University of Ladakh

Course Structure and Syllabus (Choice Based Credit System)

M.Sc. Chemistry
Effective from Academic Year 2022-23

Department of Chemistry
Kargil Campus

Introduction to CBCS
(Choice Based Credit System)

Ladakh is one of the coldest places in India. It experiences a very severe and extended winter season, starting from late October till March, with the temperatures dipping as low as -35°C. Therefore, the syllabi (Laboratory Courses) are framed diligently keeping this harsh weather conditions in consideration. The practical activities which need temperature around 25-30^{0}C has been kept in odd semesters (summer season).

Brief Description about the Course

Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year. An academic year starts from 21st March of each year.

Choice Based Credit System (CBCS): The CBCS provides choices for students to select from the prescribed courses.

Course: Usually referred to as 'papers' is a component of a programme.

Academic Programme: An entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated.

Core Course: A course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

Discipline Specific Elective (DSE) Course: An optional course to be selected by a student out of such courses offered by the Department.

Open Elective/Interdisciplinary Course: An elective course which is available for students of all programmes, including students of the same department. Students of other departments can also opt these courses.

Credit: The value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours' practical class per week equals 1 credit. Credit for practical courses could be proposed as part of a course or as separate practical courses.

Programme Details

Design: The course work is designed for students, to enhance their practical skills and knowledge in the field of Chemistry. The curriculum is prepared with the view to help students secure jobs in different chemical industries/teaching institutes or secure Ph.D. positions in any reputed national/international University/Institute and qualify the national level exams like CSIR-UGC (NET) exam for award of a junior research fellowship and eligibility for lectureship

Duration: It is two years Master Degree Programme.

Semester: There shall be four semesters (Two years) to complete the program worth a total of 80 credits, delivered in 24 months including a project work carried out in the last year 4th Semester.

Minimum teaching days: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days.

Attendance: Students must earn at least 75% of attendance in each course for appearing in the semester end examinations**.** The condonation case of students with less than 75% attendances shall be considered as per the direction of the university.

Examinations shall be conducted at the end of each Semester as per the Academic Calendar notified by the University.

Marks Distribution: Each theory course shall be divided into 70% marks for term end examination (external exam) and 30% marks for continuous internal assessment.

Continuous Internal Assessment will be done in four components: (i) Presentations (ii) Tests (iii) Assignments and (iv) On the basis of grading in day-to-day activities. Grading of day-to-day activity will be done by marking the attendance as α (Alpha), β (Beta), and γ (Gamma) with 100%, 75%, and 50% weightage on the marking scale respectively. The weightage given to each of these components shall be decided and announced at the beginning of the semester by the individual teacher responsible for the course or by the department. Any student who fails qualify continuous internal assessment will be debarred from appearing in the end-semester examination in the specific course and no Internal Assessment marks will be awarded. His/her Internal Assessment marks will be awarded as and when he/she attends regular classes in the course in the next applicable semester. No special classes will be conducted for him/her during other semesters.

The practical course in each semester (up to 3rd) carries 100 marks in full. The assessment of the practical course will be done in two parts with 50% marks for external exams and 50% marks for Continuous Internal Assessment.

Skill Based Project Work/ Two weeks Internship: 1st to 3rd Semester, a 2 credits course (50 marks), Skill Based Project work shall be conducted to inculcate research aptitude. The student can also earn the same credits by participating in a two weeks' internship programme from any recognised institute.

Project/Dissertation: The project can be carried out either in the department or in any other industry, institute or organization located anywhere in India. The project work carries 200 marks.

Pattern of end-semester question paper

a) There will be two sections, A and B.
b) There will be 9 or 5 questions in all.
c) Section A will carry one compulsory question (question no. 1) with four/two sub-parts (consisting of short answer-type questions). Each sub-part (short answer type question) will be from each unit and a student will have to attempt all the four sub-parts.
d) Section B will comprise four/two long answer-type questions (question number 2 to 5 or 2 to 3); each question will have an option. Thus, there will be two questions from each unit. In total, there will be eight/4 questions in the section; two from each unit and a candidate will be asked to attempt four/two questions.
e) All short answer-type questions will carry 3½ marks each. Thus, question No. 1 will carry a weightage of 14/7 marks. Whereas, each question from no. 2 to 5 or 2 to 3 will also carry marks equal to 14.

Any Other Information: In addition to the above mentioned regulations, any other common regulations pertaining to the PG Programmes are also applicable for this Programme as per the guidelines or notifications by the University.

Objective of the Programme:

- To train the students with essential theoretical and practical skills in synthesis, characterization, and processing techniques concerning various fields of chemistry.
- To make the Department a growing centre of excellence in teaching, research, and popularizing Chemistry.
- To provide students with the skills required to succeed in various professions like teachings, Chemical industries or Research etc.
- To make collaborations for students and faculty exchange and research cooperation with other universities.
- To expose the students to a breadth of experimental techniques using modern instrumentation.
- The Department also aims to conduct outreach programmes in the form of online courses, conducting activities and training programmes etc. that showcase the role of Chemistry.

Programme Outcomes:

After the M.Sc. Chemistry program, the students of our Department will be able to:

- Work in the interdisciplinary and multidisciplinary areas of chemical sciences and its applications.
- Apply green/sustainable chemistry approach towards planning and execution of research in frontier areas of chemical sciences.
- Have sound knowledge about the fundamentals and applications of chemical and scientific theories.
- Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.
- Acquires the ability to synthesize, separate, and characterize compounds using laboratory and instrumentation techniques.
- Carry out experiments in the area of organic analysis, estimation, separation, derivative process, inorganic semi microanalysis, preparation, conductometric and potentiometric analysis.
- Learns about the potential uses of analytical industrial chemistry, medicinal chemistry and green chemistry.
- Understands the background of organic reaction mechanisms, complex chemical structures, instrumental methods of chemical analysis, molecular rearrangements, and separation techniques.

Course details

Sem.	Core courses			Discipline Specific Elective courses (Minor Electives)		Open elective courses		Discipline Specific Elective courses (Major Electives)	(Skill Based Course) Project/ Dissertation	Total credits
	No. of Papers T+P	Credits (T+P)	Total credits	No. of Papers (T)	Total credits	No. of Papers (T)	Total credits	No. of Papers (T)	Total credits	
I	3+2	12 + 4	**16**	1	**2**	-	**-**	**-**	**2**	**20**
II	3+2	12 + 4	**16**	1	**2**	-	**-**	**-**	**2**	**20**
III	3+2	12 + 4	**16**	-	**-**	1	**2**	**-**	**2**	**20**
IV	-	-	**-**	-	**-**	-	**-**	**12**	**8**	**20**
Total credits for the course			**48**		**04**		**2**	**12**	**14**	**80**

The Key features of the course structure are as follows:

1. Maximum credit for the programme is 80 and there is option for Multiple Entry and Exit, as per NEP guide lines.
2. Each semester has an equal weightage of credit (20).
3. There are Minor & Major Electives as per CBCS guidelines.
4. In each Semester there is an option for a student to choose a course of two credits from any sister department or from Moocs or within the department.
   - So, there is options to mix & match courses to pursue pure chemistry or inter/cross disciplinary sciences.
   - A student will have the option to earn credit by completing quality-assured MOOC programmes offered on the SWAYAM portal or any other online educational platform approved by the UGC/regulatory body from time to time. In this way students shall have an option for credit transfers from MOOC platforms.
   - Provision for Skill Based Project Work from 1st to 3rd semesters of two credits.

Note: There shall only be one exit point for those who join the two-year Master's programme, that is, at the end of the first year of the Master's programme. Students who exit after the first year shall be awarded the Post-Graduate Diploma in Chemistry.

Course Structure for M.Sc. Chemistry (CBCS)						
S. No.	**Sem.**	**Course Code**	**Nature of Course**	**Title**	**Credits**	**Marks**
1.	**1st**	PGCH-C101	Core	Inorganic Chemistry-I	04	100
2.		PGCH-C102		Organic Chemistry-I	04	100
3.		PGCH-C103		Physical Chemistry-I	04	100
4.		PGCH-P101		Laboratory Course –I	04	100
5.		PGCH-P102	Skill	Skill based project work or two weeks internship from any recognized institute	02	50
		Opt any one of the following course /MOOCs course of equivalent credit				
6.		PGCH-E104	Elective	Organic Spectroscopy	02	50
7.		PGCH-E105		Chromatographic Techniques		
Total					**20**	**500**
1.	**2nd**	PGCH-C201	Core	Inorganic Chemistry-II	04	100
2.		PGCH-C202		Organic Chemistry-II	04	100
3.		PGCH-C203		Physical Chemistry-II	04	100
4.		PGCH-P201		Laboratory Course –II	04	100
5.		PGCH-P202	Skill	Skill based project work or two weeks internship from any recognized institute	02	50
6.		**Opt any one of the following course /MOOCs course of equivalent credit**				
7.		PGCH-E204	Elective	Supramolecular Chemistry	02	50
8.		PGCH-E205		Rotational and Vibrational Spectroscopy		
Total					**20**	**500**
1.	**3rd**	PGCH-C301	Core	Inorganic Chemistry-III	04	100
2.		PGCH-C302		Organic Chemistry-III	04	100
3.		PGCH-C303		Physical Chemistry-III	04	100
4.		PGCH-P301		Laboratory Course-III	04	100
5.		PGCH-P302	Skill	Skill based project work or two weeks internship from any recognized institute	02	50
		Interdisciplinary Course Opt any one of the following or MOOCS Course or Course from other sister dept. of same credits				
6.		PGCH-E304	Elective	Chemistry in Everyday Life	02	50
7.		PGCH-E305		Bio-Organic Chemistry		
8.		PGCH-E306		Biophysical Chemistry		
Total					**20**	**500**
Opt any one from each section						
1.	**4th**	PGCH-C401 PGCH-C402 PGCH-C403 PGCH-C404	Elective	Organometallic Chemistry Selected Topics in Inorganic Chemistry-I Chemistry of Materials Selected Topics in Inorganic Chemistry-II	04	100
2.		PGCH-C405 PGCH-C406 PGCH-C407 PGCH-C408		Selected Topics in Organic Chemistry Chemistry of Natural Products Medicinal Chemistry Polymer Chemistry	04	100
3.		PGCH-C409 PGCH-C410 PGCH-C411 PGCH-C412		Instrumental Methods of Analysis Hyphenated and other Analytical Techniques Scientific Research Methodology Environmental and Green Chemistry	04	100
4.		PGCH-P401	Skill	Project/Dissertation	08	200
Total					**20**	**500**
Grand Total					**80**	**2000**

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
1st Semester (Core)
Subject Code: PGCH

Course Title: Inorganic Chemistry-I **Credits: 4**
Course Code: PGCH-C101 **No. of Contact hours: 60**
Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objective: To give the students insight into Metal Ligand bonding, Electronic Spectra and Magnetic properties of transition metals.
Course Outcomes: After the completion of the course students will be able to

- Understand the Metal-Ligand Bonding in Transition Metal Complexes of the coordination complexes.
- Interpret the electronic spectra and magnetic properties of transition metal complexes
- Interpret the of transition metal complexes.

Unit-I Metal-Ligand Bonding in Transition Metal Complexes **15 hours**
Crystal field splitting diagrams in Tetrahedral, Octahedral and Square Planner complexes; Factors affecting 10 Dq values. Spectrochemical and Nephelauxetic series; thermodynamic stability and structural effects; Crystal field stabilization energy; Octahedral Vs Tetrahedral Geometries. Spinels and site Selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory, molecular orbital theory as applied to metal complexes (σ and π bonded).

Unit-II Electronic spectra of Transition Metal Complexes **15 hours**
Spectroscopic ground states; Laporte and Spin Selection Rules, Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes; Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.

Unit-III Metal-Ligand Equilibria in Solution **15 hours**
Thermodynamic stability of complexes, Stepwise and overall formation constants, factors affecting thermodynamic stability, kinetic stability of complexes. Inert & labile octahedral complexes according to CFT and VBT, Factor affecting the lability of a complex
Metal Chelates: Characteristics, chelate effect, and the factors affecting the stability of metal chelates. Macrocyclic ligands. Crown ethers, cryptands. Determination of formation constants by pH-metry, Job's method, and Spectrophotometry.

Unit-IV Magnetic properties of transition metal complexes **15 hours**
Paramagnetism, diamagnetism, ferromagnetism and antiferromagnetism, magnetic susceptibility, magnetic moments, quenching of magnetic moments, spin-orbit coupling, anomalous magnetic behaviour of metal complexes, magnetic exchange, and spin-state crossovers.
Metal π-complexes – I
Metal carbonyls and Nitrosyls: preparation and important reactions of metal carbonyls and Nitrosyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, Effective atomic number (EAN) rule as applied to metallic carbonyls and nitrosyls.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*
Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Cotton, F.A.; Wilkinson Advanced Inorganic Chemistry, 6th edition, John Wiley& Sons, 1999.
- Huheey, James E. Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Harper Collins College Publishers, 1993.
- Greenwood, N.N. and Earnshaw, A. Chemistry of the Elements, 2nd edition, Butterworth-Heinemann, A division of Read Educational & Professional Publishing Ltd., 2001.
- Carlin, Richard L. and Duyneveldt, A.J.Van Magnetic Properties of Transition Metal Compounds, Inorganic Chemistry Concepts 2, Springer-verlag New York Inc., 1977.
- Principles of Inorganic Chemistry by B.R. Puri, L.R. Sharma, et al.

Suggested Further Readings:

- Shriver, D.F.; Atkins, P.W. Inorganic Chemistry, 1st edition, Oxford University Press, 2006.
- Earnshaw, A. Introduction to Magnetochemistry, Academic Press, 1968.
- Dutta, R.L.; Syanal, A. Elements of Magneto chemistry, 2nd edition, Affiliated East West Press, 1993.
- Keith F. Purcell and John C. Kotz, Inorganic Chemistry, W. B. Sauders Com. (1987), Hong Kong.
- B.N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd. New Delhi (1976).
- Principles of Inorganic Chemistry; 1st edn.; Brain W. Pfennig; Wiley; 2015.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
1st Semester (Core)
Subject Code: PGCH

Course Title: Organic Chemistry-I **Credits: 4**
Course Code: PGCH-C102 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment = 30)
Course Objective: To introduce the students with basic and advance concepts of reactive intermediates and reaction mechanisms in organic chemistry.
Course Outcomes: After the completion of the course students will be able to

- Recapitulate some basic concept of organic chemistry.
- Identify various methods and intermediate species involved while determining the mechanism of organic reactions.
- Examine the mechanistic and synthetic aspects of nucleophilic & electrophilic substitution reactions, elimination and addition reactions, etc.

Unit-I **15 hours**
Delocalized chemical bonding: conjugation, cross-conjugation, resonance, hyperconjugation, tautomerism.
Reaction mechanism, structure, and reactivity: Classification and determination of reaction mechanisms, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, methods of determining mechanisms, isotope effects,
Effect of structure on reactivity: Linear free energy relationships (LFER), the Hammett equation – substituent and reaction constants; the Taft treatment of polar and steric effects in aliphatic compounds.
Reactive intermediates: Generation, structure, and reactions of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes, classical and nonclassical carbocations, phenonium ions and norbornyl system.
Aromaticity: Aromaticity in benzenoid and non-benzenoid compounds, antiaromaticity, homoaromatic compounds.

Unit-II **15 hours**
Aliphatic nucleophilic substitution reaction: The S_N2, S_N1, mixed S_N2 and S_N1,the S_Ni mechanism. Energy profile diagram, nucleophilic substitution at an allylic, aliphatic and vinylic carbon, reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambident nucleophile, regioselectivity, effect of solvent in a substitution reaction, competition betweenS_N2 and S_N1 mechanisms. Neighbouring group participation
Aromatic nucleophilic substitution: The S_NAr, bimolecular displacement mechanism and benzyne mechanism, reactivity effect of substrate structure, leaving group and attacking nucleophile.
Aromatic electrophilic substitution: The arenium ion mechanism, orientation, and reactivity, energy profile diagrams, ortho/para ratio, ipso attack, orientation in other ring systems, quantitative treatment of reactivity in substrates and electrophiles.

Unit III **` 15 hours**
Elimination reactions: E2, E1 and E1cB mechanisms and their spectrum, orientation of the double bond, effects of substrate structures, attacking base, the leaving group and the medium, mechanism and orientation in pyrolytic elimination.
Addition to carbon-carbon multiple bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, addition of halogen polar reagents to alkenes, Regio- and chemoselectivity, orientation and reactivity, hydroboration, epoxidation and hydroxylation.

Unit IV **15 hours**

Addition to carbon-hetero multiple bonds: Structure and reactivity of carbonyl group towards nucleophilic addition: addition of CN, ROH, RSH, H_2O, hydride ion, ammonia derivatives, $LiAlH_4$, $NaBH_4$, organozinc and organolithium reagents to carbonyl and conjugated carbonyl compounds, Arndt-Eistert synthesis. Mechanism of condensation reactions involving enolates: Aldol, Knoevenagel, Claisen, Dieckmann, Mannich, Benzoin, Perkin and Stobbe reactions. Carboxylic acids and derivatives, hydrolysis of esters and amides, ammonolysis of esters.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- March, Jerry Advanced Organic Chemistry: Reactions, Mechanism and Structure, 6th edition, John Wiley, 2007.
- Clayden, J., Greeves, N., Warren, S. and Wothers, P. (2012) Organic Chemistry
- Carry, F. A.; Sundberg, R.J. Advanced Organic Chemistry, 3rd edition, Plenum, 1990.
- Sykes, Peter A Guide Book to mechanism in Organic Chemistry, 6th edition, Longman, 1989.
- Morrison, R. T.; Boyd, R. N. Organic Chemistry, 6th edition, Prentice Hall, 1992.
- Kalsi, P. S. Organic Reactions and their Mechanisms, 2nd edition, New Age International Publishers, 2000.
- Mukherjee, S.M. and Singh, S.P. (2009) Reaction Mechanism in Organic Chemistry.

Suggested for Further Readings:

- Ahluwalia, V. K., and Parashar, R. K. (2011). Organic Reaction Mechanisms.
- Bansal, R. K. (2012). A Textbook of Organic Chemistry. New Age International.
- Bansal R.K. (2010) Organic Reaction Mechanism. New Age International (P) Ltd.
- Lowry, T. H. and Richardson K. S. (1998) Mechanism and Theory in Organic Chemistry, Addison-Wesley Longman Inc., New York.
- Solomon, T.W.G, Fryhle, C.B. and Snyder, S. A. (2013) Organic Chemistry. John Wiley and Sons, Inc.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
1st Semester (Core)
Subject Code: PGCH

Course Title: Physical Chemistry-I **Credits: 4**
Course Code: PGCH-C103 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To introduce the students with quantum chemistry and solid state chemistry.
Course Outcomes: After the completion of the course students will be able to

- To understand the basic ideas of quantum mechanics, concept of operators and wave function in quantum mechanics.
- To understand Schrödinger equation for various systems
- Interpret and solve the Schrodinger equation for different quantum mechanical models like particle in a box, harmonic oscillator etc.
- To solve Schrödinger equation for system with one electron like H-atom.
- Importance of Born-Oppenheimer approximation.
- To get general idea of angular momentum, its quantum chemical descriptions
- To know about angular momentum operators their commutation relations and Ladder operators
- To discuss the possible electronic configurations in terms of term symbols.
- To understand the concept of electronic spin angular momentum and various angular momentum coupling schemes.
- Physicochemical properties of solid, defects in solid, diffraction techniques
- To understand the theory of free electron with different models
- To discuss about various properties solid, semi-conductor, superconductor, Meissner effect and their application.

Unit-I Quantum Chemistry-I **15 hours**

Exact quantum mechanical results: Classical mechanics Vs quantum mechanics, need for quantum mechanics, Schrodinger equation and the postulates of quantum mechanics. Operator concept, some properties of quantum mechanical operators. Linear and Hermitian operators.
Complete solution of Schrodinger equation for the following model systems: Particle in a box (1 and 3 dimensional). Concept of degeneracy. The solution of problems of harmonic oscillator & the rigid rotator. Concept of zero point energy. Schrödinger wave equation for Hydrogen atom, separation into three equations, quantum numbers and their importance. Radial and angular wave functions (Spherical harmonics). Tunneling effect. Born-Oppenheimer approximation Calculation of various average values for the above systems.

Unit-II Quantum Chemistry-II **15 hours**

Angular momentum and electronic structure of atom: General theory of angular momentum. Eigen functions and Eigenvalues of angular momentum operators. Ladder operators. Spin angular momentum, antisymmetry and Pauli's principle.
Electronic configuration, Russell-Saunders terms and coupling schemes, Slater determinant. Atomic term symbols, term separation of p^n configurations, spin-orbit coupling, Zeeman splitting, virial theorem.

Unit-III Structure and Theories of Solids **15 hours**

Structure of solids: Lattice Planes and Miller indices; Bragg equation, Debye-Scherrer method of X-ray structural analysis of crystals, identification of cubic unit cells from systematic absences in diffraction pattern. Structure factor and its relation to intensity and electron density.
Crystal defects and their types. Point defects: Schottky and Frenkel defects, Thermodynamics of Schottky and Frenkel defect formation, Colourcentres, Dislocations and their types.

Theories of solids: Free electron theory of metals: The Drude and Lorentz Model, Sommerfield Model; Fermi-Dirac distribution function, Density of state and electronic heat capacity.

Unit-IV Electric and magnetic properties of Solids 15 hours

Semiconductors: Intrinsic & extrinsic semiconductor (n-type & p-type), temperature dependence of charge carriers, p-n junction- devices based on p-n junction (tunnel diode, injection laser).

Superconductors: Characteristic properties- Zero resistance, Meissner effect, Heat capacity, Thermal conductivity, absorption of em radiations and Josephson effect. BCS theory of superconductivity, applications of superconductors.

Dielectric Properties of Solids: Dielectric constant, Polarization and Polarizability, Piezoelectricity, pyroelectricity and ferroelectricity, ferroelectric materials and their applications.

Magnetic properties of solids: Origin of magnetism in solids, Diamagnetism, paramagnetism (Langevin's and quantum mechanical formulations), ferromagnetism (Wiess theory), antiferromagnetism and ferrimagnetism. Temperature dependence of magnetization.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Chandra, A.K Introductions to Quantum Chemistry, 4th edition, Tata McGraw Hill, 1994.
- Prasad, R. K Quantum Chemistry, 2nd Edition, New Age Publishers, 2001.
- Levine, Ira N. Quantum Chemistry, 5th edition, Prentice-Hall International, Inc., 2000.
- West, A.R. Solid State Chemistry and its Applications, Plenum.
- Keer, H.V. Principles of the Solid State, Wiley Eastern.
- Hannay, N.B. Solid State Chemistry.
- Chakrabarty, D.K. Solid State Chemistry, New Age Internationals.
- Elements of Solid state Physics, J.P. Srivastava, Prentice Hall of India, 2003.

Suggested for Further Reading:

- McQuarie D. A. & Simon, J. D., Physical Chemistry- A Molecular Approach- University Science Books
- Introduction to Solids, Azaroff, Tata McGraw,1993.
- The Physical Chemistry of Solids, Borg, Biens, Academic press, 1992.
- Solid State Reactions, Schmalzried, Academic press, 1995.
- Solid State Physics, N.W.Ashcroft and N.D.Mermin, Saunders college, 2001.
- Atkins, P. W.; De Paula, Julio Physical Chemistry; Ed. 10th, Oxford University Press;2014.
- A Molecular Approach - D. A. McQuarie & J. D. Simon, University Science Books, 1997.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
1st Semester (Elective)
Subject Code: PGCH

Course Title: Organic Spectroscopy **Credits: 2**
Course Code: PGCH-E104 **No. of Contact hours: 30**
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Objective: To give the students insight into basic principal and application of spectroscopic technique in organic chemistry.
Course Outcomes: After the completion of the course students will be able to

- Identify various spectroscopic techniques (UV, IR, NMR, and MS) used in organic synthesis for structure elucidation.
- Predict NMR spectra and various fragment-ions/peaks in MS of a given molecular structure.
- Analyze and interpret the combined spectroscopic data (UV-Vis, IR, ^{1}H &^{13}C NMR) for structural elucidation of unknown organic molecules.

Unit-I **15 hours**

Electronic Spectra: Types of electronic transitions in organic molecules, Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic compounds. Steric effect in biphenyls.
Rotational and Vibrational spectra: Basic principles, selection rule, fundamental vibrations, identification of some representative organic and inorganic compounds.

Unit-II **15 hours**

Nuclear Magnetic Resonance Spectroscopy: Basic principles, origin of chemical shifts, factors affecting the chemical shifts and their interpretation, spin-spin coupling, relaxation processes, coupling constants, Nuclear Overhouser effect (NOE) Resonance of other nuclei –F, P. spectra of selected compounds, Shift reagents, spin tickling.
Carbon-13 NMR Spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon). Introduction to Two-dimensional NMR spectroscopy.
Mass Spectrometry: Mass spectrometry: Basic principles and instrumentation, mass spectral fragmentation of organic compounds.
Spectroscopic Solutions of Structural Problems with reference to organic compounds.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 07.*
Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Pavia, D. L., Lampman, G. M., Kriz, G. S., and Vyvyan, J. A.). Introduction to Spectroscopy. Cengage Learning, 2008.
- Gross, J. H. Mass Spectrometry: A Textbook. Springer Science and Business Media, (2006).
- Banwell, C. N., and McCash, E. M. (1994). Fundamentals of Molecular Spectroscopy (Vol. 851). New York: McGraw-Hill.

- Yadav, L.D.S, Organic Spectroscopy
- Dyer, J. R. Applications of Absorption Spectroscopy of Organic Compounds. Phi Learning, 1965.
- Kalsi, P. S. Spectroscopy of Organic Compounds. New Age International, (2007).

Suggested Essential Readings:

- Kemp, W. Organic Spectroscopy, ELBS. 1998
- Khopkar, S. M. Basic Concepts of Analytical Chemistry. New Age International, 1998.
- Melinda, J.D. Introduction to Solid NMR Spectroscopy. Wiley India Pvt Ltd, 2010.
- Silverstein, R. M., Webster, F. X., Kiemle, D. J., and Bryce, D. L. Spectrometric Identification of Organic Compounds. John wiley and sons, 2014

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
1st Semester (Elective)
Subject Code: PGCH

Course Title: Chromatographic Techniques **Credits: 2**
Course Code: PGCH-E105 **No. of Contact hours: 30**
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Objective: To give the students insight into basic principal and application of Chromatographic technique.

Unit-I Chromatographic Techniques I **15 hours**
Introduction, Types and Classification, principles, differential migration, nature of partition forces, partition, Mobile phases, stationary phases, resolution, plate theory (concept), separation time, zone migration, column packing materials, development techniques, differential migration, partition coefficient, retention time and retention volume. Thin layer chromatography: Theory, principle, adsorbents, preparation of plates, solvents, preparative TLC.

Unit-II Chromatographic Techniques II **15 hours**
Gas-Liquid chromatography: Principle, columns and stationary phase, resolution and instrumentation. HPLC: Theory, column efficiency, extra column and band broadening, temperature effects and diffusion. Chiral chromatography, chiral stationary phases. Applications of HPLC. Ion exchange and size exclusion chromatography: Principle, mechanism of separation and applications.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 07.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Readings:

- Principles and Practice of Analytical Chemistry; 5th Edition; F. W. Fifield, D. Kealey; Blackwell Sciences Ltd.; 2000.
- Modern Analytical Chemistry; David Harvey; McGraw-Hill; 2000.
- Chromatographic Methods; 5th edn.; A. Braithwaite and F. J. Smith; Kluwer Academic Publishers.
- Fundamentals of Analytical Chemistry; 6th Indian Reprint; D. A. Skoog and D.M. West; Cenage Learning; 2012.
- Thin layer Chromatography; E. Stahl and George Allen; Unwin Ltd. London.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
1st Semester (Practical)
Subject Code: PGCH

Course Title: Laboratory Course-I **Credits: 4**
Course Code: PGCH-P101 **No. of Contact hours: 120**
Max. Marks: 100 (External=50, Continuous Internal Assessment = 50)
Course Objective:

- To develop laboratory skill in Gravimetric Estimation, Titrimetric methods, Quantitative Analysis, Paper and thin layer chromatographic techniques.
- Use of computers and their applications for their studies.
- Use of various digital platforms to gain knowledge and wisdom
- Use of software related to chemistry.
- Handling of a Refractometer, Polarimeter, and Stalagmometer.

A. Inorganic Chemistry

Experiments: Introduction to good laboratory practices in chemistry.

Gravimetric Estimation

a. Determination of Ba^{2+} as its sulphate/chromate.
b. Estimation of Aluminium (III) as Aluminium oxide.
c. Estimation of Cu^{2+}as cuprous thiocyanate.

Separation and estimation of any one metal from a mixture by gravimetric/ volumetric method:

d. Ba-Cu: Estimation of Ba gravimetrically and Cu volumetrically
e. Ni-Fe: Estimation of both by gravimetric and volumetric method
f. Ag-Ni: Estimation of volumetrically and Ni by gravimetrically.

Precipitation Titrations

a. $AgNO_3$ standardization by Mohr's method.
b. Volhard's method for Cl- determination.

Oxidation-Reduction Titrations (Any four)

a. Determination of oxalic acid and sodium oxalate in a mixture solution.
b. Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_3^{-1} and $C_2O_4^{-2}$ ions.
c. Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum)
d. Standardization of hypo solution with potassium iodate/$K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder, Sb^{3+} and Cu^{2+}.
e. Determination of hydrazine with KIO_3 titration.

Quantitative Analysis:

a. Determination of DO, COD, and BOD of a water sample.
b. To determine the total hardness of water (due to the presence of Ca^{2+} and Mg^{2+} salts)

Paper Chromatography

c. Separate Fe^{3+}, Cu^{2+} and Ni^{2+} Ions Present in the Given Mixture by Using Ascending Paper Chromatography and determine their R_f Values

B. Organic Chemistry

Separation, Purification and identification of Organic compounds from a three-component mixture: (Naphthalene, benzoic acid, p-toluidine).

Column Chromatography:

a. Isolation of Chlorophyll, lycopene and Caretenoid Pigments.

Thin-layer chromatography (TLC)

a. Separation of amino acids, Separation of drugs, and Separation of dyes, etc.
b. Monitoring the progress of chemical reactions, R_f values: identification of unknown organic compounds by comparing the R_f values with known standards.

C. Physical Chemistry

Refractometry

a. Refractive index of given liquids.
b. Refractive index of methyl acetate, ethyl acetate, n-hexane, and carbon tetrachloride and calculate refraction equivalents of carbon, hydrogen, and chlorine atom
c. Determine the composition of an unknown mixture.

Polarimetry

a. Determination of specific and molar rotation of an optically active substance.
b. Determination of the composition of a given solution of an optically active substance.
c. Determine the percentage of two optically active substances (d- sucrose and d- tartaric acid in the given solution Polarimetrically.

Surface-Tension

a. Determine the surface tension of liquids and determine the parachore of the liquid.
b. Study of variation of surface tension of solution with concentration and determination of surface excess.

Suggested Readings:

- Gary, D Christian Analytical Chemistry, 6th Ed.
- Day R.A., Jr. and Underwood, A.L. Quantitative Analysis; 6th edn.
- Johnson, D. Pasto, C. and Miller, M. Experiments and Techniques in Organic Chemistry.
- Williamson, K.L. Microscale and Macroscale Organic Experiments- (D.C. Heath and Co., 1989).
- Vishnoi, N.K. Advanced Practical Organic Chemistry, 2nd ed. - (Vikas, 1999).
- Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, 5th ed.- (ELBS,1996)
- Ahluwalia, V. K. and Aggarwal, Renu Comprehensive Practical Organic Chemistry.
- Vogel A. I., Orient Longman A Text Book of Macro and Semi-micro Quantitative Analysis.
- Bassett J., Denney R. C., Jaffery G. B. and Menaham J., A Vogel's Text Book of Quantitative Inorganic Analysis, Longman, London.
- Levitt, B.P. Findlay's Practical Physical Chemistry, 9th edition, Longman Group Ltd.
- Matthews, G. Peter Experimental Physical Chemistry, 1st edition, Oxford University Press.
- Yadav, Goel, Advanced Practical Physical Chemistry, Pub, 1994.
- Khosla, B.D.; Garg, V.C. Gulati, A. Senior Practical Physical Chemistry, 11th edition, R. Chand and Co., 2002.
- Schoemakeret al., Experiments in Physical Chemistry, 5th ed., MGH, 1989.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
2nd Semester (Core)
Subject Code: PGCH

Course Title: Inorganic Chemistry-II **Credits: 4**
Course Code: PGCH-C201 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To introduce the concept and importance of Bioinorganic chemistry, molecular symmetry and group theory.
Course Outcomes: After the completion of the course students will be able to

- Determine the structure and biological functions of Iron Storage, Transport, and Oxygen carriers
- Know the role of metalloenzymes in biology
- Know the therapeutic usage of metal ions and their salts.
- Understand the concepts to realize point groups within chemical structure, character tables, and projection operator techniques.
- Know the application of symmetry and group theory in spectroscopy.

Unit-I **15 hours**

The transport mechanism: uniport, symport and antiport. Ferritin and Transferrin: Structure, Metal-binding sites; incorporation and release of iron.
Porphyrins: Introduction, characteristic absorption spectrum, and salient characteristics.
Hemoglobin and Myoglobin: Structure, oxygen saturation curves; Mechanism of oxygen transport and storage. Bohr effect and cooperativity in hemoglobin.
Synthetic oxygen carrier model compounds: Vaska's Iridium complex: Cobalt complexes with micro and macrocyclic ligands and Schiff base ligands.
Electron Carriers: Rubredoxin & Ferridoxin (Structure and biological role).
Blue Copper proteins: Oxidases and Plastocyanin (Structure and biological role).

Unit-II **15 hours**

Zinc enzymes:- Carboxypeptadiase and Carbonic Anhydrase- introduction, structure, mechanism of action, and their model compounds.
Xanthine oxidase and Aldehyde oxidase: Structure and biological role.
Cobalt in Vitamin B12: Introduction, structure and derivatives of B12 and mechanism of alkylation reaction. Role of vitamin B12.
Mechanism of metal ion-induced toxicity: Toxicity of Pb, Cd, Hg, As, and CN- Metal ion promoted Carcinogenesis and probable mechanism of action.
Therapeutic Aspects of Chelating Drugs and types chelation Therapy
Treatment of essential metal deficiencies: Iron, Copper and Cobalt. metal salts as anti-acids, antiseptic and diuretics. Gold complexes as anti-arthritis agents.
Anti-Cancer Drugs: cis-Platin and its derivatives. Structure-function relationship.

Unit-III Molecular Symmetry **15 hours**

Molecular Symmetry - Symmetry elements and operations: Identity, rotation axis, reflection plane, inversion center, improper rotation axis. Combination of symmetry operations, Introductory idea to permutation group. Group multiplication tables. Symmetry groups Symmetry
Classification of Molecules: Point groups. Schoenflies notation of point groups. Identification of point groups. Matrices and their combination, block factored matrices, Matrix representation of symmetry operations.

Unit-IV Character Tables and Spectroscopy **15 hours**

The Great Orthoganality Theorm-elementary idea, consequences of the Great Orthogonolity Theorem. Reducible and Irreducible representations (IRs), Mullikan symbols for IRs, Properties of IRs. Character table-construction of character tables for C_2v. Applications of group theory to IR and

Raman spectroscopy. Degrees of freedom/molecular motions-Vibrational motions. Selection rules. Symmetry of IR and Raman active normal vibrational modes of AB_2, AB_3, AB_4, AB_5, and AB_6 type molecules. Applications of symmetry to Molecular Chirality, Polarity and hybridization.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Bertini I.; Gray, H.B.; Lippard, S. J.; Valentine, J.S. Bioinorganic Chemistry, University Science Books.
- Huheey J. E., Keiter, E. A. and Keiter, R. L. Inorganic Chemistry, Principles of structure and reactivity; 4th edn. Pearson Education Inc. 2003
- Bhagi Dr. Ajay and Chatwal, Dr. G.R. Bioinorganic and Supramolecular Chemistry. Himalaya Publisher
- Wilkins C. Patricia and Wilkins, Ralph G. Inorganic Chemistry in Biology; Oxford.
- William L. J. Bioinorganic Chemistry.
- Hussain K. Reddy, Bio inorganic Chemistry; New Age International (P) Ltd; 2005.
- Cotton, F.A. Chemical Applications of Group Theory, 3rd edition, Wiley Inter Science Publication.
- Reddy, K.V. Symmetry and Spectroscopy of Molecules, 1st edition, New Age International (P) Ltd.
- Garg B.S. and Jain V.K. Group Theory and Symmetry in Chemistry

Suggested Essential Readings:

- Bhattacharya P. K.; Metal -Ions in Biochemistry; Narosa Publishing House; 2005.
- Ochai Allyn and Bacon Bio inorganic Chemistry -An introduction; 1977.
- Eichhorn; Elsevier Inorganic Bio-chemistry—Vol. 1&2; 1973.
- Hanzilik, Inorganic Aspects of Biological and Organic Chemistry; Academic; 1976.
- Hughes, The Inorganic Chemistry of Biological processes; 2nd edn. 1973.
- Das Asim K., Text book of Medicinal aspects of Bio inorganic Chemistry; CBS; 1990.
- Frausto de Silva; Williams, The Biological Chemistry of Elements;; Clarenden; 1991.
- Lippard, Berg Principles of Bio inorganic Chemistry; Univ. Science Books; 1994
- Carter L Molecular Symmetry and Group Theory; Wiley; 1998.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
2nd Semester (Core)
Subject Code: PGCH

Course Title: Organic Chemistry-II **Credits: 4**
Course Code: PGCH-C202 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Objective of the Course: To impart insight into stereochemistry, photochemistry, pericyclic, and rearrangement reactions.

Course Outcomes: After the completion of the course students will be able to

- Interpret and predict the energetically favored conformation of cyclic and acyclic compounds, chirality, and reactivity.
- Differentiate between thermally and photochemically driven pericyclic reactions and explain their stereochemical aspects.
- Explore various molecular rearrangements in organic synthesis for the conversion of a different functional group.

Unit-I **15 hours**

Stereochemistry: Chirality, projection formulae, configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, diastereoselectivity, D/L, R/S, E/Z and cis/trans configurational notations, threo and erythro isomers, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis, optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape, conformational analysis of acyclic compounds and cyclic compounds such as cyclopentane, cyclohexane, cyclohexanone derivatives, decalins, 1,2, 1,3-, 1,4-disubstituted cyclohexane derivatives and D-Glucose.

Asymmetric induction: Cram's, Prelog's and Felkin-Ahn model; Dynamic stereochemistry (acyclic and cyclic), Qualitative correlation between conformation and reactivity, Curtin-Hammett Principle.

Unit-II **15 hours**

Photochemistry: Excited states and ground state, singlet and triplet states. forbidden transitions, fate of the excited molecules**:** Jablonski diagram, photosensitization, quantum efficiency, photochemistry of carbonyl compounds, Norrish type-I and type-II cleavages, Photochemistry of alkenes and enones, Paterno-Buchi reaction, Photoreduction, Di π – methane rearrangement. Photochemistry of aromatic compounds, Photo-Fries reactions of anilides, Photo-Fries rearrangement, Barton reaction, Singlet molecular oxygen reactions.

Unit-III **15 hours**

Pericyclic chemistry: Introduction, Phases, nodes and symmetry properties of molecular orbitals in ethylene, 1,3-butadiene, 1,3,5- hexatriene, allyl cation, allyl radical, pentadienyl cation and pentadienyl radical.

Electrocyclic reactions: Conrotation and disrotation, 4n and 4n+2 systems. Woodward-Hoffmann rules. (i) Symmetry properties of HOMO of open chain partner (ii) Conservation of orbital symmetry and correlation diagrams.

Cycloaddition reactions: Suprafacial and antarafacial interactions. $\pi^2 + \pi^2$ and $\pi^4 + \pi^2$ cycloadditions and stereochemicalaspects. Diels-Alder reaction. Woodward-Hoffmann Selection rules. Explanation for the mechanism by (i) Conservation of orbital symmetry and correlation diagrams (ii) FMO theory

Sigmatropic reactions: [1,j] and [i,j] shifts; suprafacial and antarafacial, selection rules for [1, j] shifts; Cope and Claisen rearrangements; explanation for the mechanism by (i) symmetry properties of HOMO (ii) Introduction to cheletropic reactions and the explanation of mechanism by FMO theory.

Unit-IV **15 hours**

Rearrangements: General mechanistic considerations-nature of migration, migratory aptitude, Memory Effects, mechanistic study of the following rearrangements: Pinacol-pinacolone, Wagner-Meerwein, Benzil-Benzillic acid, Favorskii, Neber, Beckmann, Hofmann, Curtius, Lossen, Schmidt, Carroll, Claisen, Cope, Gabriel–Colman, Smiles, Wolf Rearrangements and Sommelet–Hauser rearrangements.

Selective Name Reactions: Ene/Alder-ene reaction, Dakin reaction, Reformatsky, Robinson annulation, Michael addition,Hofmann-Loffler Fretag, Chichibabin reaction.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

1. Eliel, E. L., and Wilen, S. H. Stereochemistry of Organic Compounds. John Wiley and Sons, 2008.
2. Nasipuri, D. Stereochemistry of Organic Compounds, 3rd edition New Age International Publishers.
3. Kalsi, P.S. Stereochemistry of Organic Compounds, 10th edition, New Age International.
4. Carey, F. A., and Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms. Springer Science and Business Media, 2007.
5. Cox, A.; Camp, T. Introductory Photochemistry, McGraw-Hill.
6. Kundall, R.P.; Gilbert, A. Photochemistry, Thomson Nelson.
7. Coxon, J.; Halton, B. Organic Photochemistry, Cambridge University Press
8. Singh, Jagdamba; Singh, Jaya Photochemistry and Pericyclic Reactions, New Age International Publishers.
9. Clayden, J., Greeves, N., Warren, S. and others, P. Organic Chemistry. Oxford University Press, 2012.

c. Hornback Joseph M. Organic Chemistry; Thomson Brooks/Cole, 2005

Suggested for Further Readings:

1. Mukherji, S.M.; Singh, S.P. Reactions Mechanism in Chemistry, Vol. I, II, III, Macmillan
2. Bansal, R. K. A Textbook of Organic Chemistry. New Age International, 2012.
3. Finar, I. L. Textbook of Organic Chemistry. ELBS, Pearson Education UK. 1996.
4. Fleming, I. Pericyclic Reactions. Oxford University Press, 2015.
5. Mc Murry, J. Organic Chemistry, Brooks. Cole, New York, 657, 1996.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
2nd Semester (Core)
Subject Code: PGCH

Course Title: Physical Chemistry-II **Credits: 4**
Course Code: PGCH-C 203 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Objective of the Course: To impart the students' insight into the concept of quantum chemistry in bonding, Chemical Dynamics and Surface Chemistry.

Course Outcomes: After the completion of the course students will be able to

- To discuss the need of various approximation in quantum chemistry for multi electron system
- Understanding the basic approximation methods and their application.
- To discuss the idea of Molecular orbital theory, LCAO-MO approximation and to compare MO and VB treatment of hydrogen molecule.
- To understand the Hückel theory for conjugated systems and apply it to various conjugated molecules.
- To recapitulate the basics of chemical kinetics and discuss different methods for determining rate of reaction.
- To know about Rice-Ramsperger-Kassel (RRK) theory of unimolecular reactions and
- Marcus extention of RRK theory i.e. (RRKM).
- To know about macromolecules and the kinetics of polymerization.
- Explore different surface properties and application of different adsorption isotherms

Unit-I Quantum Chemistry-III **15 hours**

Approximate methods

The Variation theorem, linear variation principle. Perturbation theory -first order (non-degenerate). Application of variation method and perturbation method to helium atom.

Molecular orbital theory, LCAO-MO approximation, H_2^+molecular ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave function, brief introduction to H_2. Valence bond treatment of H_2, comparison of MO and VB methods. Slater determinant, Antisymmetrized wave function.

HMO method and its applications

Huckel's MO theory of conjugated systems; Application to ethylene, butadiene, cyclobutadiene. Calculation of properties- Delocalization energy, electron density, and bond order.

Unit-II Chemical Dynamics –I **15 hours**

Introduction, rates of chemical reactions, Methods of determining rate law, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady-state kinetics, kinetic and thermodynamic control of reactions.

Pyrolysis of acetaldehyde, decomposition of ethane, photochemical and thermal reaction between hydrogen and bromine, thermal reaction between hydrogen and chlorine, oscillatory reactions (Belousov-Zhabotinsky reaction). Homogeneous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method and flash photolysis.

Unit-III Chemical Dynamics – II **15 hours**

Dynamics of molecular motions, dynamics of unimolecular reactions (Lindemann, Hinshelwood, Rice-Ramsperger-Kassel (RRK) and Rice-Ramsperger-Kassel- Marcus(RRKM) theories of unimolecular reactions.

Macromolecules

Polymer: definition, types of polymers, electrically conducting polymers, kinetics of polymerization, mechanism of polymerization.

Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, sedimentation and light scattering methods), chain configuration of macromolecules, and calculation of average dimensions of various chain structures.

Unit-IV Surface Chemistry **15 hours**

Liquid Surface: Surface tension, pressure difference across curved surfaces (Laplace equation), vapor pressure of droplets (Kelvin equation), Capillary condensation.

Thermodynamics of Interfaces: Surface excess, surface tension and thermodynamic parameters, Gibbs adsorption isotherm.

Solid-liquid interface: Contact angle, young's equation, wetting, Wetting as contact angle phenomena.

Solid surfaces: Adsorption at solid surfaces, adsorption models; Langmuir adsorption isotherm, BET adsorption isotherm and its use in estimation of surface area. Adsorption on porous solids.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Atkins, P.W. Physical Chemistry, 3rd edition, ELBS, 1987.
- Chandra, A.K Introductions to Quantum Chemistry, 4th edition, Tata McGraw Hill, 1994.
- A. K. Introduction to Quantum chemistry -, Tata McGraw Hill.
- Levine, Ira. N. Quantum Chemistry -, 7th Edition, Pearson, 2009.
- Prasad, R. K. Quantum Chemistry, 2nd Edition, New Age Publishers, 2001.
- Laidler, Keith J. Chemical Kinetics, 3 edition, Harper & Row, Publishers, New York,
- Steinfeld, J. I., Francisco, J. S. and Hase, W.L., Chemical Kinetics and Dynamics, Prentice Hall.

Suggested Further Readings:

- Adamson, Arthur W. Physical Chemistry of Surfaces, 4th edition, A Wiley-Interscience Publication
- Butt. H. J., Graf, K. Kappl,m M. Physics and Chemistry of Interfaces
- Adamson A. W. and Gast A. P. Physical Chemistry of Surfaces, 6th Edition, John Wiley and Sons.
- Houston Paul L. Chemical Kinetics and Reaction Dynamics, Dover Publications.
- Masel R.I. Chemical Kinetics and Catalysis, , Wiley, 2001
- Arnaut Luis G, Formosinho Sebastiao Jose, Burrows Hugh Chemical Kinetics: From Molecular Structure to Chemical Reactivity, Elsevier, 2007

Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
2nd Semester (Elective)
Subject Code: PGCH

Course Title: Supramolecular Chemistry **Credits: 2**
Course Code: PGCH-E 204 **No. of Contact hours: 30**
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Outcomes: After the completion of the course students will be able to understand the important concepts and application of supramolecular chemistry and crystal engineering.

Unit-I **15 hours**

Supramolecular Chemistry-Definition and Development of Supramolecular Chemistry. History and Genesis of the Nobel Prizes Awarded in the Area. Types and Nature of Supramolecular/Non-Covalent Interactions: Hydrogen Bonding, π-π Interactions, Halogen Bonding, van der Waal Interactions. Quantification of non-covalent interactions through the computational method: Electrostatic Potential Maps, de-di and fingerprint Plots.

Unit –II Crystal Engineering **15 hours**

Definition and Development of Crystal Engineering. Hydrogen bonding: Definition, Nature, and Importance. Classification of Hydrogen Interactions. Identification of Weak, Moderate, and Strong Hydrogen Bonds. Crystal Engineering of organic molecules: Co-crystals and Molecular Salts. Pharmaceutical Co-crystals. Polymorphism. Crystal Engineering of inorganic molecules: Coordination Complexes and Metal-Organic Frameworks (MOFs) Transformation of Molecules into Devices Supramolecular Sensors and Devices-Thermochromism, Solvatochromism and Photophysics. Charge Transfer Complexes. Theory of π-π Stacking. Degree of Charge Transfer. Organic Conductors and Semiconductors. Organic Light-Emitting Diodes (OLEDs) and Transistors. Organic Lasers (Elementary Idea)

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 7.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested readings:

- Introduction to Medicinal Chemistry, Alex Gringauz (Wiley- VCH-1997).
- Medicinal Chemistry- An Introduction, Gareth Thomas (Wiley-2000). 3rd Edition.
- Medicinal Chemistry, Ashutosh Kar. (Wiley Eastern-1993).
- Biochemistry, Biotechonolgy and Clinical Chemistry of Enzmyes. Trevor Palmer (EWP)
- Organic Chemistry by I. L. Finar Vol. II (ELBSLongamnn)
- Lehninger's Principles of Bio-chemistry, D.L. Nelson. M.Cox Worth publications,2000.
- Introduction to nucleic acids and related natural products Ulbight (OldbornPress)
- Chemsitry of Natural Products. S.V. Bhat, B.A. Nagasampagi, M. Siva Kumar. Naroosa

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
2nd Semester (Elective)
Subject Code: PGCH

Course Title: Rotational and Vibrational Spectroscopy Credits: 2
Course Code: PGCH-E 205 No. of Contact hours: 30
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Outcomes: After the completion of the course students will be able to

- Apply microwave, infrared-vibration-rotation Raman, and infra-red Spectroscopy for chemical analysis and prediction of molecular structure
- Demonstrate and apply electronic spectroscopy of different elements and simple molecules.

Unit-I Rotational spectroscopy 15 hours

Rotational spectroscopy of diatomic molecules based on rigid approximation. Determination of bond length and/or atomic masses from microwave data. Effect of isotopic substitution. Non-rigid rotator. Classification of polyatomic molecules. Energy levels and spectra of symmetric top molecules and asymmetric top molecules. First-order Stark effect.

Unit-II 15 hours

Vibrational spectroscopy Normal coordinate analysis of homonuclear and heteronuclear diatomic molecules. Extension to polyatomic linear molecules. Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. Force constants and amplitudes. Anharmonic oscillator. Overtones and combination bands.

Dissociation energies from vibrational data. Vibration-rotation spectra, P, Q and R branches. Breakdown of the Born-Oppenheimer approximation. Nuclear spin effect.

Raman Spectroscopy

Stokes and anti-stokes lines. Polarizability ellipsoids. Rotational and Vibrational Raman spectroscopy. Selection rules. Polarization of Raman lines.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 7.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Windawi, H.; Ho, F.L. Applied Electron Spectroscopy for Chemical Analysis, Wiley Interscience.
- Drago, Russell S. Physical Methods for Chemists, 2nd edition, Saunders College Publishing, 1992.
- Ghosh, P.K. Introduction to Photoelectron Spectroscopy, 1st edition, John Wiley Inter Science, 1982.
- Glusker, J.P. Crystal Structure and Analysis: a Primer, Oxford University Press, 1985.

Suggested Essential Readings:

- Banwell, C.N. Fundamentals of Molecular Spectroscopy, 4th edition, Tata McGraw-Hill Publishing Company Ltd., 1994.
- Hollas J.M. Modern Spectroscopy, John Wiley & Sons, 2004.
- Barrow G.M. Introduction to Molecular Spectroscopy, , McGraw Hill, 1962.
- Chang R. Basic Principles of Spectroscopy, McGraw Hill, N.Y.1970
- Jaffe H.H. and Orchin M. Theory and Applications of UV Spectroscopy.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
2nd Semester (Practical)
Subject Code: PGCH

Course Title: Laboratory Course-II **Credits: 4**
Course Code: PGCH-P 201 **No. of Contact hours: 120**
Max. Marks: 100 (External=50, Continuous Internal Assessment=50)

Course Objective:

- To develop skills in analytical techniques using double-beam UV-Visible Spectrophotometer and other instruments.
- to develop and gain various experimental skills on conductivity meter, potentiometer, pH meter.

A. Spectrophotometry (Any 10)

a. Study the visible region absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$.
b. Verify Lambert-Beer's law, and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration.
c. Study the influence of pH on the spectrum of potassium dichromate solution.
d. Study the effect of structure on the UV spectra of organic compounds.
e. Study the effect of solvent on the UV spectra of organic compounds (propanone).
f. Study the spectra of mesityl oxide/ benzophenone in different solvents and classify the observed transitions in terms of $n\rightarrow\pi^*$ and $\pi\rightarrow\pi^*$ transitions. Discuss the shift in transitions relative to those in acetone.
g. Determine the dissociation constant of phenolphthalein spectrophotometrically.
h. Determine the amount of iron present in a sample using 1, 10-phenathroline.
i. Analysis of Ferrous Iron in a Vitamin Pill.
j. Spectrophotometric determination of lead in leaves using solvent extraction.
k. Ultraviolet spectrophotometric determination of aspirin, phenacetin and caffeine in APC tablet using solvent extraction.
l. IR Spectroscopy for detection of carbonyl functionality in acid, amide, aldehyde, and ketone

B. Viscosity

a. Determine the viscosity of different mixtures of benzene and nitrobenzene, determine the composition of the given mixture and validate the J. Kendall's equation.
b. Determination of molecular weight of high polymer (polystyrene) from viscosity measurements.

C. Phase diagram:

a. To construct the phase diagram for a three-component system (e.g. Chloroform-acetic acid-water, ethanol-benzene-water, & acetic acid-benzene-water).

D. Chemical Kinetics

a. Determine the specific rate constant for the acid catalysed hydrolysis of methyl acetate by the Initial Rate Method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.
b. Compare the strengths of hydrochloric acid and sulphuric acid by studying the rate of hydrolysis of methyl acetate.
c. Study the saponification of ethyl acetate with sodium hydroxide volumetrically.

E. PH meter and Conductivity meter (Any 10):

a. Determine the strength of strong and weak acid and their mixture using pH meter.
b. Determination of degree of hydrolysis of a given salt using pH-metre.
c. Determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of acid.

d. Determination of pKa values of a tribasic acid by titration with an alkali.
e. Determine the acidic and basic dissociation constant of an amino acid and hence isoelectric point of an acid.
f. Determination of H_3PO_4 content in a given sample of Coca-Cola using pH-metre.
g. Determination of the concentration of sulphuric acid, acetic acid and copper sulphate by conductometric titration with sodium hydroxide.
h. Determination of solubility and solubility product of sparingly soluble salts (e.g., $PbSO_4$, $BaSO_4$) conductometrically.
i. Titrate magnesium sulphate against $BaCl_2$ and its reverse titration, conductometrically.
j. Estimate the concentration of each component of a mixture of $AgNO_3$ and HNO_3 by conductometric titration against NaOH.
k. Determine the degree of hydrolysis of aniline hydrochloride conductometrically.
l. To determine the thermodynamic dissociation constant of a weak acid conductometrically.
m. Verification of Ostwald's dilution law and determination of the dissociation constant of a weak monobasic acid conductometrically.
n. To estimate conductometrically the quantities of HCl and NH_4Cl in a given mixture.

E. Potentiometry

a. To determine the standard redox potential and the number of electrons involved in Fe^{+2}/ Fe^{+3}
b. To determine the dissociation constant of diabasic acids oxalic acid or malonic acid.
c. To determine the solubility product of sparingly soluble salts e.g. AgCl, AgBr, and AgI
d. Determine zinc in the presence of calcium by potentiometric titration.

F. Adsorption:

a. Investigate the adsorption of oxalic acid from an aqueous solution by activated charcoal and examine the validity of classical and Langmuir's adsorption isotherm.
b. Determine the adsorption isotherm of acetic acid from aqueous solution by charcoal

Suggested readings:

- James A.M. and Prichard F.E., Practical Physical Chemistry; Longman
- Levitt B.P. Findley's Practical Physical Chemistry, Longman.
- R.C. Das and Behera B. Experimental Physical Chemistry, Tata McGraw Hill.
- Shoemaker Experiments in Physical Chemistry.
- Viswanathan and Raghavan Practical Physical Chemistry.
- James A.M. and Prichard F.E., Practical Physical Chemistry; Longman
- Khosla, B. D., Garg,V. C. and Gulati A., Senior Practical Physical Chemistry: 2018.
- Levitt B.P. Findley's Practical Physical Chemistry, Longman.
- Das R.C. and Behera B. Experimental Physical Chemistry, Tata McGraw Hill.
- Shoemaker Experiments in Physical Chemistry by.
- Viswanathan and Raghavan Practical Physical Chemistry.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Core)
Subject Code: PGCH

Course Title: Inorganic Chemistry-III **Credits: 4**
Course Code: PGCH-C301 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To equip students to understand the various mechanisms operative in inorganic complexes during substitution and in electron transfer reactions. Further, their utility towards realizing newer compounds will be demonstrated. Role of these complexes in catalysis and many bioprocesses will be taught.

Course Outcomes: After the completion of the course students will be able to

- Understand the reaction mechanism, stereochemical changes, and stability of the coordination complexes.
- Understand the bonding in an inorganic cluster, Inorganic polymer, Stereochemistry, and Bonding in Main Group Compounds

Unit-I **15 hours**

Stereochemical Changes in Octahedral Complexes

Outer sphere orientations, reactions of geometrical and optical isomers S_N1 dissociation or S_N2 displacement mechanisms, stereochemistry of the acid and base hydrolysis of Co(III) complexes, optical inversion reactions of some Co(III) complexes.

Isomerization reactions of octahedral complexes, recimerization of octahedral Co(III) complexes, salt and solvent effects, photo racemization

Unit-II **15 hours**

Stereochemical Changes in Square planar Complexes

Mechanism of substitution reactions in square planar complexes, Mechanism of substitution reactions Pt(II) complexes, Factors affecting the reactivity of square planar complexes, Trans effect, Theories of trans effect.

Electron transfer reactions: Mechanism of one electron reaction (outer sphere and inner mechanism), Mechanism of two-electron transfer reaction, complementary and non-complementary reactions.

Unit-III **15 hours**

Bonding in Inorganic Clusters

Empirical rules for bonding in boron clusters- higher boranes, carboranes and metallaboranes. Boranes as ligands, bonding in borazine, cyclophosphazenes, polyphosphazenes, phosphonitrillic halides, polythiazyls and sulphur nitrides.

Inorganic polymers

Introduction, Types of Inorganic Polymers and applications. General properties physical and chemical, conformations and special configurations, interpenetrating network and co-polymers, ultrastructures, applications.

Unit-IV **15 hours**

Stereochemistry and Bonding in Main Group Compounds

VSEPR, Walsh diagram (tri- and penta atomic molecules), dπ-pπ bonds, Bent rule and energetic of hybridization, simple reactions of covalently bonded molecules.

Isopoly and Heteropoly Acids and Salts

Isopolymolybdates, isopolytungstate, isopolyvanadates, heteropoly anions, organo heteropolyanions and Heteropoly blues.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Cotton, F.A.; Wilkinson Advanced Inorganic Chemistry, 6th edition, John Wiley & Sons, 1999.
- Huheey J. ; Keiter E. & Keiter. R Inorganic Chemistry ; 4th edn.; Addison-Wesley 2009
- Basolo F. & Pearson G. Inorganic Reaction Mechanism.
- Edwards J. O. Inorganic Reaction Mechanism
- Langford, H. & Gray, H.B. Ligand Substitution Processes W.A.Benjamin
- Malik, Madan & Tuli Selected Topics in Inorganic Chemistry.

Suggested Further Readings:

- Katakis, D. & Gordon, G. Mechanism of Inorganic Reactions John Wiley & Sons: N.Y. 1987.
- Twigg Mechanisms of Inorganic and Organo metallic reactions; Plenum press 1983.
- Jordan R. B Reaction Mechanism of Inorganic and Organometallic systems; 3rd edn., Oxford University Press 2007.
- Brain W. Pfennig Principles of Inorganic Chemistry; 1st edn.; Wiley; 2015
- Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, 1st edition, Oxford University Press, 2006.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Core)
Subject Code: PGCH

Course Title: Organic Chemistry-III **Credits: 4**
Course Code: PGCH-C302 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To provide knowledge of Metal and non-metal mediated oxidation & reduction and designing of an organic reaction.
Course Outcomes: After the completion of the course students will be able to

- Explore various oxidizing and reducing reagents logically for their application in functional group conversion in organic synthesis.
- Identify various retrosynthetic strategies and design the synthesis of target molecules.

Unit-I **15 hours**

Metal and non-metal mediated oxidation: Mechanism, selectivity, stereochemistry and applications of oxidation reactions, Baeyer-Villiger, Oppenauer oxidation, oxidation reactions using DDQ, NBS, Pb(OAc)4, Selenium dioxide, PCC, PDC, Cr and Mn-based reagents, phase transfer catalysis, Periodic acid, Ceric ammonium nitrate, OsO4, Swern oxidation, hydroboration, Sharpless asymmetric epoxidation, epoxidations using peracids. Recent approaches for oxidation using green oxidants.
Reagents in Organic Synthesis and functional group transformations: complex metal hydrides, Gilman's reagent (Lithium dimethyl cuprate), lithium di-isopropyl amide (LDSA), dicyclohexyl carbodiimide (DCC).

Unit-II **15 hours**

Metal and non-metal mediated reduction: Mechanism, selectivity, stereochemistry and applications of catalytic hydrogenations using Pd, Pt and Ni catalysts (Lindlar, Rosenmund, Adam's catalysts), Wilkinson's catalysis, Clemmensen reduction, Wolff-Kishner reduction, Meerwein-Pondorff-Verley reduction, dissolving metal reductions, Birch reduction, Reductions using metal hydride $NaBH_4$, Luche reduction $NaBH_3CN$, L-selectride, K-selectride, $NaBH(OAc)_3$, $LiAlH_4$, DIBAL.
Applications of Pd(0) and Pd(II) complexes in organic synthesis- Stille, Suzuki, and Sonogashira coupling, Heck reaction, and Negishi Coupling.

Unit III **15 hours**

Protection of functional groups: Principle of protection of functional groups and its significance. Protection of carbon-hydrogen bonds (in terminal alkynes and Carbon- hydrogen bond of aldehydes), carbon-carbon double bonds, alcoholic and Phenolic hydroxyl groups, amino groups, carbonyl and carboxyl groups.
Functional Group Interconversion (FGI) / Transformations: Significance of Functional Group Interconversion (FGI) / Transformations in Organic synthesis. Methods of transformation of different functional groups into one another. Chemoselectivity. Recent advances in protection-deprotection free organic synthesis

Unit-IV **15 hours**

Designing Organic Synthesis: The disconnection approach: Introduction to synthons, their types and equivalent reagents. Reversal of Polarity(umpolung). One group, two groups and Reteroelectrocyclic disconnections. Retrosynthetic Analysis involving connections and rearrangements. Guidelines for good disconnections. One group disconnections: Retrosynthetic analysis of alcohols, amines (aliphatic and aromatic), alkenes, carbonyl compounds, carboxylic acids

and their derivatives using one group disconnections and FGIs. Use of acetylenes in the syntheses of above-mentioned compounds

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings

- March, Jerry Advanced Organic Chemistry: Reactions, Mechanism and Structure, 6th edition, John Wiley, 2007.
- Warren S. Designing Organic Synthesis; Wiley; 2013.
- Norman R. O. C. Principles of Organic Synthesis 2nd edn;.; Chapman and Hall; 1978.
- Carey F. A. and Sundberg R.J Advanced Organic Chemistry Part B, 5th edn.; Springer; 2007.
- Clayden, Greeves, Warren and Wothers, Organic Chemistry; Oxford University Press-2012.

Suggested Further Readings

- Reagent Guide, Synthetic Organic Chemistry, & Materials Chemistry, 8th Edition.
- Carruthers W. and Coldham Iain, Modern Methods of Organic Synthesis, 4th edition.
- Gupta S, Gupta V and Dhundal R.S, A Guide to Reagents in Organic Synthesis., , 1st edition 2015.
- Tsuji Jiro Transition Metal Reagents and Catalysts: Innovations in Organic Synthesis, by, published: 17 July 2002.
- Singh Jagdamba, Yadav L.D.S Organic Synthesis, , 1st Edition, 2006
- Solomons T. W. G. and Craig B., Fryhle Organic Chemistry, 10th edn;. ; Wiley-2012.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Core)
Subject Code: PGCH

Course Title: Physical Chemistry-III **Credits: 4**
Course Code: PGCH-C303 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To impart fundamental and advance knowledge of thermodynamics and electrochemistry

Course Outcomes: After the completion of the course students will be able to

- Recapitulation of thermodynamic laws, concept of Partial molar quantities, chemical potential and Gibbs-Duhem equation and its variation with temperature and pressure.
- Concept of distribution, thermodynamic probability and most probable distribution, ensemble average and postulate of equal-a-priori probability
- To discuss the idea of Partition function & its significance. Translational, rotational, vibrational and electronic partition functions.
- Relation between partition function and thermodynamic functions
- To discuss Debye-Hückel theory of ion-ion interaction and activity coefficient, its applicability, limitations and its modification for finite-sized ions
- Able to derive D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment) and its modifications for ion-pair formation.
- To understand the Concept of electrical double layer and its structure.
- To know about Helmholtz-Perrin, Gouy-Chapman, and Stern models

Unit-I Chemical Thermodynamics **15 hours**

Maxwell Relations and thermodynamic equations of state.

Thermodynamics of multicomponent systems: Partial Molar properties, Partial molar free energy: concept Chemical Potential, Chemical potential variation with Temperature and Pressure, Determination of chemical potential, Applications of chemical potential (Henry's law, Raoult's law, and Nernst distribution law), Chemical potential and Gibbs-Duhem equation, Gibbs-Duhem-Margules equation and its application (Konovalov's First and second laws). Thermodynamics of nonideal systems – fugacity and activity concepts, excess properties.

Unit-II Statistical Thermodynamics **15 hours**

Concepts of statistical thermodynamics, entropy and probability, ensembles, distribution laws of MB, FD and BE, partition functions and statistical formulation of macroscopic variables. Use of statistical thermodynamics including calculation of electrical and magnetic properties, and heat capacity of solids, application of BE statistics to helium.

Unit-III Electrochemistry-I **15 hours**

Debye-Huckel limiting law, Debye-Huckel-Onsagar treatment and its extension. Debye- Huckel-Jerum mode, Thermodynamics of electrified interfaces. Lippman equation, Method of determination of surface excess, Structure of electrified interfaces: Helmholtz-Perrin, Guoy-Chapman, Stern models. Over potential, exchange current density, derivation of Butler-Volmer equation, Tafel plot.

Unit-IV Electrochemistry-II **15 hours**

Semiconductor interfaces-theory of double layer at semi-conductor electrolyte solution interfaces. Electrocatalysis. Bioelectrochemistry, threshold membrane phenomena, Nernst-Planck equation, electrocardiography. Polarography theory, Ilkovic equation; half-wave potential and its significance. Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention methods.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Atkins P.W. Physical Chemistry, ELBS.
- Rastogi R. P. and Mishra R. R. An Introduction to Chemical Thermodynamics, Vikas Publishing House Pvt. Ltd.
- Gupta M. C. Statistical Thermodynamics Publisher: New Age International.
- Rajaram J. and Kuriacose J. C. Thermodynamics, Educational Publishers
- Srivastava R. C., Saha S. K., Jain A. K. Thermodynamics, , Prentice Hall of India, Pvt. Ltd.
- Landau L. D. and Lifshitz E. M. Statistical Physics (Part) Course of Theoretical Physics, Vol. 5, Pergamon Press London.
- Engel T. and Reid P. Physical Chemistry, Pearson Education and Dorling Kindersley (India) 2006.
- Bockris J.O.M. and Reddy A.K.N. Modern Electrochemistry Vol. 1, Vol. 2A and Vol. 2B, Plenum.
- Hamann C. H., Hammett A. Electrochemistry, 2nd Edition, Wolf Vielstich, Wiley-VCH.
- Turro, N. J. Modern Molecular Photochemistry Univ. Science Books, 1991.
- Gilbert, A. & Baggot, J. Essentials of Molecular Photochemistry Blackwell Scientific 1990.
- McQuarrie, D. A. & Simon, J. D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books, 2001.

Suggested Further Readings:

- McQuarrie Donald A. Statistical Mechanics, Viva Books Pvt. Ltd. New Delhi, 2003
- Nash Leonard K. Elements of Statistical Thermodynamics (2nd Edition), Addison Wesley, 1974.
- Horia Metiu Physical Chemistry, Statistical Mechanics, Taylor & Francis, 2006
- McClelland B.J. Statistical Thermodynamics, , Chapman and Hall & Science Paperbacks, London

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Practical)
Subject Code: PGCH

Course Title: Laboratory Course-III **Credits: 4**
Course Code: PGCH-P301 **No. of Contact hours: 120**
Max. Marks: 100 (External=50, Continuous Internal Assessment=50)

Course Objective: To acquire knowledge of laboratory techniques for organic synthesis and characterization

A. Organic Chemistry

One-step preparation of organic compounds and study of principle, general reaction mechanism, mole ratio calculation, purification, M.P/B.P, and characterization by UV-Visible Spectroscopy and FTIR. (Any six)

1. Nitration
a) m-dinitro benzene from nitro benzene and b) p-Nitro acetanilide from Acetanilide
2. Bromination
a) p-bromoacetanilide and b) 2,4,6-tribromo aniline
3. Acylation
a) Acetanilide from aniline and b) Resacetophenone from resorcinol
4. Reduction
a) Preparation of m-nitroaniline from m-dinitro benzene
b) Preparation of m-phenylenediamine from m-dinitrobenzene
c) Reduction of benzophenone to benzhydral using $NaBH_4$.
5. Oxidation
a) Preparation of benzoic acid from benzaldehyde
b) Preparation of p-nitrobenzoic acid from p-nitro toluene
6. Condensation reaction
a) Preparation of dibenzal acetone from benzaldehyde
b) Preparation of 7-hydroxy 4-methylcoumarin
c) Synthesis of chalcones *via* Claisen-Schmidt condensation.
d) Conversion of benzaldehyde to cinnamic acid (Knoevenagel condensation)
e) Conversion of benzaldehyde to dibenzylidene acetone (Aldol condensation)
7. Diazotization reaction
a) Preparation methyl orange
b) Preparation of methyl red
8. Friedel-Craft's reaction
a) 4-methyl benzophenone (Friedal Craft reaction)
b) Preparation of aspirin

B. Inorganic Chemistry

Inorganic Synthesis and characterization (Any Six):
a. Preparation of Chloropentaammine Cobalt(III) Chloride and its IR measurements.
b. Preparation of $[Co(en)_2Cl_2]Cl$, $Na_2[Fe(CN)_5 NH_3]$. H_2O, $Cu_2(CH_3COO)_4(H_2O)_2$.
c. Preparation of $Hg[Co(CNS)_4]$.
d. Preparation of cis-and trans-$K[Cr(C_2O_4)_2 (H_2O)_2$ and its IR study.
e. Preparation of cis and trans-dichloro bis(ethylenediamine) Cobalt(III) chloride. Study of both the complexes with the help of infrared and UV-Vis Spectroscopy.
f. Preparation of lead tetraacetate.
h. Preparation and separation of isomers of $K_3[Fe(C_2O_4)_3]$, Cu(II) and Ni(II) complexes of Schiff base.

C. Physical Chemistry

Flame Photometry:

a. Estimation of sodium and potassium soil samples.
b. Estimation of sodium and potassium in water samples.

Cryoscopy:

a. Determination of molecular weight of non-volatile substance by cryoscopic method using water as solvent.
b. Determination of molecular weight a substance by cryoscopic method using benzene as the solvent.

Suggested Readings

- Vogel A. I. A text book of practical organic chemistry
- Mann and Saunders– Practical organic Chemistry
- Tatchell A.R. Vogel's Textbook of Practical Organic Chemistry, , John Wiley.
- Pasto D., Johnson C. and Miller M. Experiments and techniques in Organic Chemistry, Prentice Hall.
- Williamson K.L., Heath D.C. Macroscale and Microscale Organic Experiments,

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Elective)
Subject Code: PGCH

Course Title: Chemistry in Everyday Life **Credits: 2**
Course Code: PGCH-E304 **No. of Contact hours: 30**
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Objective: To help the students gain insight about importance of Chemistry in everyday life.
Course Outcomes: After the completion of the course students will be able to

- Understand the chemical composition of various items used in everyday life.
- Understand the importance of chemistry in everyday life.

UNIT-I **15 hours**

(a) Water an Amazing Chemical Stuff: Molecular structure and its unique properties. Composition of natural water. Hard and Soft water. Standards for drinking water.

(b) Household Chemicals Chemistry of Soaps, Detergents, Optical Brighteners and Bleaching agents, Shampoos, Conditioners, Dyes, Hair Curling and Permanents, Deodorants and Antiperspirants, Perfumes, Tooth Pastes and Sunscreen Lotions. Disinfectant, Insecticides and pesticides, Chemical treatment of vegetables and fruits.

Unit-II **15 hours**

Common chemical processes

Chemistry of photosynthesis, Rusting, Electrochemical cells, Metal electroplating, Use of polymers in daily life, Polymer based products, Teflon, Polystyrene, Plastic bags, ATM cards.

Chemistry of small bioactive molecules

Caffeine, Nicotine, Paracetamol, Aspirin, Carbohydrates, Abused substances like morphine, Cannabis, Cocaine etc.

Oil & Natural Gases Composition & Chemical structures of Petroleum Products. Refining of Petroleum, Cracking & Catalytic Reforming. Octane & Cetane rating of fuels. Diesel engine fuel, Kerosene and Gasoline. Lead in Petrol: Its role, disadvantages & alternatives. LPG & CNG as fuel. Addition of mercaptans to Natural gases for safety reasons.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 7.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested readings:

- Principles of Modern Chemistry; 2nd edn; Oxtoby and Nachtrieb; Saunders College Publications; 1987.
- Chemistry Fundamentals an Environmental Prospective; 2nd edn; Buell and Girad; Jones and Barlett; 2013.
- www.chemistryincontext; (American Chemical Society)
- Colin, B., Environmental Chemistry, W.H. Freeman and Company, New York (1995).
- Singh, K.; Chemistry in Daily Life, PHI learning, 3rd edition India
- Glasstone, S.; Chemistry in Daily Life, Cornell University, Methuen & Company Limited, 1929
- Cohan, L.; Chemistry in Daily Life; Popular Lectures, HardPress, 2012
- Anastas, P.T.; Warner J. C. (2000). Green chemistry, Theory and Practical. Oxford University Press, 1st edition, US.
- Grieco, P.A. (1997). Organic Synthesis in Water. Blackie, 1st edition

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Elective)
Subject Code: PGCH

Course Title: Bioorganic Chemistry **Credits: 2**
Course Code: PGCH-E 305 **No. of Contact hours: 30**
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Outcomes: After the completion of the course students will be able to

- Understand the chemical origin of biology with some examples.
- Determine the structure and biological functions of enzymes and co-enzymes.

Unit-I **15 hours**

(a) Bio-organic chemistry: Introduction, Proximity effects in Organic Chemistry, Molecular rearrangements. Pre-Biotic Chemistry: Role of HCN and HCHO in biosynthesis, Nucleophiles, and Electrophiles in a solution of HCN, Formation of Purines and Pyrimidines from HCN under prebiotic conditions. Carbohydrates from Aldol reaction with HCHO, Formation of Amino acids under prebiotic conditions.

(b) Enzymes: Types of specificity, The active sites; The Fischer 'lock and key 'hypothesis, The Koshland 'induced fit' hypothesis, Hypothesis involving strain or transition state stabilization. Enzyme Inhibition: Introduction, Competitive inhibition, Uncompetitive inhibition, Non-competitive, Allosteric inhibition.

Unit-II **15 hours**

Coenzymes: Introduction, Nicotinamide Nucleotides (NAD^+ and NADP+), Flavin Nucleotides (FMN and FAD), Adenosine phosphate (ATP, ADP, AMP). Coenzyme A (CoA -SH), Thiamine Phosphate, Biotin, Tetrahydrofolate, Coenzyme B_{12}.

Biosynthesis of Natural Molecules Biosynthesis of Fatty Acids and Triglycerides, Biosynthetic Pathway of Terpenoids and Steroids, Inhibitors of Terpene biosynthesis, Biosynthesis of Flavonoids.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 7.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested readings

1. Introduction to Bioorganic Chemistry and chemical biology. D. V. Vranket and Gregary Weiss; Taylor and francis. 2013.
2. Bio-organic chemistry : Harman Dugas 3rd ed.Springer (2010) .
3. Bio-organic chemistry J.Rohr ,Springer (2000).
4. Enzymes 2nd ed. T. Palmer and P. Bonner (2008).
5. Biochemistry :DonaldVoet, Judith.G. Voet 2nded.Willey (1995)

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
3rd Semester (Elective)
Subject Code: PGCH

Course Title: Biophysical Chemistry **Credits: 2**
Course Code: PGCH-E 306 **No. of Contact hours: 30**
Max. Marks: 50 (External=35, Continuous Internal Assessment=15)

Course Outcomes: After the completion of the course students will be able to

- Determine the factors that govern the thermodynamic of living systems
- Work on the kinetics, thermodynamics, and mechanism of biochemical reactions.

Unit-I **15 hours**

Biophysical Chemistry-I: Review of the basic concepts of Thermodynamics, Thermodynamics of living systems, Biochemists standard state, standard free energy changes in biochemical reactions, ATP as energy currency of cell, Principles of coupled reactions. Nernst equation,
Standard potentials: Thermodynamic standard potentials, variation of potential with pH, the biological standard potential, converting standard potential to a biological standard value. Electron transfer in bioenergetics; Electron transfer reactions, oxidative phosphorylation.

Unit-II **15 hours**

Biophysical Chemistry-II: Biological membranes, structure, and functions of cell membrane, molecular motion across membranes, ion transport through cell membrane, Mechanism of Membrane Transport: Transport through cell membrane, active and passive transport systems. Irreversible thermodynamic treatment of membrane transport. Semipermeable membrane and Donnan membrane equilibrium, Donnan effect in Osmosis, its dependence on pH difference across the membrane. Membrane potential, Classical theory of membrane potentials; Nernst Equation, Nernst Planck equation, permeability of membranes, Goldman-Hodgkin Katz model, Goldman equation, Nerve conduction; Action potential, factors affecting speed of action potential propagation, Nerve impulse and cardiovascular problems, Mechanism of vision. An introduction to bio-electroanalysis.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with two sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 7.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be four questions of which one will have to attempt two, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt three questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested readings

- Physical Chemistry for the Biosciences, Raymond Chang, University Science Books, 2005.
- Physical Chemistry for the Life Sciences, 2nd Edition, Peter Atkins, Julio de Paula, Oxford University Press 2015.
- Biophysical Chemistry Part III: The behaviour of biological macromolecules, Charles R. Cantor and Paul R. Schimmel, W. H. Freeman and Company, New York, 2002.
- Fundamentals of Biochemistry, D. Voet, J. G. Voet, C. W. Pralt, Wiley, 1999.
- Lehninger Principles of Biochemistry, 7th Edition, Albert L. Lehninger, D. L. Nelson, N. M. Cox. W.H.Freeman& Co Ltd

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Organometallic Chemistry **Credits: 4**
Course Code: PGCH-C401 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To give the students insight into organometallic compounds.
Course Outcomes: After the completion of the course students will be able to Understand the

- chemistry of sigma and pi bonded organometallic complexes and compounds of transition metal-carbon multiple bonds
- Chemistry on alkyls and aryls of transition metals and fluxional organometallic compounds
- Chemistry of Catalytic Processes involving Transition Metal Organometallic Compounds

Unit-I Sigma Bonded Organometallic Compounds **15 hours**

Classification, Stability, Comparison to main Organometallic Compounds, Routes of synthesis, Reactions. Decomposition Pathways: Choice, α and β hydrogen transfer. Intramolecular elimination of alkane, Cyclometallation, Stability from bulky substituents, Agostic alkyls, Umpolung. Metal Hydride Complexes: Synthesis, Characterization and Chemical reactions, Non-classical Hydrides (Kubas complexes).

Unit-II Pi-bonded Organometallic Compounds **15 hours**

Classification, Structure and bonding in Metal- alkene, alkyne, allyl, 1,3-butadiene and Cyclobutadiene Complexes. Sandwich Compounds: Characteristics; Classification, Synthesis, Reactions, Structure and bonding of Ferrocene. Compounds with Transition Metal to Carbon multiple bonds: Alkylidene (Schrock and Fischer) Synthesis; Structural characteristics; Nature of bonding. Reactions and their
synthetic applications.

Unit-III Transition Metal Organometallic Compounds as catalyst **15 hours**

Mechanistic aspects: Oxidative addition, Insertion reactions Reductive elimination and water gas shift reaction (WGSR). Catalytic mechanism of Hydrogenation, Hydroformylation, Oxidation and Isomerization of alkenes; Olefin metathesis. Fischer-Tropsch Synthesis and Ziegler Natta polymerization of alkenes. Asymmetric and supported Organometallic Catalysis (brief idea).

Unit-IV Fluxional Organometallic Compounds **15 hours**

Fluxional Organometallic Compounds and Synthetic Reactions involving Organo- Fluxional Organometallic Compounds: Characteristics; Rates of rearrangement and Techniques of study. NMR study of Fluxional behavior, Classification of Fluxional Organometallic Compounds. Mechanism of Fluxionality in compounds of η1 Cyclopentadienyls and η3–allyls. Stereochemical nonrigidity in case of coordination numbers- 4 & 5 (cis-trans, atomic inversion, Berry Pseudorotation).
Synthetic Reactions involving Organometallics: Reactions of coordinated ligands, carbon monoxide, alkyls, alkenes (Green, Mingo's rules). Activation of small molecules: Carbon monoxide, Carbon dioxide and Alkanes. Role of organo-iron as synthons, Carbon-Carbon coupling and its reactions (Suzuki and Heck).

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

***Section – B**: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Crabtree R.. H, The Organometallic Chemistry of Transition Metals; 6th edn;; Wiley; 2014.
- Lukehart C. M.; Fundamental Transition Metal Organometallic Chemistry; Brooks / Cole; 1985.
- Mehrotra & Singh Organometallic Chemistry; 2nd edn ; New age international 2007
- Collman & Finke Principles and Applications of Organotransition Metal Chemistry
- Powel P. Principles of Organometallic Chemistry; 2nd edn.; Chapman & Hall; 1998.
- Pearson A.J. Metallo-Organic Chemistry; Wiley.
- Twigg, Mechanisms of Inorganic and Organo metallic reactions;; Plenum press 1983.
- Jordan R. .B. Reaction Mechanism of Inorganic and Organometallic systems; 3rd edn.
- Huheey J., Keiter E. & Keiter R. Inorganic Chemistry ; 4th edn.;; Addison-Wesley ;2009

Suggested Essential Readings:

- Jolly A. Modern Inorganic Chemistry; William.; 2nd edn. McGraw Hill; 1991.
- Pfennig Brain W. Principles of Inorganic Chemistry; 1st edn.; Wiley; 2015

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Selected Topics in Inorganic Chemistry-I **Credits: 4**
Course Code: PGCH-E402 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To impart advanced knowledge on the Chemistry of Non-aqueous Solvents, periodicity, Inorganic Photochemistry and Electron Transfer in Excited Metal Complexes.
Course Outcomes: After the completion of the course students will be able to

- Understand non-aqueous solvent
- Know some advanced concepts about the chemistry of main group elements, periodicity
- Know basics of Inorganic photochemistry and its application as Photochemical supra-molecular devices
- The characterization of transient intermediates by ultrafast modern techniques.

Unit-I Chemistry of Non-Aqueous Solvents **15 hours**
Introduction to non-aqueous solvents, Protonic solvents: ammonia, solutions of metals in ammonia, sulphuric acid, hydrogen fluoride Aprotonic solvents, molten salts, room-temperature molten salts, solutions of metals in molten salts, solid acid and base catalyst, electrode potentials and electromotive forces, electrochemistry in nonaqueous solutions.

Unit-II Chemistry of the main group elements: Periodicity **15 hours**
Fundamental trends, First and second-row anomalies, size effect in nonmetals, the diagonal relationship, the use of p orbitals in pi bonding, carbon-silicon similarities and contrast, nitrogen-phosphorus analogies and contrast, Ppi-Ppi bonding in heavier nonmetals, the use (or not) of d orbitals by nonmetals, dpi-Ppi bonding: the phosphorus-oxygen bond in phosphoryl compounds, reactivity, and d orbital participation, periodic anomalies of the nonmetal and posttransition metals, relativistic effects,

Unit-III Inorganic Photochemistry; the basics **15 hours**
A. Excited states: Excitation: d-d transition, charge transfer & intra-ligand transitions and selection rules. Excited states; term symbols, splitting of terms in ligand field, Orgel diagram; electrostatic description of spin allowed d-d transitions & energy level diagrams depicting excited states.
Fate of excited states; energy dissipation by radiative and non-radiative processes. Jablonoski diagram. Molar integrated absorption intensity, natural radiative lifetime & the calculation of lifetimes.
B. Kinetics: Photochemical laws & quantum yield. Kinetics & quantum yield of photo-physical (radiative) and photochemical processes. Quantum Yields of a unimolecular and bimolecular photochemical reaction; Quenching and Stern-Volmer plots.
C. Tools and Technique: Chemical Actinometry. Time-Resolved Spectroscopies: Time correlated Single-photon counting technique Time-Resolved Transient Absorption Spectroscopies: Flash Photolysis

Unit-IV Electron Transfer in Excited Metal Complexes **15 hours**
A. Marcus-Hush Model: Energy transfer under conditions of weak and strong interaction. Excited state electron transfer. Conditions of the excited states to be useful as redox reactants. Photochemical electron transfer, $[Ru(bipy)_3]^{2+}$; Structure, excited state properties and photochemistry as sensitizers
B. Inorganic Photochemistry in practice: Applications, Prospects and Challenges Solar energy storage and conversion. Photovoltaic Solar cells, Perovskite Solar cells, Dye-sensitized and quantum dot sensitized solar cells. Metal oxide semiconductor-based photo-splitting of water.

Photochemical supra-molecular devices: devices for photo-induced energy or electron transfer, Devices for information processing, photo-chemically driven molecular machines Supramolecular photochemistry in natural systems: photosynthesis, bacterial photosynthesis, and artificial photosynthesis

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Huheey, James E. Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Harper Collins College Publishers, 1993.
- Robert. H. Crabtree; The Organometallic Chemistry of Transition Metals; 2nd and 4th edn; Wiley;
- Lukehart Charles M. Fundamental Transition Metal Organometallic Chemistry; Brooks / Cole;1985.
- Wayne Carol J. and Wayne Richard P. Photochemistry; Oxford University Press; 1996.
- Mehrotra & Singh Organometallic Chemistry; 2nd edn; ; New age international 2000.
- Collman & Finke Principles and Applications of Organo Transition Metal Chemistry; University Science Books;1994.
- Rohatgi C, Mukhergi Fundamentals of Photochemistry; Wiley Eastern.; 1992

Suggested Further Readings:

- Powel P. Principles of Organometallic Chemistry; 2nd edn.;; Chapman & Hall;1998.
- Pearson A.J. Metallo-Organic Chemistry;Wiley.
- Twigg Mechanisms of Inorganic and Organo metallic reactions;; Plenum press1983.
- Jordan Robert Reaction Mechanism of Inorganic and Organometallic systems; 2nd edn.; 1998.
- Modern Inorganic Chemistry; McGraw Hill; 1985.
- Jolly W. A. Chemistry of Light; Suppan, Royal Society; 1994.
- Sutin, N. & Creutz, C. J.Chem Edu Inorganic Photochemistry;Vol .60, No.10,1983.
- Russell, H. S.& Kirk S. S., J. Chem. Edu Applications of Inorganic Photochemistry;.; Vol.74, No 69. 1997.
- Wardle B., Principles and applications of Photochemistry, Wiley 2009

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Chemistry of Material **Credits: 4**
Course Code: PGCH-E403 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Outcome: The students will able to learn

- Inorganic, organic and mixed materials
- Characterization of these materials
- The relationship between material structure and physical attributes associated with them.

Unit I **15 Hours**

Magnetic Materials (Ferrites) Introduction, structure and classification, hard and soft ferrites, synthesis of ferrites by various methods (precursor and combustion method), characterization of ferrites by Mossbauer spectroscopy, significance of hysteresis loop and saturation magnetization in ferrites, magnetic properties of ferrites, applications of ferrites.

Glasses, Ceramics, Composites and Nanomaterials: Glassy state, glass formers and glass modifiers, applications. ceramic structures, mechanical properties, clay products. microscopic composites; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites, nanocrystalline phase, preparation procedures, special properties, applications.

Unit II **15 Hours**

Mesmorphic behaviour, thermotropic liquid crystals, positional order,bondorientational order, nematic and smecticmesophases; smectic - nematic transition and clearing temperature -homeotropic, planar and sCHMieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystals. dielectric susceptibility and dielectric constants. lyotropic phases and their description of ordering in liquid crystals.

Thin Films and Langmuir- Blodgett Films

Prepartion techniques; evaporation/sputtering, chemical process, sol gel etc. Langmuir – Blodgett (LB) films, growth technique, photolithography, properties and applications of thin and LB films

Materials for Solid State Devices

Rectifiers, transistors, capacitors –IV-V compounds, low–dimensional quantum structure; opticalproperties.

Unit III **15 Hours**

Types of ionic conductors, mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors; phase transitions and mechanism of conduction in superionic conductors, examples and applications of ionic conductors.

Molecular Conductor: Oligo(phenylenevinylene)s, oligo(phenyleneethynylene)s, oligo (eneyne)s, oligo(thiophenevinylene), oligo (thipheneethynylene) etc. and their applications.

Preparation and characterization of silica and zirconia based stationary phases by (a) dynamic chemical modification, in which chiral selector is adsorbed on the surface of the zirconia by physical forces, (b) permanent chemical modification, in which a CS is chemically bonded onto the zirconia surface, and (c) physical screening, in which zirconia surface is coated with a polymer or carbon layer, and their application in chiral separations by LC

Unit IV **15 Hours**

Fullerenes, Carbon Nanotubes and Graphene: Types and Properties, methods ofpreparation and separation of carbon nanotubes, applications of fullerenes, CNTs and graphene.

Nonlinear optical materials: Non-linear optical effects, second and third order – molecularhyperpolarisability and second order electric suspceptibility – materials for second and third harmonic generation.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Readings

- Ashcroft, N. W., andMermin, N. D. (1976*). Introduction to Solid State Physics*. Saunders.
- Callister Jr, W. D., andRethwisch, D. G. (2012). *Fundamentals of Materials Science and Engineering: An Integrated Approach*. John Wiley and Sons.
- Anderson, J. C., Leaver, K. D., Rawlings, R. D., andLeevers, P. S. (2004). *Materials Science for Engineers*. CRC Press.
- Keer, H. V. (1993). *Principles of the Solid State*. New Age International.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Selected Topics in Inorganic Chemistry-II **Credits: 4**
Course Code: PGCH-E404 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To give students insight into advance concept into inorganic materials.
Course Outcomes: After the completion of the course students will be able to

- Understand the concept of functional inorganic materials, method of synthesis, properties and applications
- use various analytical techniques to analyze and understand the structure of functional materials
- understand the concept and applications of inorganic nanomaterials

Unit-I Functional Inorganic Materials-I **15 Hours**

Introduction to functional materials, Synthesis of solid functional materials (single crystals, polycrystalline powders, thin/thick films, fibers, amorphous and porous materials). Fundamentals of nucleation of crystals and growth mechanisms

Solid-state reactions: ceramic method, carbothermal reduction, combustion synthesis, sintering, solid-gas reactions.

Synthesis of solids from the gas phase: Chemical Vapor Transport, Chemical Vapor Deposition, Physical Vapor Deposition (sputtering, thermal evaporation, vapor phase epitaxy, Chemical Vapor Infiltration), aereosol processes.

Homogeneous and heterogeneous nucleation of crystals. Structure of crystal surfaces and growth mechanisms. Dependence of crystal morphology on growth parameters.

Sol-gel processes with alkoxysilanes. Synthesis of porous materials: hybrid organic-inorganic materials (polysiloxanes, polysilsesquioxanes)). Micro-, meso-, macroporisity. Ordered porosity by templating agents: synthesis of zeolites and mesoporous silica

Unit-II Functional Inorganic Materials-II **15 Hours**

Defects and ion transport: extended defect, atom and ion diffusion, solid electrolytes

Metal oxides, nitrides, and fluorides: monoxide of the 3d metals, higher oxides and complex oxides, Nitrides and fluorides

Inorganic pigments: coloured solids, white and black pigments

Hydrides and hydrogen storage materials: metal hydrides, other inorganic hydrogen storage materials

Unit-III Physical techniques in inorganic chemistry **15 Hours**

Diffraction Methods: X-ray diffraction, Neutron diffraction

Resonance techniques: NMR, EPR, Mossbauer

Ionization based techniques: Photoelectron spectroscopy, X-ray absorption spectroscopy, Mass spectroscopy

Chemical analysis: Atomic absorption spectroscopy, CHN analysis, Thermal analysis (TGA and DSC)

Unit-IV Inorganic nanomaterials **15 Hours**

General introduction to nanomaterials. Metals and alloys-Synthesis of nanoparticles of gold, silver, rhodium, palladium and platinum. Metal oxides of transition and nontransition elements-SiO_2, TiO_2, ZnO, Al_2O_3, iron oxides and mixed metal oxide nanomaterials. Non-oxide inorganic naomaterials. Porous Silicon nanomaterials

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings:

- Schubert U., Hüsing N. Synthesis of inorganic materials - (2012)
- Van der P. J. Put The inorganic chemistry of materials: how to make things out of elements.
- Brinker C. J., Scherer G. W. Sol-gel science: the physics and chemistry of sol-gel processing
- Cheetham A. K., Day P. Solid state chemistry. Compounds - Eds. - (1992)
- Kickelbick G. Hybrid Materials: synthesis, characterization, applications, Ed.- (2007)
- Gomez-Romero P., Sanchez C. Functional hybrid materials - - (2004)
- Dhanaraj G., Byrappa K., Prasad, V. & Dudley M. Springer handbook of crystal growth - Eds.
- Shriver & Atkin's Inorganic chemistry, 5th edition, (2009)
- Bhagyaraj S. M., Synthesis of Inorganic Nanomaterials: Advances and Key Technologies.

Suggested Further Readings:

- Oluwatobi S., Oluwafemi N., & Thomas, S., Elsevier: synthesis of Nano Particles, 2018,
- Altavilla, C. & Cilibert E., Inorganic Nanoparticles: Synthesis, Applications, and Perspectives, CRC Press, 2010.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Selected Topics in Organic Chemistry **Credits: 4**
Course Code: PGCH-C405 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To give students insight into Free radical, Heterocyclic and Green Chemistry.
Course Outcomes: After the completion of the course students will be able to

- Know the potential of free radical chemistry for various coupling reactions including metal-free C-H bond activation/functionalization
- Apply the concept of enolate chemistry for controlling the selectivity of various organic transformations.
- Compare the reactivity of smaller, five, and six-membered heterocyclic compounds.

Unit-I **15 hours**

Free radical reactions: Free radical reactions: Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, reactivity of the attacking radicals, the effect of solvents on reactivity, allylic halogenation by NBS, oxidation of aldehydes to carboxylic acids, auto-oxidation.

Enolate Chemistry: Regio- and stereo-selectivity in enolate generation. "O" versus "C" alkylation, effect of solvent, counter-cation and electrophiles; symbiotic effect; thermodynamically and kinetically controlled enolate formations; transition state models to explain stereo selective enolate formation; regioselectivity in generation, application in controlling the selectivity of alkylation.

Unit-II Heterocyclic Chemistry **15 hours**

Nomenclature of heterocycles (Hantzsch- Widman and replacement methods). Non-aromatic and aromatic heterocycles. Tautomerism in heterocycles, Meso-ionic systems. Spectroscopic properties of heterocycles (IR, UV-Visible and NMR). Reactions most frequently used in heterocyclic ring synthesis like C-C bonding, C- heteroatom bonding, typical reactant combinations, Electrocyclic processes in heterocyclic ring synthesis, Nitrenes in heterocyclic synthesis. Hantzsch Pyridine, Skraup, Fischer-Indole synthesis.

Unit-III Monocyclic and Bicyclic Heterocycles **15 hours**

Structure, Synthesis and Reactions of Oxirane, Thirane, Azetidine, Pyrrole, Furan, Thiophene, Diazenes, Pyrimidines, Pyridine and Pyrans. Chemistry of five-membered heterocycles with two heteroatoms like 1,3-Azoles, 1,2- Azoles. Structure, Synthesis and reactions of Benzo-fused heterocycles like Benzo-pyrrole, Benzo-furan, Benzo-thiophene, Quinoline, Isoquinoline, Chromones and Coumarins. Importance of heterocyclic compounds in medicinal chemistry.

Unit-IV Approaches to green synthesis **15 hours**

Principles and applications of phase transfer catalysis, crown ethers and polymer-supported reagents in organic synthesis.

Principles of Green Chemistry and its applications: Biotransformations: Classification of enzymes, advantages, and disadvantages, Artificial enzymes, applications in organic synthesis; Principles of ultrasound and microwave-assisted organic synthesis. Reactions in ionic liquids.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings

- Finar, I.L., Organic Chemistry Vol. 1. Pearson Education, UK. 2012
- Finar, I.L., Organic Chemsitry Vol. 2: Stereochemistry and the Chemistry of Natural Products. Pearson Education, UK.2012
- Fleming I., Molecular Orbitals and Organic Chemical Reactions. John Wiley and Sons. 2011.
- Li, J. J., . Name Reactions: A Collection of Detailed Reaction Mechanisim. Springer-Verlag. 2014.
- Gupta R.R., Kumar M., and Gupta V., Heterocyclic Chemistry-II Five Membered Heterocycles. Vol. 1-3, Springer Verlag, India. 2010.
- Joule, J.A.,and Mills, K., Heterocyc1ic Chemistry.Blackwell Publishers, New York, 2010.
- Mukherjee, S.M., and Singh, S.P., Reaction Mechanism in Organic Chemistry. Macmillan India Ltd. 2009
- Smith, M. B., March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure. John Wiley and Sons. 2013.
- Sykes, P. A. Guide Book to Mechanism in Organic Chemistry. Prentice Hall, 1997.
- Carruthers, W. (Some Modern Methods of Organic Synthesis. Cambridge Uni. Press, UK. 2004.

Suggested Essential Readings

- Heterocyclic Chemistry. Addison Wesley Longman Publishers, US.
- Kalsi, P.S. Organic Reactions and Their Mechanisms. New Age International Pub. 2010
- McMurry, J. Organic Chemistry, Brooks Cole. 1996
- Solomon, T.W.G., Fryhle, C.B. and Snyder, S. A., Organic Chemistry. John Wiley and Sons, Inc. 2013

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Chemistry of Natural Product **Credits: 4**
Course Code: PGCH-C406 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To introduce the basic knowledge of terpenes, Carotenes, steroids, alkaloids and other related bio molecules.
Course Outcomes: After the completion of the course students will be able to

- Recognize various types of natural products and their importance.
- Identify various types of natural products including their properties, occurrence, structure, and biosynthesis.

Unit I **15 hours**
Terpenoids and Carotenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Geraniol, Menthol and β-Carotene.

Unit II **15 hours**
Alkaloids: Nomenclature and physiological action, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, structure, stereochemistry, synthesis of the following: Ephedrine, Nicotine and Morphine.

Unit III **15 Hours**
Steroids: Occurrence, nomenclature, basic skeleton and stereochemistry, structure determination and synthesis of cholesterol, partial synthesis of testosterone and progesterone, chemical tests for steroids.

Unit IV **15 Hours**
Plant pigments: Occurrence, nomenclature and general methods of structure determination. isolation and synthesis of anthocyanins Carbohydrates: Introduction of sugars, structures of triose, tetrose, pentose, hexose, stereochemistry and reactions of glucose, conformation and anomeric effects in hexoses

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*
Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Essential Readings

- Bhat, S.V., Nagasampagi, B.A., andMeenakshi, S. (2009). Natural Product Chemistry and Applications. Narosa Publishing House, New Delhi.
- Cseke, L.J., (2009).Natural Products from Plants.CRC Press.
- Dewick, P.M. (2009). Medicinal Natural Products: A Biosynthetic Approach. Wiley andSons,UK.

- Finar, I.L.,(2006). Organic Chemistry: Stereochemistry and the Chemistry of Natural Products. Dorling Kindersley Pvt. Ltd., India.
- Hornback Joseph M. Organic Chemistry; Thomson Brooks/Cole, 2005
- Peterson, F. andAmstutz, R., (2008). Natural Compounds as Drugs.Birkhauser-Verlay.
- Rohm, B.A. Introduction to Flavonoids, Harwood Academic Publishers.

Suggested Essential Readings

- Rahman, Att-ur-; Choudhary, M.I. New Trends in Natural Product Chemistry, Harwood Academic Publishers.
- Dev, Sukh Insecticides of Natural Origin, Harwood Academic Publishers.
- Mann, J.; Davidson, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B. Natural Products: Chemistry and Biological Significance, Longman, Essex.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Medicinal Chemistry **Credits: 4**
Course Code: PGCH-E407 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To give the students insight into medicinal chemistry.
Course Outcomes: After the completion of the course students will be able to

- Understand Drug design is an important task since the discovery of drugs and in future drugs are the need of the society.
- Understand the concepts of how to develop a drug.
- Understand what are antibiotics and where/when to use them.

Unit-I **15 Hours**

Drug Design

Classification and discovery of new drugs, history and development of chemotherapeutic agents, therapeutic index, LD50 and ED50, naming of (new) drugs.

Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control. Membrane bound enzymes-activation/deactivation. Chemical basis of messenger induced change of shape by the receptor. Design of agonists, antagonists and partial agonists.

Drug development: Screening of natural products, isolation and purification, structure determination, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres, concept of lead compounds.

Brief overview of pharmacokinetics and pharmacodynamics, concept of prodrug and synergism.

Unit-II **15 Hours**

Synthesis, General Mode of Action and Medicinal Uses of Important Drugs in the Following Categories.

Antineoplastic Agents: Mechlorethamine, Chlorambucil, cyclophosphamide, carmustine, aminopterin, 6-mercaptopurine, paclitaxel (synthesis of paclitaxel excluded).

Antimalarials: Chloroquine, primaquine, chloroguanide, pyrimethamine.

Analgesics, Antipyretics and Antiinflammatory agents: Morphine and related compounds (codeine and heroin), meperidine, methadone, aspirin, acetaminophen, indomethacin, phenylbutazone, mefenamic acid, ibuprofen, diclofenac, naproxen, celecoxib.

Antifertility agents: Ovulation inhibitors and related hormonal contraceptives – norethindrone, norethynodrel, estradiol, mestranol, nonhormonal contraceptive- centchroman (synthesis of all the drugs excluded).

Cardiovascular Drugs: Calcium channel blockers and □-blockers: sorbitrate, diltiazem, atenolol and verapamil.

AIDS and drugs against HIV: HIV infection to the system, structure and mode of action of important drugs against HIV (nucleoside reverse transcriptase inhibitors) - AZT, ddI, ddC, d4T and 3TC (synthesis only of AZT).

Unit-III **15 Hours**

Antibiotics Cell wall biosynthesis and protein synthesis inhibitors: Penicillins and semi-synthetic penicillins. synthesis, structure elucidation and medicinal uses of penicillin G, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity, solving these problems leading to the development of penicillin V, oxacillin, cloxacillin, ampicillin, amoxicillin, carbenicillin and carfecillin.

Cephalosporins - Discovery, structure elucidation and synthesis of cephalosporin-C.

Unit-IV **15 Hours**

Flavonoids Occurrence, nomenclature, general methods (chemical and spectroscopic) of structure determination of flavonoids. Isolation, structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin. Biosynthesis of Flavonoids: Acetate and Shikimic acid pathway, biosynthesis of catechin**.**

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested essential Readings:

- Gringauz Alex Introduction to Medicinal Chemistry, (Wiley- VCH-1997).
- Thomas Gareth Medicinal Chemistry- An Introduction, (Wiley-2000). 3rd Edition.
- Ashutosh Kar Medicinal Chemistry,. (Wiley Eastern-1993).
- Palmer Trevor Biochemistry, Biotechonolgy and Clinical Chemistry of Enzmyes. (EWP)
- Finar I. L Organic Chemistry by Vol. II (ELBSLongamnn)
- Nelson D.L Cox M. Lehninger's Principles of Bio-chemistry, Worth publications,2000.
- Ulbight Introduction to nucleic acids and related natural products (OldbornPress)
- Bhat S.V., Nagasampagi B.A, Kumar M. Siva. Naroosa Chemsitry of Natural Products.

Suggested Further Readings:

- Hostettmann, Kurt; Gupta, M.P.; Marston, A. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Harwood Academic Publishers.
- Mann, J.; Davidson, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B. Natural Products: Chemistry and Biological Significance, Longman, Essex.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Polymer Chemistry **Credits: 4**
Course Code: PGCH-E408 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objectives: To acquire knowledge of different techniques of polymerization, their molecular weight determination and processing of polymers.
Course Outcome: The students will acquire knowledge of:

- Physico-chemical properties and molecular architecture of biopolymers.
- Folding, stability, and dynamics of protein.
- Dynamics by using fast kinetic methods (Stopped flow and laser flash photolysis)
- Catalyst, its use in various types of chemical reactions for synthesis of various products.

Unit-I **15 Hours**

Introduction: Polymers and their classification.
Synthesis of Polymers: Chemistry of radical, anionic and cationic polymerization; Zieglar–Natta catalysts; Polycondensation and ring opening polymerization.
Methods of polymerization: Bulk, solution, suspension and emulsion polymerizations.
Geometry of the polymers: Homopolymers; copolymers; branched-polymers; crosslinked polymers; random, alternating, block and graft copolymers; star polymers and dendrimers; tacticity of polymers.

Unit-II **15 Hours**

Characterization of polymers: Molecular weight determination of polymers; thermal properties of polymers; Glass transition temperature; plasticizers.
Polymer Processing: Injection moulding, compression moulding, blow moulding, Extrusion compounding, elastomer properties, vulcanization, reinforcement, fillers, plasticisers and other additives.

Unit-III **15 Hours**

Role of Catalysis in Chemical Synthesis: The art of catalysis, Thermodynamic data and catalyst designing, Metal catalyzed organic reactions, characteristics of transition metals which make them suitable as catalysts; Homogeneous and heterogeneous catalysts and their characterization.

Unit-IV **15 Hours**

Catalyst and molecular activation, Catalytic reaction and the 16 electron rule, Catalyts for fine chemical synthesis, transition metal ion catalysts for organic transformations and their applications in epoxidation of alkenes, isomerization of unsaturated molecules, Alkene Metathesis, Oligomerisation and polymerization (Zeigler Natta polymerization), olefin oxidation (Wacker Process), Hydroformylation (oxoreaction) , Fischer-Tropsch Reaction, The water- Gas Shift Reaction, Monsanto Acetic Acid Process, Reppe Carbonylation, Hydrocyanation, activation of C-H bond, Green Chemistry and Catalysis, Computer applications in catalysis research.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

***Section – B**: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested Readings:

- Billmeyer Jr., F. W. Textbook of Polymer Science 3rd Ed. Wiley-Blackwell (1984)
- Odian , G. Principles of Polymerization 4th Ed. Wiley (2004)
- Hodge, P. & Sherrington, D.C. Polymer-supported Reactions in Organic Synthesis John Wiley & Sons (1980)
- Collman J.P. & Hegedus Louis S., Principles and Application of Organotransition Metal Chemistry, University Science Books (1980).
- Elschenbroich C. & Salzer A. Organometallics: A Concise Introduction VCH (1989).
- Roberts, S.M. & Poignant, G., Eds. Catalysis for Fine Chemical Synthesis, Volume 1-5, John Wiley & Sons (2002)
- Sheldon, R.A., Isabel, A. & Hanefeld U., Green Chemistry and Catalysis, Wiley-VCH (2007).

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Instrumental Methods of Analysis **Credits: 4**
Course Code: PGCH-E409 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To give the students insight into Instrumental Methods of Analysis **Course Outcomes:** After the completion of the course students will be able to

- Know the application of the principles of instrumental analysis
- Choose and plan the use of suitable instrumental/analytical technique for actual analytical problem solving with a reasonable degree of knowledge of potentially relevant methods.
- Motivate the students to work in different analytical labs.

Unit-I **15 hours**

Electroanalytical Methods: Types of Electroanalytical Methods.
Interfacial methods: a) Potentiometry: Principle, Electrochemical cell, Electrodes- (i) Indicator and (ii) Reference electrodes – Normal Hydrogen Electrode, Quinhydrone
Electrode, Saturated Calomel Electrode. Numerical Problems. Application of Potentiometry
b) Voltametry – three electrode assembly; Introduction to types of voltametric techniques, micro electrodes, Over potential and Polarization.
Bulk methods – Conductometry, Conductivity Cell, Specific Conductivity, Equivalent Conductivity. Numerical Problems. Applications of conductometry.

Unit-II **15 hours**

Atomic Absorption/Atomic and Flame Emission Spectroscopy
Absorption of radiation by atoms; equipment: radiation sources (Hollow cathode lamps and electrodeless discharge lamps); atomizers (Flame and carbon); wavelength selector and detectors; interferences in atomic absorption spectroscopy; applications and problems: qualitative and quantitative analysis. Introduction to plasma, arc and spark emission spectroscopy; equipment: inductively coupled plasma spectrometer and flame photometer; applications and problems
Thermal diffraction methods
Principles, instrumentation and application of TGA, DTA and DSC

Unit-III **15 hours**

CHN Analyser: Basic principle, instrumentation, and quantitative analysis.
Chromatography: Principles of HPLC and gas chromatography, functions of each component, stationary phases, eluting solvents, pumps, detectors, qualitative and quantitative applications. GC-columns, gas chromatographic detectors; Recording and analysis; Resolution; Application of GSC and GLC; Applications of GC/Mass and GC/IR analysis; comparison of GC and HPLC.

Unit-IV **15 hours**

Transmission electron microscopy (TEM): Instrumentation, electron gun, electromagnetic lens and illumination system, working principles of transmission electron microscopes, image formation, resolving power, magnification, bright field, and dark field images, sample preparation techniques.
Scanning electron microscopy (SEM): Instrumentation, the interaction of electrons with the matter, optics of sem, modes of operation, image formation, chemical analysis in a scanning electron microscope.
SAXS and Particle Size Analysis: Small-angle X-ray scattering and Particle sizer: Instrumentation, basic principle, and applications.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested readings:

- Braun R. Instrumental Analysis, Mcgraw Hill, International Edition
- Merilt W. Instrumental Analysis, CBS.
- Cazes, M. & Dekkar E., Analytical Instrument hand book
- Kellner et. al., Analytical Chemistry, Wiley VCH
- Patnaik, Deans Analytical Chemistry Handbook –Mcgraw Hill Co

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Hyphenated and Other Analytical Techniques **Credits: 4**
Course Code: PGCH-E 410 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)

Course Objective: To give the students insight into Hyphenated and Other Analytical Techniques.
Course Outcomes: After the completion of the course students will be able to

- Understand the basic principle, instrumentation, functioning, and applications of, Chromatographic technique

UNIT-I: GC-MS –Introduction **15 Hours**

Instrumentation–GC-GC-MS interface-Mass spectrometer (MS), Instrument operation, processing GC-MS data –Ion chromatogram, Library Searching-Quantitative measurement –sample preparation, selected ion monitoring-Application of GC-MS for Trace constituents. Drugs analysis, environmental analysis and others. Gas Chromatography-Fourier Transform-Infrared (GC-FT-IR): Principle, Instrumentation, Applications.

UNIT-II: LC-MS –Introduction **15 Hours**

Instrumentation –liquid chromatography- Mass spectrometer, Interface- Instrumental details processing LC-MS data –Ion chromatograms, Library Searching-Quantitative measurements. Sample preparation, Selected ion monitoring-Application of LC-MS for Drugs analysis, Environmental samples and others.
Inductively Coupled Plasma _Mass Spectrometry (ICP-MS): Principle, Instrumentation, Applications.

UNIT-III: Radio Chemical Methods: **15 Hours**

Radioactive decay, Types of radiation, units and detection and measurements of radioactivity, activation analysis, isotope dilution method, tracer techniques, Radiometric titrations, Radio immuno assay.

UNIT-IV: Thermal Methods of Analysis: **15 Hours**

Thermogravimetry- Theory, Instrumentation, applications with special reference to $CuSO_4.5H_2O$,CaC_2O_4 $.2H_2O$. Applications of TG study of oxalates and chromates.
Differential thermal analysis- Principle, Instrumentation, applications with special reference to the Clays, minerals& Coals (fuels).
Differential Scanning Calorimetry- Principle, Instrumentation, applications to inorganic materials like chlorates and per chlorates, ammonium nitrate. Organic Compounds and Drugs.

Instructions for paper setters and candidates

- *Examiner will set question paper in the given format –*

Section – A: *(Short Answer Type Questions). One compulsory question with four sub-parts i.e. one from each unit. Each short answer type question will carry 3½ marks, thus in total, the question will carry maximum mark of 14.*

Section – B*: (Long Answer Type Questions). There will be one question from each unit with an option. Thus, in total there will be eight questions of which one will have to attempt four, one from each unit. Each question will carry a maximum mark of 14.*

- *All questions will carry equal marks (14 marks each).*
- *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A.*

Suggested readings:

- Dick J.G. Analytical Chemistry-
- Holler S. and Neimann W. Principles of Instrumental analysis, , 6th edition.
- Longmann V. text book of Quantitative Inorganic Analysis. Ed. Bassett et al., ELBS 3rd edition.
- Jeumings W. Analytical gas chromatography, Academic Press, New York
- Day R. A. Quntitative analysis VI Edition. Underwood Prentice- Hall India.
- Christian G. D. Analytical chemistry, , 6th edition John Wiley and sons. Inc, New York, 1994.
- Arrora M. G. Polarographic methods in analytical chemistry
- Moore G. I., Introduction to Inductively coupled plasma emission spectroscopy, Elsevier Science Publisher, New York, 1989.
- Date A. R. and Glay A. L. Applications of ICP-MS, , London (Eds), Blakie, London
- Frank S. Instrumental techniques for Analytical chemistry, Ed..
- Wendlandt, Thermal Analysis, John Wiley Sons, New York.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Scientific Research Methodology **Credits: 4**
Course Code: PGCH-E 411 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous Internal Assessment=30)
Objective of the Course:

- To know the purpose and importance of research for future development in science.
- To familiarize the methodology behind the laboratory techniques
- To learn the ways of carrying out literature review
- To know the methodology of writing thesis and journal articles.

Unit-I **15 Hours**

Introduction: Nature and importance of research - aims, objective, principles and problems - selection of research problem - survey of scientific literature - primary and secondary sources-citation index for scientific papers and journals - patents.

Conduct of Research Work: Physical properties useful in analysis and methods of separation prior to analysis - Isolation techniques - extraction - Soxhlet extraction, crystallization, sublimation - methods for vacuum sublimation and distillation under reduced pressure. Chemistry of working with hazardous materials- acid/water sensitive, corrosive, toxic, explosive and radioactive materials.

Unit-II **15 Hours**

Data Collection and Analysis Execution of research –observation and collection of data-Methods of data collection: Experimental data, field data, data from other sources-Sampling method–Data processing and analyzing: Precision and accuracy Reliability - determinate and random errors - distribution of random errors - normal distribution curve. Statistical treatment of finite samples - the student's t test and F test - Criteria for rejection of an observation - the Q test, significant figures and computation rules - data plotting - least square analysis.

Unit-III **15 Hours**

Scientific Writing Scientific writings: research reports, theses, journal articles, and books. Steps to publishing a scientific article in a journal: types of publications communications, articles, reviews; when to publish, where to publish, specific format required for submission, organization of the material.

Documenting: abstracts-indicative or descriptive abstract, informative abstract, footnotes, end notes, referencing styles, bibliography-journal abbreviations (CASSI), abbreviations used in scientific writing. Patent writing and filing

Unit-VI **15 Hours**

Computer Usage in Research Searches of Literature: ASAP Alerts, CA Alerts, SciFinder, ChemPort, Science Direct STN International. Journal home pages. Preparing research papers: Using word processing software – MS office/Latex/others, Drawing graphs and diagrams – Origin/Excel/others. Seminar presentations – Power point for oral and poster presentations. Different file formats particularly useful in research communication (pdf, jpg, jpeg, djvu, etc.)

Suggested readings:

- Kothari, C.R (1990): Research Methodology: Methods and Techniques, New Age International.
- Sinha, S.C. and Dhiman, A.K (2002): Research Methodology, 2 volumes, Ess Publications.
- Coley, S.M. and Scheinberg, C. A. (1990):Proposal Writing, Sage Publications.
- Fink, A (2009): Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
- Douglas A. Skoog, Donald, M. West, F. James Holler & Stanley R. Crouch (2013): Fundamental of analytical chemistry, 9th Edition, Mary Finch.
- H. F. Ebel, C. Bliefert and W. E. Russey (1988): The Art of Scientific Writing, VCH, Weinham.

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Elective)
Subject Code: PGCH

Course Title: Environmental and Green Chemistry **Credits: 4**
Course Code: PGCH-E312 **No. of Contact hours: 60**
Max. Marks: 100 (External=70, Continuous internal assessment = 30)

Course Objective: To give students insight into environmental chemistry and role of chemistry sustainable development.
Course Outcomes: After the completion of the course students will be able to

- Know chemistry and environment and analytical methods to measure pollution.
- Know the concept and various tools of Green Chemistry.
- Explain the relevance of Green Chemistry in the context of environment issues.
- Realise the judicious utilization of abundantly available precursors instead of depleting petroleum based feedstocks.

Unit-I Chemistry and Environment **15 hours**
Atmosphere: Vertical profile of the atmosphere; troposphere activity patterns; stratospheric chemistry (Chapman mechanism and ozone depletion). Chemistry and control of Greenhouse effect, Acid rain and Photochemical smog.
Hydrosphere: Factors determining the composition of water bodies (acid-base, Distribution diagram), thermal-stratification, pE concept and Pourbiax diagram and oxygen sag curve). Chemistry of water treatment: Chlorination, Ozonation and UV radiation. Water treatment techniques: adsorption and Photocatalysis by Nanomaterials.

Unit-II Analytical Environmental Monitoring **15 hours**
Analytical methods for measuring air pollutants: General aspects, Sampling and methods of analyses. Water quality parameters: Dissolved oxygen, metals (As, Cd, Hg, Pb, and Se), chloride, phosphate, and nitrate. Water quality standards. Continuous monitoring instruments as analytical tools for real-time monitoring of pollutants (NDIR, GC-MS, Chemiluminescence, and Spectrophotometry).
Water Analysis Methods: Classical, Spectrophotometry (Chromogenic step), Electrochemical methods, and Ion-chromatography. Analytical methods for determining dissolved oxygen, BOD, and COD. Choice of methods for determining trace metals (As, Cd, Hg, Pb, and Se)

Unit-III Green Chemistry-I **15 hours**
Adverse effect of some of the current chemical practices on health and environment, concept and need of green chemistry, basic principles of green chemistry with examples– atom economy, wastage minimization, selection of starting materials etc. limitations/obstacle in the pursuit of the goals of green chemistry.
Emerging non-conventional techniques: Microwave heating as energy efficient source, mechanism of microwave heating, Examples of microwave assisted organic synthesis, sono-chemistry and green chemistry.

Unit-IV Green Chemistry-II **15 hours**
Green solvents: Ionic liquids: properties and advantages,use ofionic liquids as solvent as well as catalyst, recyclability of ionic liquids. Solvent-free synthesis.
Value addition of abundantly available precursors: Need for the use of renewable precursors over petroleum based feedstocks, biomass conversion (carbohydrates, lignocellulose biomass) into value added molecules.

Suggested readings:

- Nigel J. Bunce Environmental Chemistry; Wurez Publishers; 1991.
- Baird C. Environmental Chemistry; 2nd edn; Freeman & Co;1991.
- Tyagi O.D. & Mehra M. A Textbook of Environmental Chemistry; Anmol Publishers; 1990.
- De A. K. Environmental Chemistry;; Wiley Eastern; 1995.
- Khopkar S. M. Environmental pollution Analysis; WileyEastern.
- Manahan S. E. Environmental Chemistry; (6th /7th /8th/9thEdns); Lewis Publishers.
- Sharma B. K. & Kaur H. Environmental pollution; Goel Publishers;1996.
- Oxtoby and Nachtrieb Principles of Modern Chemistry; 2nd edn;; Saunders College Publications
- Buell and Girad Chemistry Fundamentals an Environmental Prospective; 2nd edn; Jones and Barlett; 2013.
- Kumar B. A., Environmental Chemistry www.chemistryincontext; (American Chemical Society)
- Anastas, P. T. and Warner J. C. Green chemistry: Theory and Practical. Oxford University Press, US. 2000
- Ahluwalia, V.K and Kidwai, M. New Trends in Green Chemistry. Springer. 2004
- Malhotra, S. V. Ionic Liquids in Organic Synthesis. Oxford University Press, US. 2007.
- Ahluwalia, V. K. Green Chemistry: Greener Alternatives to Synthetic Organic Transformations. Alpha Science International Limited. 2011

University of Ladakh
Syllabus M. Sc. Chemistry
Effective from Academic Year 2022-23
4th Semester (Skill Enhancement Course)
Subject Code: PGCH

Course Title: Project/Dissertation **Credits: 8**
Course Code: PGCH-P401
Max. Marks: 200

Part-A (Theory)

Basic principles of research: Meaning and importance of research, Critical thinking, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results, and discussion.

Bibliographic index and research quality parameters: citation index, impact factor, h index, i10 index, etc.

Research engines such as google scholar, Scopus, web of science, etc.

Plagiarism: Plagiarism, definition, Search engines, regulations, policies and documents/thesis/manuscripts checking through software, Knowing and Avoiding Plagiarism during documents/thesis/manuscripts/ scientific writing

Intellectual Property Right

Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Patents: Basic and associated right, WIPO, PCT system, Traditional Knowledge.

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs: Definition, How to obtain, features, International design registration.

Trade Secrets: Introduction, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Part-B (Practical)

Guidelines for Project/Dissertation work

1. Each student must carry out a project/dissertation under the supervision of a faculty from the department.
2. The project/dissertation can be carried out either in the department or in any other industry, institute, or organization located anywhere in India.
3. Each student must submit a project/dissertation on the topic of their study comprising of (a) an introduction on the topic along with a literature survey and justification for the selection of the topic (b) materials and methods (c) methodology (d) results and discussion and (e) summary and conclusion along with the references.
4. Each student must give a monthly report of their work at the department.
5. The student must discuss/present the details of the project/dissertation through a PowerPoint presentation.
6. The project/dissertation would be examined by the supervising teacher and external examiner.

Division of Marks for the Evaluation Dissertation/Project

Component	**Marks**
Project Report/Dissertation (Introduction, Materials & Methods, Results & discussion Conclusion and References)	80
Presentation (Clarity, understanding and Time Management)	100
20 Multiple Choice Question from Part A	20
Total	**200**