactions of alkens and alkynes, Zieglar- Natta catalysis, photo dehydrogenation catalyst (platinum POP).

Unit-3: Green Chemistry :16M: (16-20L)

Over view, 12 principles, Green synthetic methods, catalytic methods, organic synthesis in; microwave methodology; sonochemistry, mechanochemistry, combinatorial chemistry aqueous media, ionic liquid, supercritical fluids. Reagents on solid-support; solid-phase synthesis.

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New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Explain structure and properties of different important biomolecules and enzymes	PO 2	PSO 3	E
CO 2:	Understand the mechanism of different organometallic reactions	PO 2	PSO 3	Ap, C
CO 3:	Design new organometallic complexes for catalysis	PO 2	PSO 5	C
CO 4:	Apply the fundamental knowledge of green chemistry and combinatorial chemistry for sustainable development	PO 1	PSO 3	Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR MCT08

- Fronties Orbitals and Organic Chemcal Reactions-I. Fleming
- Pericyclic Reactions- Gill & Willis
- Pericyclic Reactions- S. M. Mukherjee
- Steriochemistry-E. Eliel & S. H. Wilen
- Steriochemistry- D. Nasipuri
- Steriochemistry of Organic Compounds- P. Kalsi
- NMR in Chemistry-A Multinuclear approach—W. Kemp
- Application of N. M. R. Spectroscopy in Organic ChemistryL- L. M. Jackman M.
- Interpretation of ^{13}C –NMR Spectra- F. W. Werli & T. W. Wirthlin
- Mass Spectrometry-Organic Applications-K. Biieman
- Free Radicals in Organic Chemisrey—Fossey, Lepost & Sorbs
- Elements of Organic Photochemistry-D. O. Cowan & K. L.Drisco
- Application of Organotransition Metal in Organic Synthesis-S.G. Davies
- Comprehensive Heterocyclic Chemistry- A. R. Katritzky, & C. W. Rees (eds)

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SEMESTER – 3	
CHEMISTRY -MCP07: INORGANIC CHEMISTRY PRACTICAL-3	
PGCHEMMCP07	Credits: 5
Number of lectures required: 60	
MCP07: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Preparation of different inorganic double salts, and complex salts
2. Optimization of reaction parameters and solvent to maximize the product yield
3. Work-up procedure and purification of the reaction product
4. Characterization of the prepared compounds by different spectroscopic techniques and magnetic moment measurements

MCP07: Inorganic Chemistry Practical-3

Inorganic Synthesis

Preparation and characterization (by chemical analysis, electronic spectra, conductance and magnetic measurements as applicable) of typical inorganic compounds [at least six (6) compounds derived from at least three (3) different metal ions].

Model Compounds

$[Ni(en)_3]X_2.\ x\ H_2O$ ($X = Cl^-, SO_4^{2-}, S_2O_3^{2-}$)
$(Et_4N)_2[NiX_4]$, ($X = Cl^-, Br^-$)

$(Et_4N)_2[CuX_4]$, ($X = Cl^-, Br^-$)
$[Cu(biguanide)_2]\ SO_4$
$[Cu\ (acac)_2]$
$[Cu(NH_3)_4]\ SO_4.\ H_2O$

$Et_4N)_2[CoX_4]$, ($X = Cl^-, Br^-, I^-$)
$Na_3[Co(NO_2)_6]$
$[Co(NH_3)_6]\ Cl_3$
$[Co(NH_3)_5\ H_2O]\ Cl_3$
$[Co(NH_3)_5\ Cl]\ Cl_2$
$[Co(NH_3)_5\ (N_3)]\ Cl_2$
$[Co(en)_2(CO_3)]Cl$
$[Co(en)_2(N_3)_2]\ NO_3$
$[Co(acac)_3]$ and its nitro derivative
$[Co(NH_3)_5(SO_3)]_2\ SO_3.2H_2O$
$[Co(NH_3)_4(CO_3)]\ NO_3.\ ½\ H_2O$

Mohr's salt
Ferric alum
$[Fe(acac)_3]$

Chrome alum
$K_3[Cr(C_2O_4)_3].\ 3H_2O\ NO_3.(½)\ H_2O$
$[Cr(acac)_3]$
cis- $K_2[Cr(C_2O_4)_2(H_2O)_2]$
$NH_4[Cr(NH_3)_2\ (NCS)_4].\ xH_2O$
(Reineke's salt)

$(NH_4)_2\ SO_4\ .\ MnSO_4.\ 6H_2O$
$(Et_4N)_2[MnX_4]$, ($X = Cl^-, Br^-$)
$(NH_4\ )_2[MnF_5]$
$[Mn(acac)_3]$

$(NH_4)_2\ [VO(C_2O_4)_2].\ 2H_2O$

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New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply the knowledge of inorganic synthesis for preparation of novel inorganic compounds	PO 2	PSO 2	Ap
CO 2:	Develop new methodologies for work-up and purification of the reaction product	PO 2	PSO 5	C
CO 3:	Analyse qualitatively and quantitatively new inorganic compounds	PO 3	PSO 3	An
CO 4:	Interpret the spectroscopic and magnetic moment results to characterize the prepared compounds	PO 2	PSO 3	E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP07

- Physical Methods in Inorganic Chemistry-R. S. Drago
- Instrumental Methods in Chemical Analysis- Willrd, Meritt and Dean
- Instrumental Methods in Chemical Analysis- G. W. Ewing
- Vogel`s Text Book of Quantitative Chemical Analysis G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denny
- Advanced Experiments in Inorganic Chemistry-G. N. Mukherjee (U. N. Dhur)
- Macro and Semi-micro Qualitative Inorganic Analysis- A. I. Vogel
- Semi-Micro Qualitative Inorganic Analysis- G. N. Mukherjee (C.U.Press)
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SEMESTER – 3	
CHEMISTRY -MCP08: ORGANIC CHEMISTRY PRACTICAL-3	
PGCHEMMCP08	Credits: 5
Number of lectures required: 60	
MCP08: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Estimation of drugs, such as, paracetamol / aspirin, ascorbic acid (vitamin-C), isoniazide
2. Semi micro-quantitative estimation of nitrogen in organic samples
3. Determination of DO, COD, BOD and hardness of water sample
4. UV-VIS-spectrophotometric estimations of amino acids, proteins, carbohydrates etc.

MCP08: Organic Chemistry Practical-3

Quantitative Organic & Environmental Analysis
Model Experiments

1. Semi micro-quantitative estimation of nitrogen by Kjeldahl`s method.
2. Estimation of methoxyl group by Zeisel`s method.
3. Estimation of glucose and sucrose in a mixture using Fehling`s solutions.
4. Estimation of drugs:
   (a). Paracetamol / Aspirin, (b). Ascorbic acid (vitamin-C), (c). Isoniazide.
5. Determination of percentage of number of hydroxyl groups in an organic compound by acetylation method.
6. Determination of amines / phenols using bromate-bromide solution.
7. Determination of iodine value and saponification value of an oil.
8. Determination of DO, COD, BOD and hardness of water sample.
9. Estimation of iron and phosphate in water sample (spectrophotometric methods).
10. Estimation of total halide in water sample by argentimetric method.
11. UV-VIS-spectrophotometric estimations:
    (i). Amino acids, (ii). Proteins, (iii). Carbohydrates, (iv). Cholesterol, (v). Aspirin
    (vi). Caffine.

(At least four (4) experiments are to be carried out by a candidate during lab. session)

New Addition: 0% Modifications: 100% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Estimate different drugs such as, paracetamol / aspirin, ascorbic acid (vitamin-C), isoniazide quantitatively	PO 2	PSO 5	C
CO 2:	Quantitatively estimate nitrogen in soil and fertilizers	PO 2	PSO 5	C
CO 3:	Determine DO, COD, BOD and hardness of water sample of different natural sources	PO 2	PSO 5	E
CO 4:	Apply spectrophotometric and titrimetric techniques to estimate iron, phosphate, halides in water samples	PO 4	PSO 5	Ap, C

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP08

- Practical Physical Chemistry- A. M. James & F. F. Prichard
- Findlay's Practical Physical Chemistry- B. P. Levit
- Experimental Physical Chemistry- Shoemaker & Garland
- Introduction to Magnetic Resonance-A. Carrington & A. D. McLachlan
- NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry- R. V. Parish

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SEMESTER – 3	
CHEMISTRY -SCC: INTERDISCIPLINARY ADVANCED CHEMISTRY	
PGCHEMSCC	Credits: 4
Number of lectures required: 60	
SCC : Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Instrumental methods like UV-VIS, IR, ORD-CD, Mass, NMR spectroscopy
2. Instrumental methods like electronic, ESR, NQR, MB, PES spectroscopy
3. Instrumental methods like X-Ray, electron and neutron diffraction techniques

SCC: Interdisciplinary Advanced Chemistry

Unit-1. Instrumental Methods in Chemistry (1): 14M: (12-15L)

UV-VIS, IR, ORD-CD, Mass and NMR Spectroscopy

UV-VIS Spectroscopy: Various electronic transitions (185-800 nm), effect of solvent, Lambert-Beer law; uv-bands of saturated and unsaturated carbonyl compounds, -dienes, -conjugated polyenes, Fieser-Woodward rules; uv- spectra of aromatic and heterocyclic compounds; steric effects in biphenyls.

IR Spectroscopy: Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic and heterocyclic compounds, ethers, phenols and amines, carbonyl compounds (aldehydes, ketones, esters, carboxylic acids, amides, anhydrides, lactones, lactams, and conjugated carbonyl compounds). Effects of solvent, hydrogen bonding on vibrational frequencies, overtones, combination bands and Fermi resonance, FT IR.

Mass Spectrometry: Basic instrumentation, ion production - EI, CI, FD and FAB techniques, Mass spectral fragmentation of typical organic compounds, common functional groups.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Basic instrumentation, nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift, and its measurements, factors influencing chemical sift, deshielding, spin-spin interactions, factors influencing coupling constant `J`. Classification of molecules: (ABX, AMX, ABC, A_2B_2, etc. types), spin decoupling. FT-NMR (qualitative idea) and its advantages, Applications of NMR in medical diagnosis.

Unit-2. Instrumental Methods in Chemistry (2): 13M: (12-15L)

Electronic Spectroscopy: Metal centered d-d transitions, Orgel diagrams and Tanabe Sugano diagrams, correlation between weak field and strong field terms, f-f spectra of lanthanides and actinides, bonding parameters and structural evidences from electronic spectra, charge transfer spectra, LMCT and MLCT transitions. ORD and CD spectra and absolute configuration of coordination compounds.

Electron Spin Resonance (ESR) Spectroscopy: Hyperfine coupling, spin polarization of atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4, F_2^- and $[BH_3^-]$. Basic principles, zero field splitting, and Kramer`s degeneracy, factors affecting the `g` value. Basic instrumentation, measurement techniques and simple applications.

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Nuclear Magnetic Resonance (NMR) Spectroscopy: Chemical shift, quantum mechanical theory of magnetic resonance. Bloch equations and their solutions; diamagnetic and paramagnetic shielding, dipolar hyperfine interaction, spin –spin coupling; spin-lattice and spin-spin relaxations, relaxation time and line broadening, factors affecting nuclear relaxation, echo experiments. NMR imaging (MRI). NMR of paramagnetic substances in solution: Doppler shift, contact shift and pseudo contact shift, relationships between magnetic susceptibility and resonance shift; structural information from ^{11}B, ^{13}C, ^{15}N, ^{19}F, ^{27}Al, ^{31}P, ^{119}Sn, ^{195}Pt, NMR spectra.

Nuclear Quadruple Resonance (NQR) Spectroscopy: Qudrupole nuclei, qudrupole moments, electric field gradient, coupling constant, splitting and simple applications.

Mössbauer (MB) Spectroscopy: Basic principle, instrumentation, spectral parameters and spectrum display, center shift, qudrupole and magnetic interactions. Application to the elucidation of structure and bonding of Fe^{III} and Fe^{II}, Sn^{IV} and Sn^{II} compounds, detection of oxidation states and inequivalent MB atoms.

Photoelectron Spectroscopy (PES): Photo excitation and photo ionization, core level photo ionization (XPS, ESCA.) and valence level (UPS) experiments, detection of atoms in molecules, chemical shift, differentiating same element in different environments.

Unit-3. Instrumental Methods in Chemistry (3): 13M: (12-15L)
X-Ray, Electron & Neutron Diffraction Spectroscopy

X-Ray Diffraction: Bragg condition, Miller indices, Lau method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absence in diffraction pattern. X-ray intensities and structure of simple lattices, structure factor and its relation to intensity and electron density, phase problem. Procedure for X-ray structure analysis, absolute configuration of molecules, Ramachandran diagram.

Electron Diffraction: Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

Neutron diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques. Elucidation of structure of magnetically ordered unit cell.

New Addition: 100%	Modifications: 0%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply the instrumental techniques like UV-VIS, IR, ORD-CD, Mass, NMR spectroscopy to analyze chemical samples	PO 3	PSO 3	An
CO 2:	Apply the instrumental techniques like electronic, ESR, NQR, MB, PES spectroscopy to analyze new chemical samples	PO 3	PSO 3	Ap, C
CO 3:	Apply the instrumental techniques like X-Ray, electron and neutron diffraction techniques to analyze chemical samples	PO 3	PSO 5	Ap
CO 4:	Design new reactions and characterize the product applying the different instrumentation techniques	PO 3	PSO 5	Ap, C

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR SCC

- Instrumental Methods in Chemical Analysis- Willrd, Meritt and Dean
- Instrumental Methods in Chemical Analysis- G. W. Ewing
- Spectrometric Identification of Organic Compounds-(6th. edn)-Silverstein & Webster
- An Introduction to Experimental Organic Chemistry- Robert, Gilbert, Rodewaid & Wingrove

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SEMESTER – 3	
CHEMISTRY -OE01: OPEN ELECTIVE-01	
PGCHEMOE01	Credits: 4
Number of lectures required: 60	
OE01:	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Principles of molecular association and organization in enzymes, nucleic acids, membranes, micelles and vesicles
2. Synthesis and characterization of different supramolecules
3. Principles of gene synthesis, regulation of protein biosynthesis, synthetic receptors.
4. Supramolecular devices and nanotechnology

OPEN ELECTIVES

OE-01

Supramolecular Chemistry 40M (35-40 L)

Supramolecular Chemistry: Molecular Recognition: Proximity effects and molecular adaptation, molecular receptors for different types of molecules including arisonic substrates, designing of co-receptors, cryptands, cyclophanes, calixerenes, cyclodextrines, multiple recognition. Supramolecular self -assembly: Principles of molecular association and organization in enzymes, nucleic acids, membranes 9(as examples) and micelles and vesicles (as models). Supramolecular reactivity and catalysis.

Principles of gene synthesis, regulation of protein biosynthesis, synthetic receptors. Enzyme chemistry, catalytic antibodies. Molecular channels, transport processes and carrier design. Supramolecular devices and nanotechnology: supramolecular electronic, ionic and switching devices, Supramolecular photochemistry.

New Addition: 100%	Modifications: 0%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply the principles of molecular association and organization to explain the chemical interactions in enzymes, nucleic acids, membranes, micelles and vesicles	PO 2	PSO 3	Ap, E
CO 2:	Design novel supramolecules for advanced applications	PO 4	PSO 5	Ap, C
CO 3:	Apply the principles of gene synthesis, regulation of protein biosynthesis, synthetic receptors to explain related systems	PO 3	PSO 3	Ap, E
CO 4:	Design new supramolecular devices for versatile applications	PO 4	PSO 5	C

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REFERENCE BOOKS FOR OE1

- Principles of Organic Synthesis-Norman, Coxon & Blakie
- Current Trends in Organic Synthesis-C.Scolastico & F. Nicotra
- Fronties Orbitals and Organic Chemcal Reactions-I. Fleming
- Supramolecular Chemistry: Concepts & Perspective- J. M. Lehn
- Experimental Organic Chemistry: Principles & Practice-L. M. Harwood & C. J. Roodey

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SEMESTER – 3	
CHEMISTRY -OE02: OPEN ELECTIVE-02	
PGCHEMOE02	Credits: 4
Number of lectures required: 60	
OE02:	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Different types of drugs, drug – receptor interactions, and mechanisms of drug actions.
2. SAR and QSAR with special reference to antimalarials, antibiotics, anticholenergic and CNS – active drugs
3. Different established and new generation antibiotics
4. Activity of different vitamins

OE-02
Medicinal Chemistry 40M (35-40 L)

Medicinal Chemistry: Different types of drugs. Drug – receptor interactions; mechanisms of drug actions. Drug designing and synthesis. Structure-Activity Relationships (SAR) and Quantitative Structure Activity Relationship (QSAR) with special reference to antimalarials, antibiotics, anticholenergic and CNS – active drugs. Concepts of LD_{50} and ED_{50}. Antibiotics: penicillins, cephalosporins, tetracyclines, newer generation of antibiotics; Vitamins: vitamin B complex, vitamin-C, vitamin-K.

New Addition: 100%	Modifications: 0%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Understand types of drugs, drug – receptor interactions, and mechanisms of drug actions.	PO 1	PSO 1	U
CO 2:	Apply the mechanism of drug actions to design new drug molecules	PO 3	PSO 5	Ap, C
CO 3:	Design next generation antibiotics	PO 3	PSO 5	Ap
CO 4:	Analyze the activity of different vitamins in biological systems	PO 2	PSO 2	An

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REFERENCE BOOKS FOR OE2

- An Introduction to Medicinal Chemistry- Graham L. Patrick
- Foye's Principles of Medicinal Chemistry - Wolters Kluwer
- Fundamentals of Medicinal Chemistry- Gareth Thomas
- Some Modern Methods in Organic Synthesis-W. Carruthers

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SEMESTER – 3	
SOC 3: Value Education and Indian Culture	
PGSOC03	Credits: 1
Number of lectures required: 20	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Attain awareness about daily routine, self-evaluation & Integral Personality Development
2. Understand the educational needs, the Power of thoughts and the Science of Peace
3. Understand the relation: Values and enlightened citizenship
4. Attain awareness about the Indian Practice and Culture

SOC 3: Value Education and Indian Culture

Class: 15 hrs

Unit 1: Daily Routine: **1 class**

- A suggested daily routine
- The daily routine & the concept of biological clock: key to a healthy and productive life
- Necessity for an all-round daily routine
- Combining Rest and Activity, Hardships and Joy in a daily routine
- The scope of developing the power of concentration and detachment through a daily routine
- Daily Routine disciplines the system but confers conviction on oneself

Unit 2: Self Evaluation & Integral Personality Development **2 classes**

- Why is Self-Evaluation important? Because if you win yourself, you win the world
- Quantitative Self Evaluation for a qualitative change: A method
- Traits to track Personality Development: Academic Excellence, Social Compatibility, Participation in Group events, Sense of Responsibility, Role as a Consumer, Scientific Temperament, Aesthetic taste and creativity, Leisure time Activities, Concern for others, Spiritual values.
- Close and Constant Self Evaluation: a stitch in time saves nine
- The world is as we are: A minor inner change may nullify a major outer perturbation

Unit 3: Our Educational Needs **2 classes**

- The need of a correct blend of inner and outer well-being in education
- Man-making, Character building education: growing from within, a surer foundation of progress
- The outer crust and the inner core of our personality: "What you are shouts so loudly in my ears that I cannot hear what you say."
- A 5-point training in Discipline, Cleanliness, Behaviour, Manners and Ambition
- Sharpening the sword of will: controlling its expression, a basic educational need
- How to study effectively?

Unit 4: The Power of thoughts and the Science of Peace **1 class**

- Shanti Mantras: Peace can be radiated from and reflected back upon ourselves
- You can create an ambience and others can enjoy it, can be benefitted by it.
- How to create a positive, peaceful and inspiring ambience? the aggressive exertion and the

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Rahara, Kolkata – 700 118

unquestioning sacrifice involved in it

Unit 5: Subhashita: The Well said **1 class**

- Bringing home high thoughts in nuggets of wisdom
- Pearls of Wisdom and flames of fire: simple parables and anecdotes from the great ones.

Unit 6: Values and Enlightened Citizenship **2 classes**

- Intrinsic and Instrumental Values
- What makes a man great? A powerful will to do good born out of self-control and self-sacrifice
- Learning the art of inter-personal relations: Not I but You
- The combination of the Head, Heart and Hand: a valuable value for Enlightened Citizenship

Unit 7: Indian Practice and Culture **2 classes**

- The idea of sacredness & its necessity
- Every aspect of life is sacred in India
- Renunciation and service the twin ideals for India
- My freedom from Nature helps me to serve nature and the world better
- I never say I am the body, I always say this body is mine: I as a master of the body-mind complex
- Weakness is death: in search of real strength of self-knowledge, reliance on God and unselfish service
- Meditation, Concentration and the silent Indian path for becoming a dynamo of power
- The Indian concept of Unity in diversity: Harmony of Religions

Unit 8: Four Yogas **2 classes**

- The Real and Apparent Man, the science of knowing myself: Jnana Yoga
- Taming the mighty current of emotions and giving them their right food: Bhakti Yoga
- The Science of working wisely: Karma Yoga
- The Process of making my mind mine: Raja Yoga
- Selected portions from Swami Vivekananda's Karma Yoga
- Harmony of 4 Yogas: a needed balance for the modern man

Unit 9: Modern India: her hopes, challenges and Swami Vivekananda **2 classes**

- Swami Vivekananda's method of combining the best of the East & the West: where Indian values and Western workmanship join hands
- Invigorating rationality in the field of the Indian search for the supreme joy : erasing the misconception of dogmatism
- Rousing a sense of pride in the age-long Indian discoveries in the field of inner truths as opposed to an inferiority complex posed by Western material supremacy.
- Do you feel: Service, Swami Vivekananda's acid test for modern science and traditional spirituality.

Unit 10: Students' Presentations/Project: (may be in groups)

- Project on Service, Teaching and Cleanliness

New Addition: 100% Modifications: 0% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Define, demonstrate and apply the daily routine, self- evaluation & Integral Personality Development	PO 1	PSO 3	R, U, Ap
CO 2:	Learn, and apply the Power of thoughts & the Scienceof Peace	PO 4	PSO 3	U, Ap
CO 3:	Demonstrate the relation: Values and enlightenedcitizenship	PO 4	PSO 3	U
CO 4:	Discuss the awareness about the Indian Practice andCulture	PO 4	PSO 3	C

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

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SEMESTER – 4	
CHEMISTRY -MCT09: PHYSICAL CHEMISTRY-3	
PGCHEMMCT09	Credits: 5
Number of lectures required: 60	
MCT09: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Symmetry elements, symmetry operations and fundamentals of group theory
2. CFT and MO approaches for explaining bonding and chemical reactions
3. Crystal structures, crystal defects and electronic properties of solids
4. Fundamentals of biophysical chemistry and its applications

Unit-1. Chemical Applications of Group Theory: 18M: (16-20L)

Elements of group theory: groups subgroups, classes and characters, classes of symmetry operations, symmetry point groups; representation of groups by matrices. Representation of symmetry operator- transformation of basis vector, Symmetry transformation of operators The Great Orthogonality Theorem (without proof) and its consequences; construction and applications of character tables, representation of cyclic groups. Group theoretical representation of quantum mechanics, vanishing integrals, wave functions as bases for reducible and irreducible representations; direct product and projection operator and their applications; symmetry adapted linear combination (SALC)s.

Simple applications of symmetry and group theory: hybridizations involving *s, p* and *d* orbitals, symmetry and shapes of AB_n (n = 1-6) molecules; LCAO approximation, Huckel`s theory of pi-electrons, LCAO-mo-pi-bonding, three center bonding (open and closed); pericyclic reactions- dimerization of ethylene, Diel`s Alder reaction.

Crystal field splitting of free ion terms in weak and strong crystal fields (Oh and Td), energy level diagrams and symmetries and multiplicities of energy levels, correlation diagrams, effect of lowering symmetry on the d-orbital energy levels, selection rules for electronic transitions, vibronic coupling and vibronic polarization, electronically allowed transitions (Laporte selection rule); construction of mo diagrams of polyatomic molecules including coordination complexes (Oh and Td), sandwich complexes:(ferrocene , dibenzenechromium). Symmetry of normal vibrations, normal mode analysis, selection rules for vibration and Raman spectra.

Unit-2: Solid State Chemistry: 16M: (16-20L)

Crystal structure: Unit cell, Diffraction of X-rays by crystals, structure factor, systematic absences, Fourier synthesis, Patterson function.

Crystal defects and Non- stoichiometry: Perfect and imperfect crystals, intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, non-stoichiometric defects.

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Rahara, Kolkata – 700 118

Electronic Properties and Band Theory: Thermal properties: Free electron theory of metals, specific heat, Hall effect and its quantum manifestation, Band theory of metals: band gap, electrical and thermal conductivity of metals, semi-conductors, insulators, rectifiers and transistors and insulators. p-n junctions, super conductors.

Magnetic properties: Classification of materials: dia-, para-, ferro- and antiferro-magnetic materials; quantum theory of paramagnetic cooperative phenomena, magnetic domains and hysteresis. Magnetic susceptibility and magnetic moment (including determination)

Optical properties: Optical reflectance, photoconduction, colour centers, photovoltaic effect.

Unit-3: Biophysical Chemistry: 16M: (16-20L)

Constituents of living cell. Primary, secondary, tertiary and quaternary structures functions of proteins, enzymes; nucleic acids- DNA and DNA, helix- coil transition; A, B, Z conformations, t-RNA conformation.

Bioenergetics: Standard free energy change in biological reactions, exergonic and endergonic processes. ATP - ADP inter conversion. Biopolymer interactions: Electrostatic, hydrophobic and dispersion forces. Multiple equilibria involving various types of binding processes. Thermodynamics aspects of biopolymer solutions: osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mitochondrial system. Structure and functions of cell membrane, ion transport across biological membrane, muscle contraction and nerve function. Applications of ORD, CD, IR, Raman, NMR and fluorescence spectroscopy, low angle X-ray scattering and X-ray diffraction techniques in studying the structures and functions of biomolecules (examples).

Co-enzymes and cofactors: Vitamins, prosthetic groups, apoenzymes. Stuctures and biological functions of coenzyme-A, thiamine pyrophosphste, pyrodoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, coenzyme Q, lipoic acid, vitamin $-B_{12}$.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Ramakrishna Mission
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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Recall the fundamentals of group theory to explain the related problems	PO 1	PSO 1	R, E
CO 2:	Apply the CFT and MO concepts to explain the bonding and molecular properties	PO 2	PSO 3	Ap, E
CO 3:	Evaluate the crystal structures, crystal defects and electronic properties of new crystalline solids	PO 3	PSO 5	E
CO 4:	Apply the concepts of biophysical chemistry in different enzymatic reactions	PO 3	PSO 2	Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR MCT09

- Chemical Applications of Group theory- F. A. Cotton
- Molecular Symmetry & Group Theory- R. L. Carter
- Group Theory and Chemistry—D. M. Bishop
- Thermodynamics and an Introduction to Thermostatistics- H. B. Callen
- Coulson`s Valence- R. McWeeny
- Modern Electrochemistry-J.O`M. Bockris & A. K. N. Reddy
- Principles of Physical Biochemistry- K. E. van Holde, C. Johnson & P. S. Ho
- Polymer chemistry-P. J. Flory
- Microwave Spectroscopy-C. H. Townes & A. L. Schawlow
- Symmetry and Spectroscopy- D. C. Harris & M. d. Bertolucci
- Solid State Physics- A. J. Dekker
- Introduction to Solid State Physics- C. Kittel

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SEMESTER – 4	
CHEMISTRY -MCP09: PHYSICAL CHEMISTRY-3	
PGCHEMMCP09	Credits: 5
Number of lectures required: 60	
MCP09: Practical (30) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Understanding application of viscometric method in determination of molecular radius of a molecule, molecular weight of polymer.
2. Understanding and analysing different aspects of kinetic study of chemical reactions.
3. Understanding and analysing experimental data to determination of order, rate constant, variation of rate constant with ionic strength, etc.
4. Understanding and application of spectrophotometric method in determination of composition of metal – ligand complex and hands-on experience in using UV-Visible spetroscope.

MCP09: Physical Chemistry Practical-3

Model Experiments

1. Determination of molecular radius of sucrose by viscometric method

2. Determination of molecular weight of a polymer (Polyvinyl alcohol) by viscometric method.

3. Study of Primary Kinetic Salt Effect in case of $K_2S_2O_8$ + KI reaction.

4. Verification of Onsager Equation and determination of solubility and solubility product of a sparingly soluble salt (say, $BaSO_4$) by conductometric method.

5. Kinetic study of an Autocatalytic reaction ($KMnO_4$ + oxalic acid).

6. Spectrophotometric determination of the composition of metal – ligand complex using Job's method/ mole ratio method / slope ratio method

New Addition: 100%	Modifications: 0%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Determine molecular weight of polymer by viscometric method	PO 2	PSO 2	E
CO 2:	Analyse different aspects of kinetic study of chemical reactions.	PO 2	PSO 2	An
CO 3:	Analyse experimental data to determine of order, rate constant, variation of rate constant with ionic strength, etc.	PO 2	PSO 2	An, E
CO 4:	Apply spectrophotometric method to determine of composition of metal – ligand complex and hands-on experience in using UV-Visible spetroscope.	PO 4	PSO 5	Ap, E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

Experiment (20) + LNB (05) + Viva (05) + Attendance (05)

REFERENCE BOOKS FOR MCP09

- Practical Physical Chemistry- A. M. James & F. F. Prichard
- Findlay's Practical Physical Chemistry- B. P. Levit
- Experimental Physical Chemistry- Shoemaker & Garland
- Introduction to Magnetic Resonance-A. Carrington & A. D. McLachlan
- NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry- R. V. Parish

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SEMESTER – 4	
CHEMISTRY -ME01: ADVANCED INORGANIC CHEMISTRY-1	
PGCHEMME01	Credits: 4
Number of lectures required: 60	
ME01: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Stability constants of metal ligand complexes and their determination by different methods
2. Factors affecting the stability of complex in solution
3. Bioinorganic chemistry of human iron metabolism
4. Nuclear reactions and application of radioactive techniques

ME01: Advanced Inorganic Chemistry-1

Unit-1: Complex Equilibria :13M: (12-15L)

Stability constants of metal-ligand complexes (definitions). Determination of composition and stability constants of complexes by spectrophotometric-, pH-metric and polarographic-methods. Conditional stability constants and their importance in complexometric EDTA titration of metal ions.

Statistical and non – statistical factors affecting stability of complexes in solution. Stability of mixed-ligand complexes.

Solubility equlibria: Quantitativeness of precipitation, separation of metals by precipitation of metal-hydroxides, -sulfides and -chelate complexes.

Unit-2. Advanced Bioinorganic Chemistry :14M: (12-15L)

Metal ion interactions with purine and pyrimidine bases, nucleosides, nucleotides and nucleic acids DNA and RNA, metal ions in genetic information transfer. Metal ions in metabolic energy transfer- mechanism of metal ion catalyzed and metal complex catalyzed non-enzymic ATP hydrolysis.

Redox enzymes: Catalase, peroxidase, super oxide dismutase (SOD), cytochrome P-450, nitric oxide synthases (NOS), ascorbate oxidase, aldehyde oxidase; molybdo enzymes: xanthene oxidase, nitrate reductases, sulfite oxidase. Hydrolytic enzymes: carbonic anhydrase, carboxypeptidases, urease

Bioinorganic chemistry of human iron metabolism: ferritin, transferrin, siderophore and ceruloplasmin

Vitamins and coenzymes: Vitamin B_6 and vitamin B_{12} coenzymes, model systems

Unit-3: Nuclear Chemistry & Radiochemical Analysis: 13M: (12-15L)

Nuclear models: Nuclear forces, liquid drop model, shell model, Fermi gas model; magic numbers, nuclear spin and nuclear isomerism.

Nuclear reactions: Nuclear reactors and particle accelerators, energetics of nuclear reactions, Q-value, nuclear cross-section, mechanism and models of nuclear reactions. Nuclear fission and nuclear fusion, fission products and fission yields. Interactions of radiation with matters, chemical effects of nuclear transmutation elementary idea), radiolysis of water and other liquids/ solutions

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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

Radioactive Techniques: Detection and measurement of radiation- GM ionization and proportional counters. Study of chemical reactions by tracer techniques, isotope exchange and kinetic isotope effect. Radiometric analysis: Isotope dilution analysis, age determination, neutron activation analysis (NAA) and their applications. Radiation hazards and safety measures.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Determine stability constants of metal ligand complexes	PO 2	PSO 3	E
CO 2:	Analyse the factors affecting the stability of complex in solution	PO 2	PSO 3	An
CO 3:	Understand the mechanism of redox enzymes, vitamins and coenzymes and apply the concept to explain different biological phenomenon	PO 2	PSO 3	U, Ap, E
CO 4:	Develop new nuclear medicine and radiation technique in the medical field	PO 4	PSO 5	C

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR ME01

- Kinetics and Mechanism of Reactions of Trans. Metal Complexes- R. G. Wilkins
- An Introduction to Bioinorganic Chemistry-D. R. Williams
- Inorganic Chemistry of Biological Processes-M. N. Hughes
- Bioinorganic Chemistry-E. I. Ochiai
- Bioinorganic Chemistry- R. W. Hay
- Elements of Bioinorganic Chemistry- G. N. Mukherjee & A. Das
- Nuclear and Radio Chemistry-Friedlander, Kennedy & Miller
- Radioactivity Applied to Chemistry- A. C. Wahl & N. A. Bonner

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SEMESTER – 4	
CHEMISTRY -ME02: ADVANCED INORGANIC CHEMISTRY-2	
PGCHEMME02	Credits: 4
Number of lectures required: 60	
ME02: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Synthesis, structure and bonding features, technical applications of different inorganic polymers
2. Understanding the mechanism of substitution, electron transfer and photochemical reactions of transition metal complexes
3. Determination of magnetic susceptibility of magnetic materials by different methods
4. Magnetic behaviour of Lanthanides and actinides

ME2: Advanced Inorganic Chemistry-2

Unit-1: Inorganic Materials: 13M: (12-15L)

Synthesis, structure and bonding features, technical applications as applicable in respect of following materials:

Polysilanes, polyoxysilanes and silazanes, borazens, polyphosphates and polyphosphazenes; silicates and aluminosilicates with special reference to talc, asbestos, mica and zeolite; polythiazyl.

Inorganic polymers: Coordination polymers, dendritic macromolecules based on inorganic elements, halogen X_n^+ and X_n^- ions, zintle ions; clathrates, one dimensional solids, solid state extended arrays, cheveral phases, inorganic nano materials.

Unit-2: Kinetics and Mechanism of Inorganic Reactions: 14M: (12-15L)

Mechanism of substitution reactions: Mechanistic classification: D-, A-, I_a,- and I_d-mechanisms; solvent exchange, aquation, and pseudo – substitution reactions; deduction of mechanisms using rate laws (typical examples), activation parameters: $\Delta H^{\#}$, $\Delta S^{\#}$ and $\Delta V^{\#}$ and their physical significances; electronic and structural factors affecting reaction rates. Mechanism of isomerization reactions: linkage isomerism, *cis-trans* isomerism, intramolecular and intermolecular racemization reactions.

Mechanism of electron transfer reactions: General characteristics and classification of redox reactions, self exchage reactions, Frank-Condon principle (non-mathematical approach). Outer sphere and inner sphere reactions, applications of Marcus expression (simple form) redox catalysed substitution reactions.

Photochemical reactions of transition metal complexes: Excitation models, fate of photo exited species, fluorescence and phosphorescence applied to inorganic systems. Intra molecular energy transfer, vibrational relaxation, internal conversion and intersystem crossing. Photochemical substitution and photoelectron transfer reactions of coordination compounds (typical examples).

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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

Unit-3: Magnetochemistry:13M: (12-15L)

Types of magnetic materials. Magnetic susceptibility and its determination: Gouy, Faraday and Evans methods, vibrating sample magnetometer, SQUID and NMR methods. Magnetic anisotropy, diamagnetism in atoms and polyatomic systems, Pascal's constants. Spin and orbital moments, spin-orbit coupling, Lande interval rule, energies of J states. Curie equation, Curies law and Curie-Weiss law.

First order and second order Zeeman effects, temperature independent para magnetism, simplification and application of Van Vleck susceptibility equation. Quenching of magnetic moments of transition metal compounds in cubic and axially symmetric crystal fields, low spin-high spin crosser. Magnetic behaviour of Lanthanides and actinides; magnetic exchange interactions, magnetic materials

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Design new inorganic polymer for with versatile application	PO 4	PSO 5	C
CO 2:	Explain the mechanism of substitution, electron transfer and photochemical reactions of transition metal complexes	PO 3	PSO 3	E
CO 3:	Determine the magnetic susceptibility of materials by different methods	PO 2	PSO 3	E
CO 4:	Apply different laws and equations of magnetochemistry to explain related systems	PO 3	PSO 4	Ap, E

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Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

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Rahara, Kolkata – 700 118

REFERENCE BOOKS FOR ME02

- Magnetochemistry- Selwood
- Intriduction to Magnetochemistry- Earnshaw
- Environmental Analysis- S. M. Khopkar
- Physical Methods in Inorganic Chemistry-R. S. Drago
- Inorganic Chemistry- J.E. Huheey, E.A. Keiter & R. L. Keiter, Harper & Row
- Chemistry of Elements- N. N. Greenwood & A. Earnshaw
- Concept and Models of Inorganic Chemistry-Douglass, McDaniel & Alexander
- Coordination Chemistry- S. F. A. Kettle

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SEMESTER – 4	
CHEMISTRY -ME03: ADVANCED ORGANIC CHEMISTRY-1	
PGCHEMME03	Credits: 5
Number of lectures required: 60	
ME03: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Applications of different spectroscopic techniques in organic synthesis
2. Applications of mass, UV-VIS, IR and NMR spectroscopy to simple structural and mechanistic problems
3. Stereoselective and stereospecific synthesis of organic molecules
4. Enantio- and diastereo- selective synthesis
5. Introductory course on molecular mechanics computations

Unit-1: Advanced Spectroscopy: 14M: (12-15L)

Applications to Organic Systems

Optical Rotatory Dispersion (ORD) and Circular Dichorism (CD): Definition, deduction of absolute configuration, octant rule for ketones.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Chemical shift values and correlation of protons bonded to carbon atoms in aliphatic, olefin, aromatic compounds, alcohols, aldehydes, phenols, enols, carboxylic acids, amines, amides and mercaptans; chemical exchange: effect of deutaration, complex spin- spin interaction between two, three, four, and five nuclei (first order spectra), virtual coupling. Stereochemistry: hindered rotation, Karplus curve, variation of coupling constant with dihedral angle. Simplification of complex spectra, nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier Transform technique (FT-NMR), nuclear Overhauser effect (NOE). ^{19}F and ^{31}P NMR (examples).

Carbon -13 NMR spectroscopy: Chemical shifts for aliphatic, olefin, alkyne, aromatic, heteroaromatic and carbonyl carbon atoms, coupling constants. Two-dimensional NMR spectroscopy- COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

Application of mass, UV-VIS, IR and NMR spectroscopy to simple structural and mechanistic problems.

Unit-2. Dynamic Aspects of Stereochemistry: 13M: (12-15L)

Stereoselective and stereospecific synthesis, enantio- and diastereo- selective synthesis; *Diastereoselective reactions*: Addition to prochiral and chiral carbonyl compounds; reactions of chiral enolates; α-substitution of prochiral ketones (RAMP/SAMP and related methodologies); asymmetric aldol reactions (including Mukaiyama aldol reaction; addition to C=C bonds, conjugate addition.

Enantioselective reactions: Chiral catalysis; Asymmetric epoxidation (including Sharpless epoxidation, Jacobsen-Katsuki epoxidation, Shi epoxidation), dihydroxylation; asymmetric cycloprpanation; asymmetric hydrogenation, CBS reduction.

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Vivekananda Centenary College
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Unit-3: Advanced Stereochemistry :13M: (12-15L)

Advanced course involving conformation and reactivity- acyclic system, monocyclic systems- 3 to 10 member rings, 6-6, 6-5, 6-4, 5-5 bicyclic systems, 6-6-6, 6-5-6, 5-6-5, 5-5-5 tricyclic systems, Introductory course on molecular mechanics computations.

New Addition: 0%	Modifications: 100%	Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply different NMR techniques in the structure elucidation of newly synthesized organic molecules	PO 3	PSO 3	Ap
CO 2:	Apply mass, UV-VIS, IR and NMR spectroscopy to evaluate simple structural molecules	PO 3	PSO 5	Ap, E
CO 3:	Design new organic molecules following stereoselective and stereospecific synthesis	PO 4	PSO 5	C
CO 4:	Design new organic molecules following enantio- and diastereo- selective synthesis	PO 4	PSO 5	C

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

REFERENCE BOOKS FOR ME03

- Organic Chemistry- I. L. Finer, Vols. 1 & 2, ELBS
- Adv. Organic Chemistry: Reaction, Mechanism- Jerry March
- Adv. Organic Chemistry-F. A. Carey & R. J. Sundberg
- Organic Chemistry (3rd. edn) -Hendrikson, Cram, Hammond
- Organic Chemistry- Clayden, Greeves, Warren & Wolthers

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- Organic Chemistry- R. T. Morrison & R. N. Boyd
- Organic Reaction Mechanics- A. Gallego, M. Gomer & M. A. Sierra
- A Guide Book to Mechanism of Organic Reactions-Peter Sykes
- Reaction Mechanism in Organic Chemistry- S. M. Mukherjee & S. P. Singh
- Structure and Mechanism in Organic Chemistry- C. K. Ingold

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SEMESTER – 4	
CHEMISTRY -ME04: ADVANCED ORGANIC CHEMISTRY-2	
PGCHEMME04	Credits: 5
Number of lectures required: 60	
ME04: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Biosynthesis of nucleosides, proteins and folic acid
2. Structure, types and chemistry of sugars
3. Synthesis and reactions of hetero aromatic rings containing one/two hetero atom
4. Chemical synthesis, bio-synthesis, chiral synthesis of different natural products

Unit-1: Nucleoside, Nucleotide and Carbohydrate Chemistry: 13M: (12-15L)

Purines and pyrimidines; nucleosides and nucleotides: synthesis and biosynthesis of nucleosides and folic acid, DNA, RNA; biosynthesis of proteins.

Basic structure and type of sugars. Protection and deprotection. Deoxysugars, amino sugars, glycal sugars and their synthetic aspects. Synthetic approach (Combinatorial) towards polysaccharides of biological and industrial importance. Carbohydrates as chiral pools in organic synthesis. Carbohydrates as chiral pool material.

Unit-2: Heterocyclic Compounds 2: 13M: (12-15L)

Synthesis and reactions of hetero aromatic rings containing one/two hetero atom: purines and pyrimidines, aziridine, azetidine; pyrazines, pyridazines, and their analogues; oxazole, thiazole, imidazole, isothiazole, pteridines, folic acid and nomenclature of the fused systems.

Unit-3: Chemistry of Natural Products 2: 14M: 16-20L)

Definition, classification, nomenclature, occurrence, isolation, synthesis, biosynthesis/ biogenesis (where applicable), general method of structure determination (With emphasis on the use of spectral parameters whenever possible), stereochemistry / biological roles/technical applications (where applicable) in respect of following natural products:

(i).Steoroids: Cholesterol, bile acids, androsterone, testosteron, estone, progesterone, aldosteron.

(ii). Porphyrins: hemoglobin and chlorophyll (structure and synthesis).

(iii). Prostaglandins: PGE_2 and $PGF_2\alpha$.

(iv). Plant pigments (structure elucidation excluded): Flavonoids (biosynthesis of- acetate pathway and shikimic acid pathways), apigenin, luteolin, quercetin, Myrcein, quercetin-3-glucose, vitexin, diadzein, butein, aureusin, cyanidin-7-arabinoseside, cyanidin, hirsutidin.

Chiral synthesis –including enantio selective synthesis; synthesis of camphor, longifoline, cortisone, reserpine, vitamin-D, juvabione, aphidicolin and fredericamycin-A.

Oxidising agents: Jones reagent, Sarett oxidation, Collins oxidation, PCC, PDC, Moffatt oxidation, Swern oxidation, Hypervalent iodine (including Dess-Martin periodinane oxidation), Fetizon's reagent, Thalium (III) trinitrate.

Reducing agents: Lusche reagent, Hojo's reagent, Red Al, DIBALH, $NaBH_3CN$, Selectrides.

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Vivekananda Centenary College
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Reactions and Reaarangements: Neber rearrangement, Baker-Venkatraman rearrangement, Shapiro reaction, Peterson alkenylation reaction, Organo catalysis reactions, metathesis reaction, mulcticomponent reaction (MCR) (UGI, Passerinc reaction, Biginelli reaction), Pauson Khand reaction, Baylis Hillmann reaction, Bergman Cyclisation, Nazarov cyclisation, Domino reaction, Tandem reactions, Click chemistry.

Free Radical Reactions: Methods of generation and detection and reactivity patterns of free radicals. Types of free radical reactions, cyclisation of radicals, Single-electron transfer reactions (SET)- radical anions and radical cations, Fukui Effect, concept of ETC / DAISET. Free radical substitution reactions, neighbourig group assistance.

New Addition: 0% Modifications: 100% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Design new synthetic strategy for functional biomolecules	PO 4	PSO 5	C
CO 2:	Apply the knowledge of carbohydrate chemistry in the synthesis of new drug molecules	PO 2	PSO 2	Ap
CO 3:	Develop new drug molecules with hetero aromatic rings containing one/two hetero atom	PO 4	PSO 5	C
CO 4:	Apply the knowledge for isolation of different natural products	PO 3	PSO 3	Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

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Vivekananda Centenary College
Rahara, Kolkata – 700 118

REFERENCE BOOKS FOR ME04

- Organic Chemistry- I. L. Finer, Vols. 1 & 2, ELBS
- Adv. Organic Chemistry: Reaction, Mechanism- Jerry March
- Adv. Organic Chemistry-F. A. Carey & R. J. Sundberg
- Organic Chemistry (3rd. edn) -Hendrikson, Cram, Hammond
- Organic Chemistry- Clayden, Greeves, Warren & Wolthers
- Organic Chemistry- R. T. Morrison & R. N. Boyd
- Organic Reaction Mechanics- A. Gallego, M. Gomer & M. A. Sierra
- A Guide Book to Mechanism of Organic Reactions-Peter Sykes
- Reaction Mechanism in Organic Chemistry- S. M. Mukherjee & S. P. Singh
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SEMESTER – 4	
CHEMISTRY -ME05: ADVANCED PHYSICAL CHEMISTRY-1	
PGCHEMME05	Credits: 5
Number of lectures required: 60	
ME05: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Ensemble, its classification, partition function, BE and FD distribution formula
2. Non-Equilibrium Thermodynamics and statistical formulation of chemical kinetics reaction dynamics
3. Classification of polymers and polymerization reactions
4. Kinetics and mechanism of polymerization, thermodynamics of polymer solution

Unit-1. Statistical Mechanics (1):14M: (12-15L)

Introduction: Concept of ensemble and ergodic hypothesis phase space. Microcanonical ensemble, temperature. Canonical ensemble distribution probability partition function, its relation with different thermodynamic state functions. Gibb's paradox and Sackur- Tetrode equation. Concept of thermal wave length. Molecular partition functions- translational, rotational vibrational electronic, nuclear. Equipartition theorem and its validity. Chemical potential and chemical equilibrium – Saha ionization formula. System of interacting molecules – Imperfect gas. Grand canonical ensemble- nature of quantum particles. Bose Einstein and Fermi Dirac distribution. Specific heat of electron gas, Bose condensation. Liouville theorem and its consequences, its quantum version. Formulation of Quantum statistics- density matrix.

Unit-2. Statistical Mechanics (2): 13M: (12-15L)

(i). Non-Equilibrium Thermodynamics

Thermodynamic criteria of non-equilibrium states, entropy- production, flow and balance, non-equilibrium stationary states, linear laws, Gibbs equation, phenomenological equations, microscopic reversibility and Onsager`s reciprocity relations, electro kinetic phenomena, diffusion and electric conduction, irreversible thermodynamics for biological systems and coupled reactions.

(ii) Einstein's theory of Brownian motion. Langevin's description of Brownian motion. Brownian motion in velocity space and Fokker-Planck equation. Brownian motion in phase space. Kramer's equation. Over damped motion. Smoluchowski's equation. Diffusion over a barrier. Master equation and its application.

(iii) Statistical formulation of chemical kinetics reaction dynamics: Intermolecular collision and its consequence. Role of intermolecular potential, elastic and inelastic collision. Thermodynamics of reaction rates. Activation energy- Experimental and zero point activation energy. Rate constant expression for chemical reaction based on Eyring equation with examples. Physical rate processes –viscosity and diffusion.

Head of the Department of Chemistry
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Vivekananda Centenary College
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Unit-3. Polymers & Macromolecules :13M: (12-15L)

Definition and classification of polymers, polymer types: electrically conducting, fire resistant, liquid crystal polymers. Polymerization reactions: initiation, propagation, inhibition, termination, chain transfer and co-polymerization. Condensation polymerization and addition polymerization; kinetics and mechanism of polymerization.

Biopolymers: carbohydrates, proteins and nucleic acids.

Thermodynamics of polymer solution: Entropy, heat and free energy of mixing, Polymer conformation, application of statistical mechanics to polymers: chain configuration, distribution end to end dimensions, average dimensions of chain structures-polypeptide and protein structures, protein folding (elementary idea).

Molecular masses of polymers: number and mass average molecular masses and their determinations by diffusion, light scattering, sedimentation, viscometry and osmometry, electrophoresis and rotational methods.

New Addition: 0% Modifications: 100% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply the knowledge to classify the real systems into different statistical models	PO 2	PSO 2	U, Ap
CO 2:	Solve problems related to the non-equilibrium thermodynamics and applications of statistical formulation of problems related to chemical kinetics reaction dynamics	PO 4	PSO 4	Ap, C
CO 3:	Understand different polymerization reactions and design new functional polymers	PO 3	PSO 3	U, C
CO 4:	Compare the kinetics and various mechanisms of polymerization	PO 2	PSO 3	E

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

REFERENCE BOOKS FOR ME 05

- Physical Chemistry: A Molecular Approach-D. A. McQuarrie & J. D. Simon
- Physical Chemistry- R. S. Berry, S. A. Rice & J. Ross
- Introduction to Quantum mechanics- L. Pauling & E. B. Wilson
- Quantum Mechanics J. L. Powel & B. Crasemann
- Elementary Quantum Chemistry-F. L. Pilar
- Quantum Chemistry- I. N. Levine
- Chemical Kinetics-K. J. Laidler
- Fundamentals of Chemical Kinetics-S. W. Benson
- Theoretical Chemistry- S. Glasstone
- The Principles of Chemical Equilibrium-K. Denbigh
- The Physical Chemistry of Surfaces- N. K. Adams
- Physical Chemistry of Surfaces- A. W. Adamson

Head of the Department of Chemistry
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Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

SEMESTER – 4	
CHEMISTRY -ME06: ADVANCED PHYSICAL CHEMISTRY-2	
PGCHEMME06	Credits: 4
Number of lectures required: 60	
ME06: Endsem (50) + Midsem (10) + Attendance (05)	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Different surface phenomena and their spectroscopic characterizations
2. Dielectric behaviour of molecules and related theoretical equations
3. n-dimensional vector space, matrix representation of operators and many electron Hamiltonian
4. Variation Method and Perturbation theory

Unit-1. Surface Chemistry& Dielectric Behaviours:13M: (12-15L)

Surface phenomena: Surface tension, adsorption of solids, vapour pressure over curved surface, the Young- Laplace equation, vapour pressure of droplets (Kelvin equation), Interfacial region, adsorption on solid, the adsorption isotherms (Gibbs, Langmuir), estimation of surface area (BET equation). Surface active agents and their classification, micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsion, reverse micelles. Study of surface phenomena by photoelectron spectroscopy, ESCA and Auger spectroscopy. Surface films on liquids (electro-kinetic phenomena), catalytic activity at surfaces.

Dielectric Behaviours: Dielectric polarization and solvent effect, polar molecules, Mossotti-Clausius relation and its limitations, Debye equation. Dipole moment and molecular structure. Intermolecular forces: attraction and repulsion potentials, van der Waals, Keesom, Debye and London forces and their relative contributions. Onsager reaction field, dielectric effects on absorption and emission spectra, Lippert equation

Unit-2. Advanced Quantum Mechanics :13M: (12-15L)

Elementary ideas of Vectors, Matrices, n- dimensional vector space, matrix representation of operators. Hermitian operators and Hermitians matrices. Projection operators and their properties. Commutability and compatibility. Heisenberg uncertainty principle (Operator method), Heisenberg's equation of motion, constant of motion, Virial theorem, parity, time reversal symmetry. Angular momentum operator – commutation relation –step up and step-down operator, Angular momentum operator in polar coordinates.

Many electron Hamiltonian, its commutation with composite L^2 and Lz
Spin operator and Pauli spin matrices. Many electron atom and construction of wave function representing spectroscopic state.

Unit-3. Applications of Quantum Mechanics :14M: (12-15L)

Variation Method and Quantum chemistry: Euler variation, Rayleigh-Ritz variation theorem (simple applications). Over view of Born- Oppenheimer separation, applications of VB and MO theories on H_2 molecule and their relative merits. Characteristics of many electron systems, independent particle model (IPM) and its limitations; electron correlation: closed shell

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(with Post-Graduate Section)
Ramakrishna Mission
Vivekananda Centenary College
Rahara, Kolkata – 700 118

and open shell models- Hartree and Hartree Fock methods, LCAO method and Roothaan equation, Huckel method. Koopman's theorem.

Perturbation theory: Rayleigh – Schrodinger perturbation theory for non-degenerate state and theorems, simple applications: expression for polarizability, ground state of Helium atom.

Time dependent perturbation theory: Interaction of matter with radiation (semi classical treatment), first order and second order effects, Fermi golden rule, selection rule for vibrational spectra, anharmonicity correction, overtones; Raman scattering, selection rule for rotational spectra, nonlinear scattering.

Degenerate perturbation theory: Stark effect, lifting of degeneracy in a magnetic field ($^1P_1$ state of He atom).

New Addition: 0% Modifications: 100% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Apply the knowledge of surface phenomena including heterogeneous catalysis and their physicochemical characterizations	PO 3	PSO 3	Ap
CO 2:	Interpret the dielectric behaviour of molecules and related theoretical equations from molecular level	PO 2	PSO 3	E
CO 3:	Apply n-dimensional vector space model to solve many electrons Hamiltonian	PO 2	PSO 3	Ap, C
CO 4:	Apply variation method and perturbation theory to explain degenerate and non-degenerate systems	PO 1	PSO 1	An, Ap

R = Remembering, U = Understanding, Ap = Applying, An = Analysing, E = Evaluating, C = Creating

Question Pattern for End Semester Examination

UNIT-1: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-2: A set of two questions carrying a total of 16 marks for each question to be set. Students will be required to answer any one question out of the two questions.

UNIT-3: A set of two questions carrying a total of 18 marks for each question to be set. Students will be required to answer any one question out of the two questions.

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REFERENCE BOOKS FOR ME 06

- Physical Chemistry: A Molecular Approach-D. A. McQuarrie & J. D. Simon
- Physical Chemistry- R. S. Berry, S. A. Rice & J. Ross
- Introduction to Quantum mechanics- L. Pauling & E. B. Wilson
- Quantum Mechanics J. L. Powel & B. Crasemann
- Elementary Quantum Chemistry-F. L. Pilar
- Quantum Chemistry- I. N. Levine
- Chemical Kinetics-K. J. Laidler
- Fundamentals of Chemical Kinetics-S. W. Benson
- Theoretical Chemistry- S. Glasstone
- The Principles of Chemical Equilibrium-K. Denbigh
- The Physical Chemistry of Surfaces- N. K. Adams
- Physical Chemistry of Surfaces- A. W. Adamson

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SEMESTER – 4	
PGCHEMSOC: Computer for Chemists	
PGSOC04	Credits: 1
Number of lectures required: 20	

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Drawing 2D and 3D plots from different experimental data
2. Analysis of data and plots
3. Drawing of different chemical structures and reaction schemes

UNIT 1: Graphics for Chemists (Origin Lab): 10L

- Data Import [CSV connector, Excel connector]
- Graphing
- Publishing
- Curve Fitting
- Peak Analysis

UNIT 2: Graphics for Chemists (Chem Draw): 10L

- Drawing simple and complex chemical structure
- Schematic presentation of reactions
- Drawing biological objects and reaction pathways
- Prediction properties and spectra of organic molecules
- Convert chemical structure to IUPAC name, view 3D structures

New Addition: 100% Modifications: 0% Total change = 100 %

Note: The marked portions have been revised vide BOS meeting dated 26/02/2018

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Interpret different 2D and 3D plots	PO 3	PSO 5	E
CO 2:	Analyze data and plots	PO 2	PSO 5	An
CO 3:	Construct new chemical structures and reaction schemes	PO 2	PSO 5	C

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SEMESTER – 4	
CHEMOT01: Project & Presentation	
PGCHEMOT01	Credits: 6

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Identify the research problem
1. Literature review on the proposed research problem
2. Experimentation and analysis of experimental data
3. Preparation of report and presentation

Project work:

During Semester-IV, each candidate shall carry out some investigative work independently or under the supervision of one or more guides(s), who may be Teacher / Guest Teacher / Member of P.G Board of Studies of the College / University / Scientist of any Recognized Research Institute. The work may be carried out either in the College / University itself or in any Recognized Research Institute, with the approval of the appropriate authority of the College/ University. Duration of the work shall be four weeks (approximately 90-100 hours). The findings of the project work should be submitted in the form of a dissertation for evaluation by an External Expert, not related in any way with the project work.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Choose new research problems	PO 3	PSO 3	Ap
CO 2:	Design new reactions/materials	PO 4	PSO 5	C
CO 3:	Analyze the properties of the materials	PO 2	PSO 3	An
CO 4:	Compile the experimental and theoretical data and build the project report	PO 2	PSO 3	C

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SEMESTER – 4	
PGCHEMOT02: Grand Viva and Seminar	
PGCHEMOT02	Credits: 6

Course Objectives:

At the end of studying this course a student will acquire knowledge on:

1. Preparation of seminar reports
2. Presentation of seminar in front of experts
3. How to defend the viva

Seminar:

Each candidate shall present his /her project work in a departmental seminar during a period not exceeding 30 minutes. Performance of the candidates in the seminar shall be evaluated jointly by External and Internal Examiners (including the Guide).

Grand Viva-Voce:

Grand Viva-Voce examination shall be conducted jointly by the External and internal Examiners. Short questions on the theoretical principles, experimental methodologies, instrumentations etc. of the different experiments included in the entire practical syllabus of Semesters-I, -II, -III and -IV may be asked. The candidate may be asked to answer the questions verbally or in writing. Maximum time for viva-voce examination of a candidate shall not exceed 30 minutes.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes	POs Addressed	PSOs addressed	Cognitive Level
CO 1:	Compose seminar report and presentation	PO 2	PSO 3	Ap
CO 2:	Take part in lectures, presentation and debates	PO 2	PSO 3	An
CO 3:	Develop own scientific understanding and self-confidence to face interviews	PO 4	PSO 5	C

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