Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: Masters in Science (M. Sc.)

Total Credits:96

SYLLABUS

(Approved in the Academic council meeting held on /07/2022)

M.Sc.-I

Chemistry

Revised as per
Choice Based Credit System (60:40)
w. e. f. Academic Year 2022-23

MASTERS IN SCIENCE (M. Sc.)
Programme Outcomes

After completion of M.Sc. programme students will acquire

S. N.	After completion of M.Sc. program students will acquire	Graduate Attribute
PO1	An ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge
PO2	An ability to demonstrate proficiency in various instrumentation, modern tools, advanced techniques and ICT to meet industrial expectations and research outputs.	Disciplinary knowledge/Digital literacy
PO3	An ability to identify problems, formulates, and proves hypotheses by applying theoretical knowledge and skills relevant to the discipline.	Problem-solving
PO4	An ability to be articulate thoughts, research ideas, information, scientific outcomes in oral and in written presentation to range of audience.	Communication skills
PO5	A capacity for independent, conceptual and creative thinking, analysis and problem solving through the existing methods of enquiry.	Problem solving
PO6	Skills required for cutting edge research, investigations, field study, documentation, networking, and ability to build logical arguments using scholarly evidence.	Research skills
PO7	An ability to portray good interpersonal skills with ability to work collaboratively as part of a team undertaking a range of different team roles	Teamwork
PO8	The ability to understand ethical responsibilities and impact of scientific solutions in global, societal and environmental context and contribute to the sustainable development	Moral and ethical awareness/ multicultural competence
PO9	An ability to demonstrate leadership, to take action and to get others involved.	Leadership
PO10	An openness to and interest in, life-long learning through directed and self-directed study	Self-directed learning
PO11	An ability to translate the knowledge and demonstrate the skills required to be employed and successful professional development.	Life-long learning

Programme: M.Sc. Organic Chemistry

PSOs No.	After completing the programme in M.Sc. Organic Chemistry, Student will able to:	Graduate Attribute
PSO1	Develop analytical thinking and apply the same for understanding principles, proposing mechanism and logical conclusions, understanding of the interdisciplinary nature of Chemistry and emerging trends in Chemistry.	Disciplinary knowledge Problem solving
PSO2	Get research opportunities in academics as well as employment at R & D in synthetic division of chemical, pharmaceutical, dyestuff and food industries	Research skills
PSO3	Competency in design and planning of synthesis and carry out with Good Laboratory Practices, handling instruments and interpretation of spectral data for structure determination of organic compounds	Research skills

Programme: M.Sc. Analytical Chemistry

PSOs No	After completing the programme in M.Sc. Analytical Chemistry, Student will able to:	Graduate Attribute
PSO1	Understand the principles, methodologies of analytical techniques and their applications in industrial, social, and environmental context.	Disciplinary knowledge/ Multicultural competence
PSO2	Integrate and apply the knowledge of the analytical methods, tools, and ICT facilities to the range of scientific problems using critical thinking and communicate results effectively.	Problem solving
PSO3	Demonstrate research skills in the core and allied areas of chemical sciences, professionalism and ethical conduct.	Research skills/ lifelong learning

Masters in Science (Chemistry)
Syllabus for Semester I and II

Preamble:

Master of Science (M.Sc.) in chemistry is a post-graduate course of department of chemistry, Changu Kana Thakur Arts, Commerce & Science College, New Panvel (Autonomous).

There are two P.G. programmes in Chemistry, namely M.Sc. programme in Organic Chemistry and M.Sc. programme in Analytical Chemistry. Both P.G. programmes are equivalent in all respect for employment and higher studies. Each of these two P.G. programmes shall extend over a period of two academic years comprising of four semesters. The syllabi and scheme of examinations of these two programmes are detailed below. The theory and practical's of courses of two Semesters of the two programmes are same. Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. Chemistry is important to the world economy as well. The developments in Chemistry during last few decades are phenomenal. It is also seen that these developments are crossing the traditional vertical boundaries of scientific disciplines; the more inclination is seen towards biological sciences. New branches of chemistry are emerging and gaining importance, such as bioorganic chemistry, materials chemistry, computational chemistry, etc.

The practice of Chemistry at industrial scale also is undergoing radical changes and is more or more based on deep understanding the chemical phenomena. The emerging Chemical Technologies are highly science based. The aid of computers has not only accelerated growth in the practice of Chemistry, but revolutionized the entire field. A chemist cannot isolate himself from other disciplines. Thus, after a long span of more and more specialization in graduate and post-graduate syllabi, a symbiotic interdisciplinary approach now seems to be more relevant.

Semester - I (CHEMISTRY)
[Under CBCS Scheme]

Course	Course Type	Course code	Hrs/ week	Internal assessment	Semester-end examination	Total	Credits
Physical chemistry	Core	PSC1PC1	4	40	60	100	4
Inorganic chemistry	Core	PSC1IC1	4	40	60	100	4
Organic chemistry	Core	PSC1OC1	4	40	60	100	4
Analytical chemistry	Core	PSC1AC1	4	40	60	100	4
Practical Physical chemistry	Core	PSC1PCP	4	--	50	50	2
Practical Inorganic chemistry	Core	PSC1ICP	4	--	50	50	2
Practical Organic chemistry	Core	PSC1OCP	4	--	50	50	2
Practical Analytical chemistry	Core	PSC1ACP	4	--	50	50	2

Semester - II (CHEMISTRY)
[Under CBCS Scheme]

Course	Course Type	Course code	Hrs/ week	Internal assessment	Semester-end examination	Total	Credits
Physical chemistry	Core	PSC2PC2	4	40	60	100	4
Inorganic chemistry	Core	PSC2IC2	4	40	60	100	4
Organic chemistry	Core	PSC2OC2	4	40	60	100	4
Analytical chemistry	Core	PSC2AC2	4	40	60	100	4
Practical Physical chemistry	Core	PSC2PCP	4	--	50	50	2
Practical Inorganic chemistry	Core	PSC2ICP	4	--	50	50	2
Practical Organic chemistry	Core	PSC2OCP	4	--	50	50	2
Practical Analytical chemistry	Core	PSC2ACP	4	--	50	50	2

Examination Scheme

Choice Based Credit System (CBCS)

❖ **Revised Scheme of Examination**

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Any two tools out of these (10 Marks each) 1. Group/ Individual Project 2. Presentation and write up on the selected topics of the subjects / Case studies. 3. Test on Practical Skills 4. Open Book Test 5. Quiz	20 Marks

Question Paper Pattern

(Periodical Class Test for the Courses at Post-Graduate Programmes)

- ❖ Maximum Marks: 20
- ❖ Duration: 30 Minutes

Particular	Marks
Match the Column / Fill in the Blanks / Multiple Choice Questions/ True/False/Answer in One or Two Lines (Concept based Questions) (1 Marks each)	20 Marks

Question Paper Pattern for Semester End Examination

B) Semester End Examination: 60 % 60 Marks

- Duration: The examination shall be of 2 $\frac{1}{2}$ hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be five questions each of 12 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

❖ **Passing Standard**

The learners shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of grade D in each project wherever applicable to pass a particular semester.

Semester End Practical Examination (50 Marks)

Laboratory Work 40 Marks

Journal 05 Marks

Viva 05 Marks

The practical examination will be held for two days as described below. The candidates will be examined practically and orally on each day.

Day	Session	Paper-I	Paper-II	Paper-III	Paper-IV
Day 1	Morning	A	B	C	D
	Evening	B	A	D	C
Day 2	Morning	C	D	A	B
	Evening	D	C	B	A

Question Paper Pattern for Continuous Assessment

Marks	**Group Project*/ Individual Project**	**Presentation and write-up**	**Practical Skills**	**Open book test**	**Quiz**
5	Hypothesis/Topic of the project	Presentation skill	Demonstration of skill	High order thinking questions **(HOTS)**	Quiz on application of subject in real life
5	Actual laboratory work/Field work	Knowledge	Viva		
5	Result/output	Quality of ppt	Report		
5	Dissertation/Report	Writing skill	Problem solving ability		

SEMESTER-I

Course Description	
Semester	**I**
Course Name	**Physical Chemistry**
Course Code	**PSC1PC1**
Eligibility for Course	**T.Y.B.Sc. (Chemistry)**
Credit	**4**
Hours	**60**

Course Objectives

1. To develop laboratory competence in relating physical aspects in chemistry
2. To demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.
3. To provide the students with sound preparation for requirement of modern industry and provide competency in basic academic research as well as a cohesive, clearly structured overview of Chemistry

Course Outcomes

After successful completion of this course students will be able to

Sr. No	Course Outcomes	Bloom Taxonomy Level (BLT)
CO1	Prove Maxwell relations and its significance and applications to ideal gases, Joule Thomson experiment, Joule Thomson coefficient and inversion temperature. Apply Third law of Thermodynamics to find out absolute entropy	Understand
CO2	Make use of quantum mechanics for Particle waves and Schrödinger wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions. Particle in a one, two- and three-dimensional box	Apply
CO3	Define, understand basic terms of Chemical Dynamics i.e. rate constant, order of reaction, molecularity of reaction also compare Composite Reactions and Polymerization reactions	Evaluate
CO4	Make use of of Colloids and Surface Phenomena in daily applications	Apply

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	**Thermodynamics-I**				
	1.1. State function and exact differentials. Maxwell equations, Maxwell thermodynamic Relations; its significance and applications to ideal gases, Joule Thomson experiment, Joule Thomson coefficient, inversion temperature, Joule Thomson coefficient in terms of van der Waals constants. [8L] 1.2. Third law of Thermodynamics, Entropy change for a phase transition, absolute entropies, determination of absolute entropies in terms of heat capacity, standard molar entropies and their dependence on molecular mass and molecular structure, residual entropy. [7L]	15	1	1,2	2, 11
2.	**Quantum Chemistry**				
	2.1. Classical Mechanics, failure of classical mechanics: Need for Quantum Mechanics. 2.2. Particle waves and Schrödinger wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions. 2.3. Operators and their algebra, linear and Hermitian operators, operators for the dynamic variables of a system such as, position, linear momentum, angular momentum, total energy, eigen functions, eigen values and eigen value equation, Schrödinger wave equation as the eigen value equation of the Hamiltonian operator, average value and the expectation value of a dynamic variable of the system, Postulates of Quantum Mechanics, Schrodinger‟s Time independent wave equation from Schrodinger‟s time dependent wave equation. **2.4.** Application of quantum mechanics to the following systems: **a)** Free particle, wave function and energy of a free particle. **b)** Particle in a one, two and three dimensional box, separation of variables, Expression for the wave function of the system, expression for the energy of the system, concept of quantization, introduction of	15	2	1	2,8, 11

	quantum number, degeneracy of the energy levels. **c)** Harmonic oscillator, approximate solution of the equation, Hermite polynomials, expression for wave function, expression for energy, use of the recursion formula.				
3.	**Chemical Dynamics-I**				
	3.1. Composite Reactions: Recapitulation: Rate laws, Differential rate equations Consecutive reactions, Steady state Approximation, rate determining steps, Microscopic Reversibility and Detailed Balanced Chain reactions-chain initiation processes. Some inorganic mechanisms: formation and decomposition of phosgene, decomposition of ozone, Reaction between Hydrogen and Bromine and some general examples Organic Decompositions: Decomposition of ethane, decomposition of acetaldehyde Gas phase combustion: Reaction between hydrogen and oxygen, Semenov – Hinshelwood and Thompson mechanism, Explosion limits and factors affecting explosion limits. 3.2. Polymerization reactions: Kinetics of stepwise polymerization, Calculation of degree of polymerization for stepwise reaction. Kinetics of free radical chain polymerization, Kinetic chain length and estimation of average no of monomer units in the polymer produced by chain polymerization. 3.3. Reaction in Gas Phase Unimolecular Reactions: Lindeman-Hinshelwood theory, Rice-Ramsperger-Kasssel (RRK) theory, Rice-Ramsperger-Kassel Marcus (RRKM) theory.	15	3	1	1,2, 6,10
4.	**Colloids and Surface Phenomena**				
	Colloidal Systems-Sols, Lyophilic and lyophobic sols, properties of sols, coagulation. Sols of surface-active reagents, surface tension and surfactants, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization. Thermodynamics of micellization, critical micelle concentration, factors affecting critical micelle concentration (cmc), experimental methods of cmc determination, Micellar catalysis. Adsorption, adsorption isotherms, methods for determining	**15**	**4**	1	1,2, 3, 6, 8, 11

	surface structure and composition, BET equation, surface area determination, Gibbs adsorption equation and its verification. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces. Numerical Problems				

References

1. Peter Atkins and Julio de Paula, Atkin‟s Physical Chemistry, 7th Edn., Oxford University Press, 2002.

2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.

3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rd Edn., John Wiley and Sons (Asia) Pte.Ltd., 2002.

4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.

5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi, 1983.

6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962

7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.

8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.

9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.

10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.

11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 19772.

12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.

13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte.Ltd., Indian Branch, New Delhi, 2000.

14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.

15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992. 16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.

17. Physical Chemistry by Gurtu and Gurtu

18. A Text book of Physical Chemistry by K L kapoorVol5 , 2nd Edn

Physical Chemistry Practical

Course Description	
Semester	**I**
Course Name	**Physical Chemistry**
Course Code	**PSC1PCP**
Eligibility for Course	**T.Y. B.Sc. (Chemistry)**
Credit	**2**
Hours	**30**

After successful completion of this course students will be able to

Sr. No.	**COs**	**Bloom Taxonomy Level (BLT)**
CO1	Know the principles of different instruments like Potentiometry, Conductometry, pH Metry.	Understand
CO2	Determine the heat of solution of sparingly soluble acid and identify the reaction between acetone and iodine.	Apply

Sr. No.	**Course Description**	Hrs	CO No.	PSO No.	PO No.
1.	To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic /salicylic acid) from solubility measurement at three different temperature.	4	1	1,2	1,2,3, 8,11
2.	To study the variation of calcium sulphate with ionic strength and hence determine the thermodynamic solubility product of $CaSO_4$ at room temperature.	4	2	1,2	1, 3,4,7,1 1
3.	To investigate the reaction between acetone and iodine. Or Kinetics of reaction between bromate and iodide. (New expt.)	4	2	1,2	1,3,4,7, 10
4.	To study the variation in the solubility of $Ca(OH)_2$ in presence of NaOH and hence to determine the solubility product of $Ca(OH)_2$ at room temperature.	4	1	1,2	1,2,4,7, 11
5.	Graph Plotting of mathematical functions –linear,	4	1	1,2	1,2,4,7,

	exponential and trigonometry and identify whether functions are acceptable or non-acceptable?				11
6.	To determine the mean ionic activity coefficient of an electrolyte by e.m.f. measurement.	4	1	1,2	1,2,3,7, 11
7.	To study the effect of substituent on the dissociation constant of acetic acid conductometrically.	4	1	1,2	1,2,4,7, 11
8.	To determine pKa values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode.	4	1	1,2	1,2,4,7, 11
9.	To verify Ostwald‟s dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.	4	**1**	1,2	1,2,3,7, 11
10.	Determination of dissociation constant of dibasic acid.		**1**		

References:

1 Practical Physical Chemistry, B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, 2005.

2 Practical Physical Chemistry, A.M. James and F.E. Prichard, 3rd Edn., Longman Group Ltd., 1974.

3 Experimental Physical Chemistry, V.D. Athawale and P. Mathur, New Age International Publishers, 2001.

Course Description	
Semester	**I**
Course Name	**Inorganic Chemistry**
Course Code	**PSC1IC1**
Eligibility for Course	**T.Y.B.Sc.in Chemistry**
Credit	**4**
Hours	**60**

Course Objectives:

1. To apply theories of bonding, hybridization, MOT for Polyatomic species.
2. To understand preparation, proporties and structures of higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyls and halide clusters.
3. To understand all elements of symmetry, point group, symmetry classification, symmetry criterion of optical activity, symmetry restrictions on dipole moment.
4. To understand concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups, Mulliken’s notations for irreducible representations. Reduction of reducible representations using reduction formula.

5. To understand concept of band theory, Fermi level, K-Space and Brillouin Zones, Defects in solids.

6. To explain Preparative methods of inorganic solids & nano materials.

7. To explain Electron Paramagnetic Resonance Spectroscopy and its applications, spectral calculations using Orgel and Tanabe-Sugano diagram.

8. To determine of formation constants of metal complexes.

Course Outcomes

Sr.No.	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Explain theories of bonding, hybridization, resonance concept, MOT for diatomic species of first transition Series, Polyatomic species and Higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyls and halide clusters.	Understand
CO2	Explain The concept of band theory, Fermi level, K-Space and Brillouin Zones. Structures of Compounds of the type: AB, AB2 etc. and Preparative methods of inorganic solids & nano materials.	Understand
CO3	Construct Group Multiplication Tables, Character tables using concept of Molecular Symmetry and Group Theory.	Apply
CO4	Determine electronic parameters such as Δ, B, C, Nephelauxetic ratio, formation constants of metal complexes and Characterize coordination compounds using techniques like thermal studies, Conductivity measurements, electronic spectral and magnetic measurements, IR, NMR and ESR spectroscopic	Evaluate

Unit	**Course Description**	Hrs	CO No.	PSO No.	PO No.
1.	**Chemical Bonding:**	15h	CO1	PSO1	PO3
1.1	Recapitulation of hybridization Derivation of wave functions for sp, sp2, sp3 orbitalhybridization types considering only sigma bonding.				
1.2	Discussion of involvement of d orbitals in various types of hybridizations. Concept ofresonance, resonance energy derivation expected. Formal charge with examples.				
1.3	Molecular Orbital Theory for Polyatomic species considering σ bonding for SF6, CO2,B2H6, I3- molecular species.				
1.4	Higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyls and halide clusters,				

	compounds with metal-metal multiple bonds.				
2.	**Molecular Symmetry and Group Theory:**	15h	CO3	PSO1	PO5
2.1	Symmetry criterion of optical activity, symmetry restrictions on dipole moment. Asystematic procedure for symmetry classification of molecules.				
2.2	Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group MultiplicationTables. Abelian and non-Abelian point groups.				
2.3	Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. The Great Orthogonality Theorem and its application in construction of character tables for point groups C2v, C3v and D2h, structure of character tables.				
2.4	**Applications of Group Theory** (a) Symmetry adapted linear combinations (SALC), symmetry aspects of MO theory, sigma bonding in ABn (Ammonia, CH4) molecule. (b) Determination of symmetry species for translations and rotations. (c) Mulliken‟s notations for irreducible representations. (d) Reduction of reducible representations using reduction formula. (e) Group-subgroup relationships. **(f)** Descent and ascent in symmetry correlation diagrams showing relationship between different groups.				
3.	**Materials Chemistry and Nanomaterials:**	15h	CO2	PSO2	PO5
3.1	**Solid State Chemistry**				
3.1.1	Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones.				
3.1.2	**Crystal Defects and non-stoichiometry:** Classification of Defects: subatomic,atomic and lattice defects in solids; Thermodynamics of vacancy in metals; Thermodynamics of Schottky defects in ionic solids ; Thermodynamics of Frenkel defects in silver halides; Calculation of number of defects and average energy required for defect.				
3.1.3	Methods of preparation for inorganic solids: sol- gel method (applications in Biosensors), microwave synthesis (discussion on principles, examples, merits and demerits are expected)				
3.2	**Nanomaterials**				
3.2.1	Preparative methods: Chemical methods, Microwave, Langmuir Blodgett(L-B) method, Biological methods: Synthesis using microorganisms				
3.2.2	Applications in the field of semiconductors, solar cells				
4.	**Characterisation of Coordination compounds**	15h	CO4	PSO2	PO5

4.1	Electron Paramagnetic Resonance Spectroscopy (EPR): i) Theory and Instrumentation of EPR in brief. ii) Spin Hamiltonian, Isotropic and anisotropic EPR spectra, Magic Pentagon rule. iii) Applications of EPR spectroscopy: Structural determination of Inorganic complexes				
4.2	Spectral calculations using Orgel and Tanabe-Sugano diagram, calculation of electronic parameters such as Δ, B, C, Nephelauxetic ratio.				
4.3	Determination of formation constants of metal complexes (Overall and Stepwise): Comparative studies of Potentiometric and spectral methods.				

References

Unit I

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.

2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.

3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.

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5. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure andReactivity, 4th Ed., Harper Collins, 1993.

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10. C. M. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt.Ltd., 1985.

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12. G. A. Jeffrey, An Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.

Unit II

1. F. A. Cotton, Chemical Applications of Group Theory, 2nd Edition, Wiley Eastern Ltd.,1989.
2. H. H. Jaffe and M. Orchin, Symmetry in Chemistry, John Wiley & Sons, New York, 1996.
3. R. L. Carter, Molecular Symmetry and Group Theory, John Wiley & Sons, New

York,1998.
4. K. V. Reddy. Symmetry and Spectroscopy of Molecules, 2nd Edition, New Age International Publishers, New Delhi, 2009.
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6. P. K. Bhattacharya, Group Theory and its Chemical Applications, Himalaya PublishingHouse. 2014.
7. S. Swarnalakshmi, T. Saroja and R. M. Ezhilarasi, A Simple Approach to Group Theory inChemistry, Universities Press, 2008.

Unit III

1. Solid State Chemistry Introduction, Lesley E. Smart, Elaine A. Moore, ISBN 0-203-49635-3, Taylor & Francis Group, LLC.
2. Nanomaterials&Nanochemistry, 2007, Catherine Brechignac, Philippe Houdy, Marcel Lahmani, ISBN 978-3-540-72992-1 Springer Berlin Heidelberg New York.
3. Nanomaterials Chemistry, Recent Developments and New Directions C.N.R. Rao, A. Muller, and A.K. Cheetham, ISBN 978-3-527-31664-9, 2007 WILEY-VCH Verlag GmbH &Co. KGaA, Weinheim.
4. Nano-Surface Chemistry, 2001, Morton Rosoff, ISBN: 0-8247-0254-9, Marcel Dekker Inc.New York.
5. The Chemistry of Nanomaterials, CNR Rao, Muller Cheetham, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.
6. Semiconductor Nanomaterials, Challa S.S.R. Kumar, ISBN: 978-3-527-32166-7, WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim, 2010.

Unit IV

1. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structureand Reactivity, Pearson Education, 2006.
2. D. Banerjea ,Coordination Chemistry
3. Geary Coordination reviews
4. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006.
5. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann; Advanced Inorganic Chemistry, 6th ed. Wiley, 1999,
6. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of Inorganic Chemistry(3rd edn.), John Wiley & Sons (1994).
7. Physical Methods in Chemistry, R. S. Drago (2nd Edition) (1977).

Course Description	
Semester	**I**
Course Name	**Inorganic Chemistry Practical**
Course Code	**PSC1IC1**

Eligibility for Course	T.Y.B.Sc.in Chemistry
Credit	2
Hours	30

Sr. No.	After completing the course, Students will be able to:	Bloom Taxonomy Level (BTL)
CO1	Prepare various inorganic complexes such as Bis-(tetramethylammonium) tetrachloroCuprate (II) (Me4 N) 2[CuCl4],Tetramminemonocarbanato Cobalt (III) Nitrate, Bis (ethylenediammine) Copper (II) Sulphate, Hydroniumdichlorobis(dimethylglyoximato) etc.	Understand
CO2	Determine the electrolytic nature of inorganic compounds	Apply
CO3	Apply Slope intercept method for determination of equilibrium constants forFe^{+3}/ SCN- system.	Apply
CO4	Analyze the inorganic complex for percentage of metal and ligand.	Analyse

Inorganic Preparations (Synthesis and Characterization)

1) Bis-(tetramethylammonium) tetrachloroCuprate (II) (Me4 N) 2[CuCl4]

2) Tetramminemonocarbanato Cobalt (III) Nitrate [Co(NH3)4CO3]NO3

3) Bis (ethylenediammine) Copper (II) Sulphate [Cu(en)2]SO4

4) Hydronium dichlorobis(dimethylglyoximato) Cobaltate(III) H[Co(dmgH)2Cl2]

Instrumentation

1) Determination of equilibrium constant by Slope intercept method for Fe+3/ SCN- system

2) Determination of Electrolytic nature of inorganic compounds by Conductancemeasurement.

Reference:

1. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N.Dhur& Sons Pvt Ltd

The Synthesis and Characterization of Inorganic Compounds by William L. Jolly 3. Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities By: Dr Deepak Pant

Course Description	
Semester	**I**
Course Name	**Organic Chemistry**
Course Code	**PSC1OC1**
Eligibility for Course	**T.Y.B.Sc (Chemistry)**
Credit	**4**
Hours	**60**

Course Objectives

4. To study the basics of addition reactions and their applications.
5. To study stereochemistry in man detail
6. To study the different reagents in the organic transformation.
7. To understand the role of carbon nucleophiles in organic synthesi

Course Outcomes

After successful completion of this course students will be able to

Sr. No.	CO	Bloom Taxonomy Level (BLT)
CO1	Understand the types of reaction and their applications	Remember
CO2	Summarize the various aspects of aromaticity, aliphatic and aromatic nucleophilic substitution reactions with their mechanism and examples.	Understand
CO3	Apply the concept of Configurational descriptors (R,S nomenclature) to chiral centres in Organic compounds	Apply
CO4	Predict the mechanism, selectivity, importance and applications of oxidizing and reducing agent	Apply

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	**Addition Reactions:** 1.1 Addition reactions to carbon carbon multiple bonds - Mechanism and Stereochemical aspects of addition reaction Involving electrophile 1.2 Structural Effect and reactivity: Halogenation, Hydrohalogenation, Hydration, Hydroxylation, Hydroboration, Epoxidation, Carbene addition and Ozonolysis. 1.3. Acids and Bases: Factors affecting acidity and	15	1	2	1,2

	basicity: Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.				
2.	**Nucleophilic substitution reactions and Aromaticity:** 2.1. Nucleophilic substitution reactions: (9 L) 2.1.1. Aliphatic nucleophilic substitution: SN1, SN2, SNi reactions, mixed SN1 and SN2 and SET mechanisms. SN reactions involving NGP - participation by aryl rings, α-and pi-bonds. Factors affecting these reactions: substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group. Ambident nucleophiles.SNcA, SN1‟ and SN2‟ reactions.SN at sp2 (vinylic) carbon. 2.1.2. Aromatic nucleophilic substitution: SNAr, SN1, benzyne mechanisms. Ipso, cine, tele and vicarious substitution. 2.1.3. Ester hydrolysis: Classification, nomenclature and study of mechanisms of acid and base catalyzed hydrolysis with suitable examples (Any two). Orientation and Reactivity-Effect of Substrate, Leaving group and attacking nucleophile 2.2. Aromaticity: (6 L) 2.2.1. Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. 2.2.2. Application of HMO theory to monocyclic conjugated systems. Frost-Musulin diagrams. Huckel‟s (4n+2) and 4n rules. 2.2.3. Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, metallocenes, azulenes, annulenes, aromatic ions and Fullerene (C60)	15	2	1	3,4
3.	**Stereochemistry:** 3.1. Concept of Chirality: Recognition of symmetry elements. 3.2. Molecules with two or more chiral centers: Constitutionally unsymmetrical molecules: erythro-threo and syn-anti systems of nomenclature. Interconversion of Fischer, Sawhorse, Newman and Flying wedge projections. Constitutionally symmetrical molecules with odd and even number of chiral centers: enantiomeric and meso forms, concept of stereogenic, chirotopic, and pseudoasymmetric centres. Stereo-descriptors: R, S, for chiral centres in acyclic and cyclic compounds. 3.3. Axial and planar chirality: Principles of axial and planar chirality. Stereochemical features and configurational descriptors (R,S) for the following classes of compounds: Allenes, Alkylidene cycloalkanes,	15	3	4	4,5

	Spirans, Biaryls (buttressing effect) (including BINOLs and BINAPs), Ansa compounds, Cyclophanes, trans-cyclooctenes. 3.4. Prochirality: Chiral and prochiral centres; prochiral axis and prochiral plane. Homotopic, heterotopic (enantiotopic and diastereotopic) ligands and faces. Identification using substitution and symmetry criteria. Nomenclature of stereoheterotopic ligands and faces. Symbols for stereoheterotopic ligands in molecules with i) one or more prochiral centres ii) a chiral as well as a prochiral centre, iii) a prochiral axis iv) a prochiral plane v) propseudoasymmetric centre. Symbols for enantiotopic and diastereotopic faces. E, Z nomenclature Resolution of Racemic mixtures				

4.	**Oxidation and Reduction:** 4.1. Oxidation: General mechanism, selectivity, and important applications of the following: 4.1.1. Dehydrogenation: Dehydrogenation of C-C bonds including aromatization of six membered rings using metal (Pt, Pd, Ni) and organic reagents (chloranil, DDQ). 4.1.2. Oxidation of alcohols to aldehydes and ketones: Chromium reagents such as K2Cr2O7/H2SO4 (Jones reagent), CrO3-pyridine (Collin‟s reagent), PCC (Corey‟s reagent) and PDC (Cornforth reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane). DMSO based reagents (Swern oxidation), Corey-Kim oxidation - advantages over Swern and limitations; and Pfitzner-Moffatt oxidation-DCC and DMSO and Oppenauer oxidation. 4.1.3. Oxidation involving C-C bonds cleavage: Glycols using HIO4; cycloalkanones using CrO3; aromatic rings using RuO4 and NaIO4. 4.1.4. Oxidation involving replacement of hydrogen by oxygen: oxidation of CH2 to CO by SeO2, oxidation of arylmethanes by CrO2Cl2 (Etard oxidation). 4.1.5. Oxidation of aldehydes and ketones: with H2O2 (Dakin reaction), with peroxy acid (Baeyer-Villiger oxidation) 4.2. Reduction: General mechanism, selectivity, and important applications of the following reducing reagents: 4.2.1. Reduction of CO to CH2 in aldehydes and ketones- Clemmensen reduction, WolffKishner reduction and Huang-Minlon modification. 4.2.2. Metal hydride reduction: Boron reagents (NaBH4, NaCNBH3, diborane, 9-BBN, Na(OAc)3BH, aluminium reagents (LiAlH4, DIBAL-H, Red Al, L and K- selectrides). 4.2.3. NH2NH2 (diimide reduction) and other non-metal based agents including organic reducing agents (Hantzschdihydropyridine). 4.2.4. Dissolving metal reductions: using Zn, Li, Na, and Mg under neutral and acidic conditions, Li/Na-liquid NH3 mediated reduction (Birch reduction) of aromatic compounds and acetylenes.	**15**	**4**	4	7,8

Organic Chemistry Practical

Course Description	
Semester	**I**
Course Name	**Organic Chemistry**
Course Code	**PSC1OCP**
Eligibility for Course	**T.Y.B.Sc (Chemistry)**
Credit	**2**
Hours	**30**

After successful completion of this course students will be able to

Sr. No	COs	Bloom Taxonomy Level (BLT)
CO1	Plan preparation of organic compounds	Apply
CO2	Demonstrate the skill of purification of organic compounds by recrystallization and sublimation methods.	Understand
CO3	Apply the thin layer chromatography technique to check the purity of the synthesized product.	Apply
CO4	Can Sketch the structure of organic compounds using software Chem Biodraw.	Apply

Sr. No.	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	One step preparations	40			
2.	(1.0 g scale) 1. Bromobenzene to p-nitrobromobenzene		1-3	2	7,8
3.	2. Anthracene to anthraquinone		1-3	3	7,8
4.	3. Benzoin to benzil		1-3	4	2,3
5.	4. Anthracene to Anthracene maleic anhydride adduct		1-3	2	1,2
6.	5. 2-Naphthol to BINOL		1-3	3	5,6
7.	6. p-Benzoquinone to 1,2,4-triacetoxybenzene		1-3	4	7,8
8.	7. Ethyl acetoacetate to 3-methyl-1-phenylpyrazol-5-one		1-3	3	7,8
9.	8. Preparation of benzilic acid from benzil		1-3	1	2,3
10	9. Preparation of p-iodonitrobenzene from p-nitroaniline		1-3	2	1,2
11.	11. Use of Computer - Chem Draw-Sketch, ISI – Draw: Draw the structure of simple aliphatic, aromatic, heterocyclic organic compounds with substituents. Get the correct IUPAC name, Get ^{1}HNMR and ^{13}C. Students can able to draw the		4	4	5

	one name reaction and its reaction mechanism.				

1. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford UniversityPress.

2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.

3. Stereochemistry: Conformation and mechamism, P.S. Kalsi, New Age International, NewDelhi.

4. Stereochemistry of carbon compounds, E.L Eliel, S.H Wilen and L.N Manden, Wiley.

5. Stereochemistry of Organic Compounds- Principles and Applications, D. Nasipuri. NewInternational Publishers Ltd.

6. March‟s Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B.Smith, Jerry March, Wiley.

7. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad,Pearson Education.

8. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.

9. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge UniversityPress.

10. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, AcademicPress.

11. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.

12. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya ShankarSingh, Pearson Education.

13. Mechanism in Organic Chemistry, Peter sykes, 6th edition onwards.

14. Modern Methods of Organic Synthesis, W. Carruthers and Iain Coldham, CambridgeUniversity Press.

15. Organic Synthesis, Jagdamba Singh, L.D.S. Yadav, Pragati

Prakashan.Organic Chemistry Practical

Course Description	
Semester	**I**
Course Name	**Analytical Chemistry**
Course Code	**PSC1AC1**
Eligibility for Course	**T.Y.B.Sc (Chemistry)**
Credit	**4**
Hours	**60**

Course Objectives

1. To develop laboratory competence in relating chemical structure to spectroscopic phenomena.
2. To demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.
3. To provide the students with sound preparation for requirement of modern industry and provide competency in basic academic research as well as a cohesive, clearly structured overview of Chemistry

Course Outcomes

After successful completion of this course students will be able to

Sr. No	**COs**	**Bloom Taxonomy Level (BLT)**
CO1	Explain the concept of data domain, performance characteristics of an instrument/method, total quality management, quality standards for laboratories, quality audits and quality reviews.	Understand
CO2	Discover the applications of UV-Visible spectroscopy, IR spectroscopy, Differential scanning calorimetry.	Apply
CO3	Identify the need of automation in chemical analysis, safety measures in laboratory, need of accreditation of laboratories and GLP.	Evaluate
CO4	Interpret the data based on calculations and statistical tests.	Evaluate

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	**1.1 Concepts of Analytical Chemistry: [5L]** 1.1.1 Analytical perspective, Common analytical problems, terms involved in analytical chemistry (analysis, determination, measurement, techniques, methods, procedures and protocol) 1.1.2 An overview of analytical methods, types of instrumental methods, instruments for analysis, data domains, electrical and non-electrical domains, detectors, transducers and sensors, **1.2 Calculations based on Chemical Principles: [5L]** The following topics are to be covered in the form of numerical problems only. a. Concentration of a solution based on volume and mass units. b. Calculations of ppm, ppb and dilution of the solutions, concept of mmol. c. Stoichiometry of chemical reactions, concept of kg mol, limiting reactant, theoretical and practical yield. 1.3 Basic Statistical Tools: [5L] Types of errors – determinate and indeterminate errors, Significant figures and propagation of errors. Confidence limit, Test of significance – the F-test and t-test - One sample t-test. Independent, Paired sample t-test. The statistical Q-test for rejection of a result, statistics for small data sets, Errors in instrumental analysis: Calibration curves, line of regression, errors in slope and intercept.	15	1, 4	1,2	1,2,11
2.	**Quality in Analytical Chemistry:** **2.1 Quality Management System (QMS): [5L]** Quality Management System: Quality management concepts and principles - Traceability, quality control, quality assurance, quality management and quality manual, calibration and test methods TQM in Chemical Industry: Applying Kaizen, Six Sigma approach and 5S to quality in industries. Quality audits and quality reviews, responsibility of laboratory staff for quality and problems.	15	3	1	1,2,8,11

	2.2 Good Laboratory Practices: [4L] GLP Principles, Documentation of laboratory work, Preparation of Standard Operating Procedures (SOPs), Validation of methods, reporting and documentation of results. 2.3. Accreditation of laboratories: [3L] International organization for standardization, National accreditation board for testing and calibration laboratories. Scope of accreditation. 2.4 Safety in Laboratories: [3L] Importance of Safety in Laboratories, classification of Personal Protection Equipment (PPE), Safety and health Standards: Indian Standards & codes for safety & health, OSHA standards, Types of Toxic Hazard (TH), Classification of Chemical Hazards and their control.				
3.	**Optical Methods:** 3.1 Recapitulation of basic concepts, Electromagnetic spectrum, Sources, Detectors, sample containers, Laser as a source of radiation, Fibre optics [3L] 3.2 Molecular Ultraviolet and Visible Spectroscopy [6L] 3.2.1 Derivation of Beer- Lambert's Law and its limitations, factors affecting molecular absorption, types of transitions [emphasis on charge transfer absorption], pH, temperature, solvent and effect of substituents. Applications of Ultraviolet and Visible spectroscopy: 1) On charge transfer absorption 2) Simultaneous spectroscopy 3) Derivative Spectroscopy 3.2.2 Dual spectrometry – Introduction, Principle, Instrumentation and Applications 3.3 Infrared Absorption Spectroscopy [6L] 3.3.1 IR Spectrosopy: Principle, Instrumentation: Sources, Sample handling, Transducers, 3.3.2 FTIR Spectroscopy: Principle, instrumentation & its advantages. 3.3.3 Applications of IR spectroscopy: structure analysis of organic compounds, inorganic Molecules e.g. Sulphato, Carbonato, Nitrato & metal chelates - Acetylacetanato Complexes.	15	2	1	1,2,6,11

	Analysis of petroleum hydrocarbons, oil and grease contents by EPA method, Quantitative analysis of multi-component mixtures. 3.3.4 Introduction and basic principles of diffuse reflectance spectroscopy and its applications.				
4.	**4.1 Thermal Methods:** [5 L] 4.1.1 Introduction, Recapitulation of types of thermal methods, comparison between TGA and DTA. 4.1.2 Differential Scanning Calorimetry-Principle, comparison of DTA and DSC, Instrumentation, Block diagram, Nature of DSC Curve, Factors affecting curves (sample size, sample shape, pressure). 4.1.3 Applications - Heat of reaction, Specific heat, Safety screening, Polymers, liquid crystals, Percentage crystallinity, oxidative stability, Drug analysis, Magnetic transition. e. g. Analysis of Polyethylene for its crystallinity. 4.2 Automation in chemical analysis: [5 L] Need for automation, Objectives of automation, an overview of automated instruments and instrumentation, process control analysis, flow injection analysis, discrete automated systems, automatic analysis based on multi-layered films, gas monitoring equipments, Automatic titrators. 4.3 Environmental Toxicology: [5] Introduction to Environmental Toxicology, Concepts of Toxicology, Toxic substances in the environment, their sources and entry roots, Transport of toxicants by air and water; Transport through food chain-bio-transformation and bio-magnification. Analysis Methods	**15**	**2, 3**	1	1,2,6, 8, 11

References

Unit I

1. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education
2. Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 1.
3. Fundamentals of Analytical Chemistry, By Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 9th Edition, 2004, Ch: 5.

4. Undergraduate Instrumental Analysis, 6th Edition, J W Robinson, Marcel Dekker, Ch:1. 5. ISO 9000 Quality Systems Handbook, Fourth Edition, David Hoyle. (Chapter: 3 & 4) (Free download).

5. 3000 solved problems in chemistry, Schaums Solved problem series, David E. Goldbers, McGraw Hill international Editions, Chapter 11,15,16,21,22

Unit II

1. Quality in the Analytical Laboratory, Elizabeth Pichard, Wiley India, Ch: 5, Ch: 6 &Ch: 7.

2. Quality Management, Donna C S Summers, Prentice-Hall of India, Ch:3.

3. Quality in Totality: A Manager‟s Guide To TQM and ISO 9000, ParagDiwan, Deep & Deep Publications, 1st Edition, 2000.

4. Quality Control and Total Quality Management - P.L. Jain-Tata McGraw-Hill (2006) Total Quality Management - Bester field - Pearson Education, Ch:5.

5. Industrial Hygiene and Chemical Safety, M H Fulekar, Ch:9, Ch:11 & Ch:15.

6. Safety and Hazards Management in Chemical Industries, M N Vyas, Atlantic Publisher, Ch:4, Ch:5 & Ch:19.

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Unit III

1. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 5th Edition, Harcourt Asia Publisher. Chapter 6, 7.

2. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis,6 th Edition, CBS Publisher. Chapter 2.

3. R. D. Braun, Introduction to Instrumental Analysis, McGraw Hill Publisher. Chapter 8.

4. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 5 th Edition, Harcourt Asia Publisher. Chapter 13, 14.

5. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis,6 th Edition, CBS Publisher. Chapter 2.

6. R. D. Braun, Introduction to Instrumental Analysis, McGraw Hill Publisher. Chapter 5.

7. G. W. Ewing, Instrumental Methods of Chemical Analysis, 5 th Edition, McGraw Hill Publisher, Chapter 3.

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11. R. D. Braun, Introduction to Instrumental Analysis, McGraw Hill Publisher. Chapter 12
12. Z. M. Khoshhesab (2012). Infrared Spectroscopy- Materials Science, Engineering and Technology. Prof. TheophanidesTheophile (Ed.). ISBN: 978-953- 51-0537- 4, InTech,(open access)

Unit IV

1. Introduction to instrumental methods of analysis by Robert D. Braun, Mc. Graw Hill (1987): Chapter 27
2. Thermal Analysis-theory and applications by R. T. Sane, Ghadge, Quest Publications
3. Instrumental methods of analysis, 7 th Edition, Willard, Merrit, Dean: Chapter 25
4. Instrumental Analysis, 5 th Edition, Skoog, Holler and Nieman: Chapter 31
5. Quantitative Chemical Analysis, 6 th Edition, Vogel: Chapter 12
6. Analytical Chemistry by Open Learning: Thermal Methods by James W. Dodd & Kenneth H. Tonge
7. Instrumental methods of analysis, 7 th Edition, Willard, Merrit, Dean: Chapter 26
8. Instrumental Analysis, 5th Edition, Skoog, Holler and Nieman: Chapter 33
9. Introduction to instrumental methods of analysis by Robert D. Braun, Mc. GrawHill (1987): Chapter 28
10. Environmental toxicology Kees van Gestel, Vrije Universiteit, Amsterdam
11. Environmental Toxicology III , by V. Popov, Wessex Institute of Technology, UK; C.A. Brebbia, Wessex Institute of Technology, UK

Analytical Chemistry Practical

Course Description	
Semester	**I**
Course Name	**Analytical Chemistry**
Course Code	**PSC1ACP**
Eligibility for Course	**T. Y BSc (Chemistry)**
Credit	**2**
Hours	**30**

After successful completion of this course students will be able to

Sr. No	COs	Bloom Taxonomy Level (BLT)
CO1	Demonstrate the titration skills for the analysis of samples of a diverse variety	Apply
CO2	Apply the statistical methods for data analysis	Apply
CO3	Analyze the measured data based on Chemical principles	Analyse
CO4	Measure the characteristics of ion exchange resins	Evaluate

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	To carry out assay of the sodium chloride injection by Volhard's method.	4	1	1,2	1,2,4,7,11
2.	a) Statistical method: Application of Q test, t test to the data obtained for calibration of 5 mL pipette. b) Determine mean, deviation, Q value and t value using MS-EXCEL software	4	2	1,2	1,2,4,7,11
3.	To determine (a) the ion exchange capacity (b) exchange efficiency of the given cation exchange resin.	4	1, 4	1,2	1,2,4,7,11
4.	To determine amount of Cr(III) and Fe(II) individually in a mixture of the two by titration with EDTA.	4	1, 3	1,2	1,2,4,7,11
5.	To determine the breakthrough capacity of a cation exchange resin.	4	3, 4	1,2	1,2,4,7,11
6.	To determine the Mg (titrimetrically) and Al (gravimetrically) content of a Magnelium alloy by titration with EDTA.	4	1	1,2	1,2,4,7,11
7.	To determine amount of Cu(II) present in the given solution containing a mixture of Cu(II) and Fe(II).	4	1, 3	1,2	1,2,4,7,11
8.	To determine number of nitro groups in the given compound using $TiCl_3$.	4	1, 3	1,2	1,2,4,7,11
9.	Separation of amino acids in a mixture by TLC using Ninhydrin (Demonstration)	4	**3**	1,2	1,2,4,7,11

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3rd Ed. ELBS (1964)

2. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education

3. Standard methods of chemical analysis, F. J. Welcher

4. Standard Instrumental methods of Chemical Analysis, F. J. Welcher

5. W. W. Scott. "Standard methods of Chemical Analysis", Vol. I, Van Nostr and Company,Inc.,1939.

6. E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals",Part-II,4th Ed.,A Wiley InterscicencePublication,New York,1978.

SEMESTER-II

Course Description	
Semester	**II**
Course Name	**Physical Chemistry**
Course Code	**PSC2PC2**
Eligibility for Course	**T. Y BSc (Chemistry)**
Credit	**4**
Hours	**60**

Course Outcomes

After successful completion of this course students will be able to

Sr. No	COs	Bloom Taxonomy Level (BLT)
CO1	Explain Bioenergetics, Real solutions and Fugacity of real gases also show graphical representations of BET isotherms	Apply
CO2	Prove expressions for the total wave function for 1s,2s, 2p and 3d orbitals of hydrogen and aapplication of the Schrödinger equation to two electron system	Evaluate
CO3	Explain terms involved in Chemical Kinetics and Molecular Reaction Dynamics. Elementary Reactions in Solution, Kinetics of reactions catalysed by enzymes -Michaelis-Menten analysis, Lineweaver-Burk and Eadie Analyses, Inhibition of Enzyme action.	Apply, Evaluate
CO4	Apply Photochemistry to solve NET, SET GATE Problems.	Apply

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	**Chemical Thermodynamics II**				
	1.1. Fugacity of real gases, Determination of fugacity of real gases using graphical method and from equation of state. Equilibrium constant for real gases in terms of fugacity. Gibbs energy of mixing, entropy and enthalpy of mixing. 1.2. Real solutions: Chemical potential in non ideal solutions excess functions of non ideal solutions calculation of partial molar volume and partial molar enthalpy, Gibbs Duhem	15	1	1	1,2, 6, 11

	Margules equation. 1.3. Thermodynamics of surfaces, Pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET isotherm (derivations expected). 1.4. Bioenergetics: standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.				
2.	**Quantum Chemistry**				
	2.1. Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wavefunction, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics. 2.2. Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the R the q * and the f equations, solution of the equation, introduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots., points of maximum probability, expressions for the total wave function for 1s,2s, 2p and 3d orbitals of hydrogen. expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots., points of maximum probability, expressions for the total wave function for 1s,2s, 2p and 3d orbitals of hydrogen. 2.3. Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate solution of the Schrödinger wave equation. 2.4. Hückel Molecular Orbitals theory for ethylene, 1,3-butadiene and benzene. (Derivation expected)	15	2	1	1,2, 6,1 1
3.	**Chemical Kinetics and Molecular Reaction Dynamics**				
	3.1. Elementary Reactions in Solution:- Solvent Effects on reaction rates, Reactions between ions- influence of solvent Dielectric constant, influence of ionic strength, Linear free energy relationships Enzyme action **3.2.** Kinetics of reactions catalysed by enzymes -Michaelis-Menten analysis, Lineweaver-Burk and Eadie Analyses. **3.3.** Inhibition of Enzyme action: Competitive, Non competitive and Uncompetitive Inhibition. Effect of pH,	15	3	1	1,2, 6,1 1

	Enzyme activation by metal ions, Regulatory enzymes. **3.4.** Kinetics of reactions in the Solid State:- Factors affecting reactions in solids Rate laws for reactions in solid: The parabolic rate law, The first order rate Law, the contracting sphere rate law, Contracting area rate law, some examples of kinetic studies.				
4.	**Photochemistry**				
	4.1: Absorption of light, laws of photochemistry, electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, construction of Jablonski diagram, electronic transition, Frank Condon principle, selection rules, intensity of absorption bands, nature of electronic spectra and primary process, photo-dissociation, pre-dissociation, **4.2** Photo physical phenomena: physical pathways of excited molecular system (radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, collisional quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. **4.3**. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and applications in chemical analysis. Photochemical reactions, photo-oxidation, photoreduction, photo-dimerization, photoisomerization and photosensitized reactions. Photochemistry of environment: Greenhouse effect.	15	4	1	1,2, 6,1 1

References:

1. Peter Atkins and Julio de Paula, Atkin‟s Physical Chemistry, 7th Edn., Oxford University Press, 2002.

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7. Principles of Chemical Kinetics, 2nd Ed., James E. House, ELSEVIER, 2007.

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15. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.

16. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.

17. Solid State Chemistry [An Introduction], 3rd Ed., Lesley E. Smart & Elaine A. Moore, Taylor & Francis, 2010.

18. The Physics and „Chemistry of Solids, Stephen Elliott, Willey India, 2010

19. Principles of the Solid State, H.V. Keer, New Age International Publishers, 2011.

20. Solid State Chemistry, D.K. Chakrabarty, New Age International Publishers, 1996.

21. Principles of physical Chemistry ,Marrown and Prutton 5th edition

22. Essentials of Physical Chemistry ,ArunBahl, B. S Bahl, G. D.Tulli , S Chand and Co. Ltd , 2012 Edition.

23. Introduction of Solids L.V Azaroff , Tata McGraw Hill .

24. A Text book of physical Chemistry ; Applications of thermodynamics vol III, Mac Millan Publishers India Ltd ,2011

25. New directions in solid state Chemistry, C.N.R. Rao and J Gopalkrishnan , Cambridge University Press.

Physical Chemistry Practical

Course Description	
Semester	**II**
Course Name	**Physical Chemistry Practical**
Course Code	**PSC2PCP**
Eligibility for Course	**T.Y. B. Sc. (Chemistry)**
Credit	**2**
Hours	**30**

After successful completion of this course students will be able to

Sr. No	COs	**Bloom Taxonomy Level (BLT)**
CO1	Know principles of different instruments like Potentiometry, Conductometry, pH Metry and colorimeter	Understand
CO2	Make use of graphical representation to identify Shape of Orbitals.	Apply

Sr. No.	**Course Description**	**Hrs**	**CO No.**	**PSO No.**	**PO No.**
1	Polar plots of atomic orbitals such as 1s, $2p_x$ & $3d_z^2$ orbitals by using angular part of hydrogen atom wave functions.	4	1,2,3,4	2	1,2,4,7,11
2	To study the influence of ionic strength on the base catalysed hydrolysis of ethyl acetate.	4	1,2,3,4	2	1,2,4,7,11
3	To study phase diagram of three component system water – chloroform /toluene - acetic acid.	4	1,2,3,4	2	1,2,4,7,11
4	To determine the rate constant of decomposition reaction of diacetone alcohol by dilatometric method.	4	1,2,3,4	2	1,2,4,7,11
5	Graph Plotting of mathematical functions – linear, exponential and trigonometry and identify whether functions are acceptable or non-acceptable?	4	1,2,3,4	2	1,2,4,7,11
6	To determine the formula of silver ammonia complex by potentiometric method. Determination of binary mixture of halides. (New expt.)	4	1,2,3,4	1	1,2,4,7,11

7	To determine CMC of sodium Lauryl Sulphate from measurement of conductivities at different concentrations.	4	1,2,3,4	1	1,2,4,7,11
8	To determine Hammette constant of m- and p- amino benzoic acid/nitro benzoic acid by pH measurement.	4	1,2,3,4	1	1,2,4,7,11
9	To determine the Michaelis – Menten's constant value (Km) of the enzyme Beta Amylase spectrophotometrically.				

References

1. Practical Physical Chemistry, B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, 2005.
2. Practical Physical Chemistry, A.M. James and F.E. Prichard, 3rd Edn., Longman Group Ltd., 1974.
3. Experimental Physical Chemistry, V.D. Athawale and P. Mathur, New Age International Publishers, 2001.

Course Description	
Semester	**II**
Course Name	**Inorganic Chemistry**
Course Code	**PSC2IC2**
Eligibility for Course	**T.Y.B.Sc.in Chemistry**
Credit	**4**
Hours	**60**

Course Objectives:

1. To study and understand Photochemical Reactions, Ligand substitution reactions of octahedral and tetrahedral complexes, Redox reactions: inner and outer sphere mechanisms, stereochemistry of substitution reactions of octahedral complexes

2. To study and understand Organometallic Chemistry of Transition metals, Eighteen and sixteen electron rule, Structure and bonding on the basis of VBT and MOT in organometallic compounds.

3. To study and understand Toxicity of metallic species including case studies. Interaction of radiation in context with the environment: Sources and biological implication of radioactive materials.

4. To study concept of green chemistry, Biomass and biofuels.

5. To study and understand Bioinorganic Chemistry related to Biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine- structure of metal active center and differences in mechanism of oxygen binding, Copper containing enzymes, Nitrogen fixation Metal ion transport and storage Medicinal applications of cis-platin and related compounds.

Course Outcomes

Sr.No.	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Recall Organometallic Chemistry of Transition metals, Eighteen and sixteen electron rules, Preparation and property's structure and bonding of the Organometallic compounds	Remember
CO2	Explain Photochemical Reactions, Ligand substitution reactions of: Octahedral complexes, Square planar complexes, trans-effect, its theories and applications. Redox reactions: inner and outer sphere mechanisms, stereochemistry of substitution reactions of octahedral complexes	Understand
CO3	Explain Bioinorganic Chemistry related to biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine- structure of metal active center and differences in mechanism of oxygen binding, Copper containing enzymes, Nitrogen fixation Metal ion transport and storage, Medicinal applications of cis-platin and related compounds.	Understand
CO4	Discuss the implication of toxic metallic species radioactive materials on environment and biological system using case studies.	Create

Unit	**Course Description**	Hrs	CO No.	PSO No.	PO No.
1.	**Inorganic Reaction Mechanism:**	15h	CO2	PSO1	PO2
1.1	Photochemical Reactions: Prompt and delayed reactions, Quantum yield, Recapitulation of fluorescence and phosphorescence. Photochemical reactions by irradiating at d-d and charge transfer bands.				
1.2	Ligand substitution reactions of: a) Octahedral complexes without breaking of metal-ligand bond (Use of isotopiclabelling method) b) Square planar complexes, trans-effect, its theories and applications. Mechanismand factors affecting these substitution reactions.				
1.3	Redox reactions: inner and outer sphere mechanisms, complimentary and non-complimentary reactions.				
1.4	Stereochemistry of substitution reactions of octahedral complexes. (Isomerization andracemization reactions and applications.)				
2.	**Organometallic Chemistry of Transition metals:**	15h	CO1	PSO1	PO2

2.1	Eighteen and sixteen electron rule and electron counting with examples.				
2.2	Preparation and properties of the following compounds (a) Alkyl and aryl derivatives transition metal complexes (b) Carbenes and carbynes of Cr, Mo and W (c) Alkene derivatives of Pd and Pt (d) Alkyne derivatives of Pd and Pt (e) Allyl derivatives of nickel **(f)** Sandwich compounds of Fe, Cr and Half Sandwich compounds of Cr, Mo.				
2.3	Basic organometallic reactions introduction: Ligand substitution, oxidative reactions, migratory reactions, migratory insertion, extrusion, oxidative addition, reductive elimination mechanism and stereochemistry				
3.	**Environmental Chemistry:**	15h	CO4	PSO2	PO5
3.1	Toxicity of metallic species: Mercury, lead, cadmium, arsenic, copper and chromium, with respect to their sources, distribution, speciation, biochemical effects and toxicology, control and treatment.				
3.2	Case Studies: (a) Itai-itai disease for Cadmium toxicity, **(b)** Arsenic Poisoning in the Indo-Bangladesh region.				
3.3	Interaction of radiation in context with the environment:Sources and biological implication of radioactive materials. Effect of low level radiation on cells- Its applications in diagnosis and treatment, Effect of radiation on cell proliferation and cancer.				
3.4	**Green Chemistry:** Biomass and Biofuels: Issues of Ethanol,Biodiesel from Plant Oils and from AlgaeActivity. Bio-based Liquid Fuels and Chemicals, Recycling Carbon Dioxide—A Feedstock for the Production of Chemicals and Liquid Fuels, Thermochemical Production of Fuels: Including Methanol and Hydrogen—Fuel of the Future.				
4.	**Bioinorganic Chemistry:**	15h	CO3	PSO2	PO5
4.1	Biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine- structure of metal active center and differences in mechanism of oxygen binding, Differences between hemoglobin and myoglobin: Cooperativity of oxygen binding in hemoglobin and Hill equation, pH dependence of oxygen affinity in hemoglobin and myoglobin and it‟s implications.				
4.2	Activation of oxygen in biological system with examples of mono-oxygenases, and oxidases- structure of the metal center and mechanism of oxygen activation by these enzymes.				
4.3	Copper containing enzymes- superoxide dismutase, tyrosinase and laccase: catalytic reactions and the structures of the metal binding site				
4.4	Nitrogen fixation-nitrogenase, hydrogenases				

4.5	Metal ion transport and storage:Ionophores, transferrin, ferritin and metallothionins				
4.6	Medicinal applications of cis-platin and related compounds				

References

UNIT-I

1. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Inorganic Chemistry, 5thEd., Oxford University Press, 2010.
2. D. Banerjea, Coordination Chemistry, Tata McGraw Hill, 1993.
3. W. H. Malik, G. D./Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry, 8thEd., S. Chand & Company ltd.
4. M. L. Tobe and J. Burgess, Inorganic Reaction Mechanism, Longman, 1999.
5. S. Asperger, Chemical kinetics and Inorganic Reaction Mechanism, 2nd Ed., Kluwer Academic/ Plenum Publishers, 2002
6. Gurdeep Raj, Advanced Inorganic Chemistry-Vol.II, 12th Edition, Goel publishing house,2012.
7. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, MilestonePublishers, 2013-2014.
8. F. Basalo and R. G. Pearson, Mechanism of Inorganic Reactions, 2nd Ed., Wiley, 1967.
9. R. Gopalan and V. Ramlingam, Concise Coordination chemistry, Vikas Publishing housePvt Ltd., 2001.
10. Inorganic reaction mechanism by Jorden & inorganic reaction mechanism by Basolo Pearson
11. Robert B. Jordan, Reaction Mechanisms of Inorganic and Organometallic Systems, 3rdEd., Oxford University Press 2008.

Unit II

1. D. Banerjea, Coordination chemistry. Tata McGrew Hill, New Delhi,1993.
2. R.C Mehrotra and A.Singh, Organometallic Chemistry- A unified Approach, 2nded, NewAge International Pvt Ltd, 2000.
3. R.H Crabtree, The Organometallic Chemistry of the Transition Metals, 5th edition, WileyInternational Pvt, Ltd 2000.
4. B.Doughlas, D.H McDaniel and J.J Alexander. Concepts and Models of Inorganic Chemistry, 2nd edition, John Wiley and Sons. 1983.
5. Organometallic Chemistry by G.S Sodhi. Ane Books Pvt Ltd.
6. G. Miessler and D. Tarr, Inorganic Chemistry, 3rd Ed., Pearson Education, 2004
7. Organometallic chemistry by B.D.Gupta.
8. Organometallic chemistry by " Crabtree

Unit III

1. Environmental Chemistry 5th edition, Colin Baird Michael Cann, W. H. Freeman andCompany, New York, 2012.
2. Environmental Chemistry 7th edition, Stanley E. Manahan, CRC Press Publishers,

3. Environmental Contaminants, Daniel A. Vallero, ISBN: 0-12-710057-1, Elsevier Inc.,2004.
4. Environmental Science 13th edition, G. Tyler Miller Jr. and Scott E. Spoolman, ISBN-10:0-495-56016-2, Brooks/Cole, Cengage Learning, 2010.
5. Fundamentals of Environmental and Toxicological Chemistry 4th edition, Stanley E. Manahan, ISBN: 978-1-4665-5317-0, CRC Press Taylor & Francis Group, 2013.
6. Living in the Environment 17th edition, G. Tyler Miller Jr. and Scott E. Spoolman, ISBN-10: 0-538-49414-X, Brooks/Cole, Cengage Learning, 2011
7. Poisoning and Toxicology Handbook, Jerrold B. Leikin, Frank P. Paloucek, ISBN: 1-4200-4479-6, Informa Healthcare USA, Inc.
8. Casarett and Doull‟s Toxicology- The Basic Science of Poisons 6th edition, McGraw-Hill,2001.

Unit IV

1. R. W. Hay, Bioinorganic Chemistry, Ellis Harwood, England, 1984.

2. I. Bertini, H.B.Gray, S. J. Lippard and J.S. Valentine, Bioinorganic Chemistry, First SouthIndian Edition, Viva Books, New Delhi, 1998.
3. J. A. Cowan, Inorganic Biochemistry-An introduction, VCH Publication, 1993.

4. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University SciencePublications, Mill Valley, Caligronic, 1994.
5. G.N. Mukherjee and A. Das, Elements of Bioinorganic Chemistry, Dhuri& Sons, Calcutta,1988.
6. J.Chem. Educ. (Special issue), Nov, 1985.

7. E.Frienden, J.Chem. Educ., 1985, 62.
8. Robert R.Crechton, Biological Inorganic Chemistry – An Introduction, Elsevier

9. J. R. Frausto da Silva and R. J. P. Williams The Biological Chemistry of the Elements,Clarendon Press, Oxford, 1991.
10. JM. D. Yudkin and R. E. Offord A Guidebook to Biochemistry, Cambridge UniversityPress, 1980.

Course Description	
Semester	**II**
Course Name	**Inorganic Chemistry Practical**
Course Code	**PSC2ICP**

Eligibility for Course	**T.Y.B.Sc.in Chemistry**
Credit	**2**
Hours	**30**

Course Outcomes

COs. No.	After completing the course, Students will be able to:	Bloom Taxonomy Level (BTL)
CO1	Analyse ores and alloys using volumetric and gravimetric analysis.	Analyse
CO2	Estimate percentage of metals in the ore and alloy	Evaluate
CO3	Apply the potentiometric method for redox titrations of Fe, Cu etc.	Apply

Ores and Alloys

1) Analysis of Devarda‟s alloy
2) Analysis of Cu – Ni alloy
3) Analysis of Tin Solder alloy
4) Analysis of Brass alloy

Instrumentation

1) Estimation of Copper using Iodometric method Potentiometrically.
2) Estimation of Fe+3 solution using Ce(IV) ions Potentiometrically

Reference:

1. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N.Dhur& Sons Pvt Ltd

2. The Synthesis and Characterization of Inorganic Compounds by William L. Jolly 3. Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities By: DrDeepak Pant

Course Description	
Semester	**II**
Course Name	**Organic Chemistry**
Course Code	**PSC2OC2**
Eligibility for Course	**T. Y BSc (Chemistry)**
Credit	**2**
Hours	**60**

Course Outcomes

After successful completion of this course students will be able to

Sr No.	COs	Bloom Taxonomy Level (BLT)
CO1	Explain the Generation of carbanion, enolate, enamine with their alkylation & acylation reaction and name reactions with their mechanism.	Understand
CO2	Illustrate mechanism, stereochemistry, applications and importance of name reactions and rearrangements.	Understand
CO3	Explain the role of reagents in organic synthesis.	Analyse
CO4	Interpret the structure of organic compounds using combined of spectral techniques.	create

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1	**1.1. Alkylation of Nucleophilic Carbon Intermediates:** 1.1.1. Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. 1.1.2. Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. 1.1.3. Alkylation of aldehydes, ketones, esters. 1.1.4. Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines. 1.1.5. Alkylation of carbon nucleophiles by conjugate addition (Michael reaction). 1.2. Reaction of carbon nucleophiles with carbonyl groups: 1.2.1. Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation. 1.2.2. Addition reactions with amines and iminium ions; Mannich reaction. 1.2.3. Amine catalyzed condensation reaction: Knoevenagel reaction. 1.2.4. Acylation of carbanions. Asymmetric methodology with enolates and Enamines	15	1	2	4,6
2	Mechanisms, stereochemistry (if applicable) and applications of the following: 2.1. Reactions: Baylis-Hilman reaction, McMurry Coupling, Corey-Fuchs reaction, Nef reaction, Passerini reaction. 2.2. Concerted rearrangements: Hofmann, Curtius, Lossen, Schmidt, Wolff, Bamberger Rearrangements. 2.3. Cationic rearrangements: Tiffeneau-Demjanov, Pummerer, Dienone-phenol, Rupe, Wagner-Meerwein. 2.4. Anionic rearrangements: Brook, Neber, Von	15	2	4	5,6

	Richter, Wittig, Benzylic acid Rearrangements, Payne.				
3	**3.1 Elimination Reactions:** E1,E2 E1CB, Stereochemistry of elimination, elimination Vs Substitution, Anti and Syn Elimination. Dehydrohalogenation, Dehalogenation, Dehydration, Hoffmann and Saytzeff elimination, Pyrolytic elimination. **3.2 Organometallic Chemistry** Organolithium, Organomagnesium, Organozinc, Organocupper, **3.3 Introduction to Molecular Orbital Theory for Organic Chemistry:**. Molecular orbitals: Formation of σ- and π-MOs by using LCAO method. Formation of π MOs of ethylene, butadiene, 1, 3, 5-hexatriene, allylcation, anion and radical. Concept of nodal planes and energies of π-MOs	15	3	3	4,6
4	**Spectroscopy:** **4.1. Proton magnetic resonance spectroscopy:** Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, enols, carboxylic acids, amines, amides. Spin-spin coupling, Coupling constant (J), Factors affecting J, geminal, vicinal and long range coupling (allylic and aromatic). First order spectra. **4.2. 13C NMR spectroscopy:** Theory and comparison with proton NMR, proton coupled and decoupled spectra, off-resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons. **4.3. Mass spectrometry:** Determination of molecular formula of organic compounds based on isotopic abundance and HRMS. Fragmentation pattern in various classes of organic compounds (including compounds containing hetero atoms), McLafferty rearrangement, Retro-Diels Alder reaction. 4.4. Structure determination involving individual or combined use of the above spectral techniques. 4.5. Applications of UV and IR spectroscopy: (8 L) 3.2.1. Ultraviolet spectroscopy: Recapitulation, UV spectra of dienes, conjugated polyenes (cyclic and acyclic), carbonyl and unsaturated carbonyl compounds, substituted aromatic compounds. Factors affecting the position and intensity of UV bands – effect of conjugation, steric factor, pH, and solvent polarity. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (using Woodward-Fieser tables for values for	15	4	3	4,8

	substituents). 4.6. Infrared spectroscopy: Fundamental, overtone and combination bands, vibrational coupling, factors affecting vibrational frequency (atomic weight, conjugation, ring size, solvent and hydrogen bonding). Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds.				

Organic Chemistry Practical

Course Description	
Semester	**II**
Course Name	**Organic Chemistry**
Course Code	**PSC2OCP**
Eligibility for Course	**T.Y.B.Sc (Chemistry)**
Credit	**2**
Hours	**30**

After successful completion of this course students will be able to

Sr. No	COs	Bloom Taxonomy Level (BLT)
CO1	Identify the chemical type of components present in a binary mixture of an organic compound.	Apply
CO2	Apply skills in the separation and qualitative analysis of organic compounds of binary mixtures by microscale technique.	Apply
CO3	Make use of crystallization, sublimation and distillation for purification of the organic compounds.	Apply
CO4	Demonstrate the practical aspects in the preparation of the organic compounds derivatives.	Understand

Sr. No.	Course Description	Hrs	CO No.	PSO No.	PO No.
1	Separation of Binary mixture using micro-scale technique 1. Separation of binary mixture using physical and chemical methods. 2. Characterization of one of the components with the help of chemical analysis and confirmation of the structure with the help of	30	1-4	1-4	9-11

	derivative preparation and its physical constant. 3. Purification and determination of mass and physical constant of the second component. The following types are expected: (i) Water soluble/water insoluble solid and water insoluble solid, (ii) Non-volatile liquid-Non-volatile liquid (chemical separation) (iii) Water-insoluble solid-Non-volatile liquid.				

1. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford UniversityPress.

2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A, page no. 713-769, and B, Plenum Press.

3. March‟s Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.

4. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, Pearson Publication (7th Edition)

5. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, PearsonEducation.

6. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.

7. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.

8. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.

9. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.

10. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.

11. Mechanism in Organic Chemistry, Peter Sykes, 6th

12. Molecular Orbital and Organic chemical reactions, Ian Fleming Reference Edition, Wiley

13. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz,Thomson Brooks.

14. Spectrometric Identification of Organic Compounds, R. Silverstein, G.C Bassler and T.C.Morrill, John Wiley and Sons.

15. Organic Spectroscopy, William Kemp, W.H. Freeman & Company.

16. Organic Spectroscopy-Principles and Applications, Jagmohan, Narosa Publication.

17. Organic Spectroscopy, V.R. Dani, Tata McGraw Hill Publishing Co.

18. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.

19. Organic Reaction Mechanisms, V.K. Ahluwalia, R.K. Parasher, Alpha ScienceInternational, 2011.

20. Reactions, Rearrangements and Reagents by S. N. Sanyal

21. Name Reactions, Jie Jack Li, Springer

22. Name Reactions and Reagents in Organic Synthesis, Bradford P. Mundy, M.G. Ellerd,and F.G. Favaloro, John Wiley & Sons.

Course Description	
Semester	**II**
Course Name	**Analytical Chemistry**
Course Code	**PSC2AC1**
Eligibility for Course	**T.Y.B.Sc (Chemistry)**
Credit	**4**
Hours	**60**

Course Outcomes

After successful completion of this course students will be able to

Sr. No	COs	Bloom Taxonomy Level (BLT)
CO1	Translate the theoretical principles of advanced separation techniques, spectroscopic techniques, radioanalytical techniques, electroanalytical techniques into applications.	Understand
CO2	Explain the working principles of surface analytical techniques such as SEM, STM, TEM, ESCA, Auger spectroscopy and ICP-AES	Understand
CO3	Compare the different ion sources and mass analyzers in mass spectroscopy	Analyze
CO4	Determine the electrical quantities such as charge, current, potential using Electroanalytical methods	Evaluate

Unit	Course Description	Hrs	CO No.	PSO No.	PO No.
1.	**Chromatography**				
	1.1 Recapitulation of basic concepts in chromatography: Classification of chromatographic methods, requirements of an ideal detector, types of detectors in LC and GC, comparative account of detectors with reference to their applications (LC and GC respectively), qualitative and quantitative analysis.[2 L] 1.2 Concept of plate and rate theories in chromatography: efficiency, resolution, selectivity and separation capability. Van Deemter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions.[5 L] 1.3 Gas Chromatography: Instrumentation of GC with special reference to sample injection systems – split/splitless, column types, solid/ liquid stationary phases, column switching techniques, temperature programming, Thermionic and mass spectrometric detector, Applications. [3 L] 1.4 High Performance Liquid Chromatography (HPLC): Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Diode array type and fluorescence detector, Applications of HPLC. Chiral and ion chromatography. [5 L]	15	1	1	1,2,6, 11
2.	**X-ray spectroscopy**:				
	principle, instrumentation and applications of X-ray fluorescence, absorption and diffraction spectroscopy. [4 L] 2.2 Mass spectrometry: recapitulation, instrumentation, ion sources for molecular studies, electron impact, field ionization, field absorption, chemical ionization and fast atom bombardment sources. Mass analyzers: Quadrupole, time of flight and ion trap. Applications. [6 L] 2.3 Radioanalytical Methods – recapitulation, isotope dilution method, introduction, principle, single dilution method, double dilution method and applications. [5 L]	15	1,3	1	1,2,6, 11
3.	**Surface Analytical Techniques**				
	Introduction, Types of surface measurements: Photon probe technique, electron probe technique, Ion probe technique, Scanning probe microscopy 3.2 Electron probe techniques: 3.1.1 Scanning Electron Microscopy (SEM):	15	2	1	1,2,6, 11

	Principle, Instrumentation and Application 3.1.2 Electron Spectroscopy (ESCA and Auger): Principle, instrumentation and Application 3.2 Atomic Spectroscopy [6 L] 3.2.1 Recapitulation: Flame AAS and furnace AAS Interferences - chemical and spectral, evaluation methods in AAS, qualitative and quantitative applications 3.2.2 AES: Principle of AES, Interferences Inductively Coupled Plasma- Atomic Emission Spectroscopy (ICP-AES) – Introduction, Principle, Instrumentation, applications 3.2.3 Applications of AAS and AES in environmental analysis				
4.	**Electroanalytical Methods**				
	(Numericals are Expected) 4.1 Ion selective potentiometry and Polarography: [10 L] Ion selective electrodes and their applications (solid state, precipitate, liquid –liquid, enzyme and gas sensing electrodes), ion selective field effect transistors, biocatalytic membrane electrodes and enzyme based biosensors. Polarography: Ilkovic equation, derivation starting with Cottrell equation, effect of complex formation on the polarographic waves. 4.2 Electrogravimetry: Introduction, principle, instrumentation, factors affecting the nature of the deposit, applications.[3 L] 4.3 Coulometry: Introduction, principle, instrumentation, coulometry at controlled potential and controlled current [2 L]	15	4	1	1,2,6, 11

References:

Unit I

1. Instrumental Analysis, Skoog, Holler & Crouch

2 HPLC Practical and Industrial Applications, 2 nd Ed., Joel K. Swadesh, CRC Press

Unit II 1.Essentials of Nuclear Chemistry, H J Arnikar, New Age Publishers (2005) 2. Fundamentals of Radiochemistry D. D. Sood , A. V. R. Reddy and N. Ramamoorthy 3. Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 12 4. Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 20

Unit III

1. Instrumental Analysis by Douglas A. Skoog - F. James Holler - Crouch, Publisher: Cengage; Edition, (2003), ISBN-10: 8131505421, ISBN-13: 978-8131505427

2. Physical Principles of Electron Microscopy, An Introduction to TEM, SEM, and AEM
3. Authors: Ray F. Egerton, ISBN: 978-0- 387-25800- 3 (Print) 978-0- 387-26016- 7 (Online)
4. Modern techniques of surface science by D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, 1994.
5. Introduction to Scanning Tunneling Microscopy by C. J. Chen, Oxford University Press, NewYork, 1993.
6. 5. Transmission Electron Microscopy: A text book for Material Science, David B Williams and C., Barry Carter, Springer
7. Modern Spectroscopy, by J.M. Hollas, 3rd Edition (1996), John Wiley, New York
8. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers, 1998.
9. Instrumental Analysis by Douglas A. Skoog - F. James Holler - Crouch, Publisher: Cengage; Edition (2003), ISBN10: 8131505421, ISBN-13: 978-8131505427

Unit IV

1. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th Edition, Harcourt College Publishers, 1998. Chapters - 23, 24, 25.
2. Analytical Chemistry Principles – John H Kennnedy, 2nd edition, Saunders College Publishing (1990).
3. Modern Analytical Chemistry David Harvey; McGraw Hill Higher education publishers, (2000).
4. Vogel's Text book of quantitative chemical analysis, 6th edition, Pearson Education Limited, (2007).
5. Electrochemical Methods Fundamentals and Applications, Allen J Bard and Larry R Faulkner, John Wiley and Sons, (1980).
6. Instrumental Methods of Analysis Willard, Merrit, Dean and Settle, 7th edition, CBS publishers.

Analytical Chemistry Practical

Course Description	
Semester	**II**
Course Name	**Analytical Chemistry**
Course Code	**PSC2ACP**
Eligibility for Course	**T. Y. B.Sc (Chemistry)**
Credit	**2**
Hours	**30**

After successful completion of this course students will be able to

Sr. No.	COs	Bloom Taxonomy Level (BLT)
CO1	Demonstrate the operational skills on the selected instruments and retrieve information	Understand
CO2	Develop a sense of time management, safe use of chemicals and environmental safety	Apply
CO3	Measure the physical property of the samples and relate it with quantity	Evaluate
CO4	Construct the graphs based on the measurements and calculations	Evaluate

Sr. No.	Course Description	Hrs	CO No.	PSO No.	PO No.
1	To determine percent purity of washing soda in terms of sodium carbonate pH metrically.	4	1,2, 3,4	1,2	1,2,4, 7,11
2	To determine amount of Ti (III) and Fe (II) in a mixture by titration with Ce (IV) potentiometrically.	4	1,2, 3,4	1,2	1,2,4, 7,11
3	To determine the amount of nitrite present in the given water sample colorimetrically.	4	1,2, 3,4	1,2	1,2,4, 7,11
4	To determine the amount of Fe (II) and Fe (III) in a mixture using 1,10-phenanthroline spectrophotometrically.	4	1,2, 3,4	1,2	1,2,4, 7,11
5	Simultaneous determination of Cr (VI) and Mn (VII) in a mixture spectrophotometrically.	4	1,2, 3,4	1,2	1,2,4, 7,11
6	To determine the percentage composition of HCl and H_2SO_4 on weight basis in a mixture of two by conductometric titration with NaOH and $BaCl_2$.	4	1,2, 3,4	1,2	1,2,4, 7,11
7	To determine amount of potassium in the given sample of fertilizers using flame photometer by standard addition method.	4	1,2, 3,4	1,2	1,2,4, 7,11
8	Separation of benzene and toluene using gas chromatography and determination of column resolution (Rs). (demonstration)	4	1,2, 3,4	1,2	1,2,4, 7,11

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