Five Year Integrated Master of Science

(Chemistry)

Programme

Scheme and Syllabus (OBE based)

for Advanced level courses in Semester VII to X

Institute For Integrated Programmes & Research In Basic Sciences (IIRBS)

Mahatma Gandhi University

P. D. Hills P.O., Kottayam-686560

PREAMBLE

I am happy to present the detailed curricula and syllabi of the final four semesters (7-10) of the five year Integrated M.Sc. programmes of Institute for Integrated Programmes and Research in Basic Sciences (IIRBS) in the following five branches of Science.

1. Chemistry (CH)
2. Physics (PH)
3. Life Sciences (LS)
4. Computer Science(CS)
5. Environmental Science(ES)

It may be noted that, an expert committee was constituted *(vide UO 4460/ACA5/2019/MGU, dated 23.09.2019)* for framing the scheme, curriculum and syllabi for the five year Integrated Master of Science (Integrated M.Sc) programmes of Mahatma Gandhi University. Subsequently, the committee drafted the regulations, scheme, curriculum and syllabi of the five year integrated Master of science programmes of IIRBS and were approved *vide UO No. 4467/AC A 5/2020/MGU, dated 05.10.2020* w.e.f 2020 admission batch. However, this approval was involved the detailed scheme and syllabus for foundation level (first six semesters) courses and only scheme for the advanced level courses (in semesters 7-10). Now the expert committee has finalized the **detailed syllabi for advanced level courses in semesters 7-10** in accordance with the OBE format approved by the Mahatma Gandhi University and is presented hereafter. ***This syllabus shall be applicable w.e.f the 2023-24 academic year (for 2020 admission batch) onwards.***

The expert committee has framed the curriculum as per the Outcome Based Education (OBE) system. OBE is an educational approach that bases each part of the educational system with respect to the goals set for the students. OBE aims to equip the students (learners) with knowledge, competency orientations required for achieving their goals when they depart the institution. Further OBE empowers students to choose what they would like to study and how they would like to study it. The teaching methodologies and the evaluation system are also modified in par with the outcome based approach. The programme Specific Outcomes (PSOs) and the Course Outcomes (COs) are presented in the syllabus. The PSOs and the COs are well correlated in the syllabus of each course.

-Sd-

P.D. Hills
July, 2023

Dr. S. Anas
(Convener, Expert committee)

Members of the Expert committee

1.	Dr. S. Anas, Honorary Director, IIRBS	Convener
2.	Dr. P. R. Biju, Professor, SPAP	Member
3.	Dr. K. B. Subila, Assistant Professor, SCS	Member
4.	Dr. Mahesh Mohan, Assistant Professor, SES	Member
5.	Dr. E.K. Radhakrishnan, Associate Professor, SBS	Member
6.	Dr. V. R. Bindu, Professor and Director, SoCS	Member
7.	Dr. Cyriac Joseph, Director, SPAP	Member
8.	Dr. Anitha C. Kumar, Director, SCS	Member
9.	Dr. K. R. Baiju, Director, SES	Member
10.	Dr. M. S. Jisha, Director, SoBS	Member

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS**)** was instituted directly under Mahatma Gandhi University in 2008 and was the first of this kind among the universities in Kerala. Subsequently, the Institute launched Five year Integrated Interdisciplinary Master of Science (Chemistry) programme in the year 2009. Over the years the institute has earned recognition as one of the best interdisciplinary institutions in terms of providing top-notch teaching learning environment and cutting edge instrumentation facilities. In 2020, IIRBS started innovative Five Year integrated interdisciplinary Master of Science programmes in five major disciplines of science (Physics, Chemistry, Life Sciences, Computer Science and Environmental Science). The major objective of the programmes is to integrate the conventional bachelors and masters programmes under a specified research oriented leaning environment by bringing together various science disciplines and thereby empower basic science education. These programmes are designed with an interdisciplinary approach to provide strong foundations for students to prepare for high quality research and expected to contribute to the talent pool of researchers and specialized technicians.

The regulations, scheme, curriculum and syllabi of the five year integrated Master of science programmes of IIRBS were approved *vide UO No. 4467/AC A 5/2020/MGU, dated 05.10.2020.* However, this approval was involved the detailed scheme and syllabus for foundation level (first six semesters) courses and only scheme for the advanced level courses (in semesters 7-10). Now the **detailed syllabi for advanced level courses in semesters 7-10** are prepared in accordance with the OBE format approved by the Mahatma Gandhi University.

Outcome based Education (OBE)

A high priority task in the context of education in India is improvement of quality of higher education for equipping young people with skills relevant for global and national standards and enhancing the opportunities for social mobility. Mahatma Gandhi University has initiated an Outcome Based Education (OBE) for enhancing employability of graduates through curriculum reforms based on a learning outcomes-based curriculum framework, upgrading academic resources, and learning environment. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The fundamental premise underlying the learning outcomes-based approach to curriculum development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes, expressed in terms of knowledge, understanding, skills, attitudes and values. Outcomes provide the basis for an effective interaction among the various stakeholders. It is the results-oriented thinking and is the opposite of input-based education where the emphasis is on the educational process.

The OBE Framework is a paradigm shift from traditional education system into OBE system where there is greater focus on programme and course outcomes. It guarantees that curriculum, teaching and learning strategies and assessment tools are continuously enhanced through a continuous improvement process. All decisions including those related to curriculum, delivery of instruction and assessment are based on the best way to achieve the predetermined outcomes. Traditionally, educators have measured learning in terms of standardized tests. In contrast, outcome-based education defines learning as what students can demonstrate that they know.

OBE is a comprehensive approach to organise and operate a curriculum that is focused onand defined by the successful demonstrations of learning sought from each learner. The term clearly means focusing and organising everything in an education system around “what

is essential for all learners to be able to do successfully at the end of their learning experiences". OBE is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a programme or a course. By the end of educational experience, each student should have achieved the outcomes.

Vision and Mission of Mahatma Gandhi University

Vision

"Mahatma Gandhi University envisions to excel in the field of higher education and cater to the scholastic and developmental needs of the individual, through continuous creation of critical knowledge base for the society's sustained and inclusive growth."

Mission

- To conduct and support undergraduate, postgraduate and research-level programmes of quality in different disciplines.
- To foster teaching, research and extension activities for the creation of new knowledge for the development of society
- To help in the creation and development of manpower that would provide intellectual leadership to the community.
- To provide skilled manpower to the professional, industrial and service sectors in the country so as to meet global demands.
- To help promote the cultural heritage of the nation and preserve the environmental sustainability and quality of life.
- To cater to the holistic development of the region through academic leadership

Vision and Mission of IIRBS

Our Vision:

Quality education in basic sciences by providing intellectual, instrumental as well as experimental support for pursuing excellence and thereby contribute to the talent pool of scholars.

Our Mission:

- To promote and disseminate high level knowledge in frontier areas of science.
- To develop students as multidimensional personalities to create innovators for the service of human welfare.
- To equip students to build up a scientific career and contribute towards the national development.
- To inculcate among students human values with global competence

Programme Outcomes (PO) of Mahatma Gandhi University

PO 1: Critical Thinking and Analytical Reasoning

Capability to analyse, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.

PO 2: Scientific Reasoning and Problem Solving

Ability to analyse, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences

from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualise into research and apply one's learning to real life situations.

PO 3: Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills
Ability to reflect and express thoughts and ideas effectively in verbal and nonverbal way; Communicate with others using appropriate channel; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner and articulate in a specific context of communication.

PO 5: Leadership Skills
Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating a goal, building a team who can help achieve the goal, motivating and inspiring team members to engage with that goal, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility
Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability
Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity, managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning
Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work and living as a dignified person in the society.

PO 9: Networking and Collaboration
Acquire skills to be able to collaborate and network with scholars in an educational institution, professional organisations, research organisations and individuals in India and abroad.

PO 10: Lifelong Learning
Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/reskilling.

Programme Specific Outcomes (PSO) of

Integrated M.Sc. (Chemistry)

Upon completion of the Integrated M.Sc. Chemistry programme, the students will be able to accomplish the following outcomes.

PSO	Expected Outcome
1	Acquire the deep knowledge and understanding in diverse areas of Chemistry that emphasizes scientific reasoning and analytical problem solving.
2	Develop skills to implement innovative and advanced ideas required to perform in Chemical industry/academia
3	Promote Research interest and aptitude in students and thereby enable them towards planning and execution of research in frontier areas of Chemical sciences
4	Capability to deal with advanced experimental and Instrumental methods/techniques required for the analysis/characterization of chemical compounds.
5	Demonstrate teamwork, communication, Time management and leadership skills across multicultural contexts
6	Work in the interdisciplinary and multidisciplinary areas of chemical science and related applications.
7	Gain deep knowledge of the topic which can develop the problem-solving skills using chemical principles.
8	Realize and analyses the world they live in, in a scientific and creative way and thereby make attempts for improving the quality of life.

SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701CH	Theoretical Aspects in Chemistry	3	1	0	3
IMSC702CH	Advanced Coordination Chemistry	3	1	0	3
IMSC703CH	Chemical Thermodynamics	3	1	0	3
IMSC704CH	Organic Reaction Mechanisms	3	1	0	3
IMSC705CH	Stereochemistry andAsymmetric Synthesis	3	1	0	3
IMSC706CH	Inorganic Chemistry Lab	0	0	6	2
IMSE707CH-n (n=1,2,3...)	1. Chemistry of Main Group elements 2. Advanced Polymer Chemistry 3. Material Chemistry	2	0	0	3
	Total	**20**	**5**	**6**	**20**
SEMESTER VIII					
IMSC801CH	Structural Inorganic Chemistry	3	1	0	3
IMSC802CH	Molecular spectroscopy	3	1	0	3
IMSC803CH	Advanced Physical Chemistry	3	1	0	3
IMSC804CH	Reactions & Reagents in Organic Synthesis	3	1	0	3
IMSC805CH	Physical Chemistry Lab	0	0	6	2
IMSC806CH	Organic Chemistry Lab	0	0	6	2
IMSE807CH-n (n=1,2,3...)	1. Photochemistry and Pericyclic Reactions 2. Bioinorganic Chemistry 3. Polymer Materials 4. Natural Products Chemistry	2 2	0 0	0 0	2 2
	Total	**16**	**4**	**12**	**20**
SEMESTER IX					
IMSC901CH	Instrumental Methods of Chemical Analysis	3	1	0	3
IMSC902CH	Organometallics	3	1	0	3
IMSC903CH	Advanced Organic Synthesis	3	1	0	3
IMSC904CH	Chemical Kinetics and Catalysis	3	1	0	3
IMSC905CH	Advanced Characterisation lab	0	0	6	2
IMSO906OC-n (n=1,2,3...)	Open Course	4	0	0	4
IMSE907CH-n (n=1,2,3...)	1. Cheminformatics 2. Analytical & Nuclear Chemistry 3. Heterocyclic Chemistry	2	0	0	2
	Total	**18**	**4**	**6**	**20**
SEMESTER X					
IMSC100PR	Major Research Project	0	0	0	16
IMSC100VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Theoretical Aspects in Chemistry**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC701CH**		
Name of Faculty			
Course Summary& Justification	This course aims to equip students with advanced knowledge of quantum mechanics necessary to conduct research and understand literature. It provides a strong foundation for further studies on quantum mechanics, molecular spectroscopy, and chemical bonding. The Content will include Review of the Schrodinger equation, The concept of the wave function, and Orbital, Degeneracy etc. It also gives an insight into a particle in a box, the harmonic oscillator, the rigid rotor, and the hydrogen atom This course introduces basic concepts of molecular symmetry and group theory in detail.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Quantum theory, statistical mechanics, Strong mathematical skill in Differential Equations and Linear Algebra.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the inadequacy of classical mechanics and the origin of quantum mechanics.	U	1,2
2	Explain the application of Schrodinger equation to rotational and vibrational model systems	U	5,6,7
3	Explain the approximation methods in quantum mechanics.	U, A	6,7
4	Describe the quantum mechanical explanation of orbitals and chemical bonding.	U, R	2,3,5
5	Describe advanced symmetry concepts of chemical molecules and its applications.	An	3,5,6
6	To identify the concept of axis, plane, center, and the point group.	U, An	2,4
7	To describe product of symmetry operation and character table of chemical compounds.	U, A	6,7
8	Make use character table to predict the spectroscopic properties of the molecule	A	6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Quantum Mechanics – I** Introduction to quantum mechanics, failure of classical mechanics, need of quantum mechanics, black body radiation, photoelectric effect, atomic spectra, wave-particle duality. Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and nature of its solutions, Born interpretation of the wave function. Model system: particle in 1D box, quantization of energy levels, zero-point energy, probability distribution functions, normalized and orthogonal wave functions. Extension to two- and three-dimensional box problems, separation of variables and degeneracy of wave function. Qualitative treatment of hydrogen atom and hydrogen-like ions, significance of quantum numbers, radial and angular wave functions for hydrogen atom	18	1,2
2	**Quantum Mechanics-II** Solution of Schrodinger equation to other model systems, vibrational motion of a particle, harmonic oscillator, rotational motion of a particle, rigid rotor, energy levels of harmonic oscillator and rigid rotor, angular momentum. Applications of Tunnelling effect. Schrödinger equation for the hydrogen atom-solutions, s-orbitals, p-orbitals, Beyond hydrogen atom, Schrödinger equation for Helium atom and ions. Approximation methods, Born-Oppenheimer approximation, Variational methods, Self-consistent field method, Hartree-Fock equations, Perturbation theory. Post HF methods, electron correlation methods, configuration interaction methods, Density functional theory methods (DFT). Bonding in polyatomic molecules molecular orbitals, molecular orbital theory for different diatomic molecular systems, Valence bond treatment for chemical bonding in molecules, Hückel molecular orbitals, concept of basic functions, Slater type orbitals (STO) and Gaussian type orbitals (GTO).	18	2,3,4
3	**Molecular Symmetry and Group Theory** Determination of point groups of molecules and ions (organic / inorganic / complex) belonging to Cn, Cs, Ci, Cnv, Cnh, C∞v, Dnh, D∞h, Dnd, Td and Oh point groups. Crystallographic point groups (no derivation), Hermann Mauguin symbols, Screw axis-pitch and fold of screw axis, glide planes, space groups (elementary idea only).Properties, Abelian groups, cyclic groups, sub groups, similarity transformation, classes - C2v, C3v and C2h, Group multiplication tables (GMTs) - C2v, C3v and C2h, isomorphic groups, Matrix representation of elements like E, Cn, Sn, I, σ-matrix representation of point groups like C2v, C3v, C2h, C4v - trace /character, block factored matrices. Standard reduction formula, statement of great orthogonality theorem (GOT), construction of character tables for C2v, C2h, C3v and C4v	18	5,6
4	**Application of Group Theory in Chemical bonding and Spectroscopy** Application in chemical bonding: Projection operator, transformation properties of atomic orbitals, construction of symmetry adapted linear	18	6,7,8

	combination of atomic orbitals (SALCs) of C2v, C3v, D3h and C2h molecules. Applications in vibrational spectra: transition moment integral, vanishing of integrals, symmetry aspects of molecular vibrations. Determination of the symmetry of normal modes of C2v, C3v and C2h point groups using Cartesian coordinates and internal coordinates. Complementary character of IR and Raman spectra determination of the number of active IR and Raman lines in Td, Oh and Square planar complexes		

References

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2. *Molecular Quantum Mechanics, P.W. Atkins, R.S. Friedman, 4 th Edn., Oxford University Press, (2005).*
3. *Quantum Chemistry, D.A. Mc Quarrie, University Science Books (2008).*
4. *Fundamentals of Quantum Chemistry, R. Anatharaman, Macmillan India (2001).*
5. *Molecular Modelling for Beginners, Hinchliffe, 2 ndEdn., John Wiley & Sons, (2008)*
6. *Chemical Applications of Group Theory, F. A. Cotton, 3rd Edn., Wiley Eastern, (1990)*
7. *Group Theory and Symmetry in Chemistry, L. H. Hall, McGraw Hill, (1969)*
8. *Group Theory in Chemistry, V. Ramakrishnan, M. S. Gopinathan, Vishal Publications (1992)*
9. *A Simple Approach to Group Theory in Chemistry, S. Swarnalakshmi, T. Saroja, R. M. Ezhilarasi, Universities Press, (2008)*
10. *Symmetry and Structure: Readable Group Theory for Chemists S. F. A. Kettle, 3rd Edn., Wiley, (2007).*
11. *Group Theory and its Applications in Chemistry, A.S. Kunju, G. Krishnan, PHI Learning, (2010)*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Advanced Coordination Chemistry**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC702CH**		
Name of Faculty			
Course Summary& Justification	The course aims to help the students to detail out the bonding, structures, and properties of coordination complexes. The description of various bonding theories with emphasis on the spectral and magnetic properties of coordination complexes helps to predict the characteristic properties of any transition metal complex. Different reactions in transition metal complexes with a supportive mechanism will be discussed. The applications of coordination chemistry in various fields will also be described in the conclusion part to understand the importance of learning this course.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90

Pre-requisite	

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the structure and bonding of coordination complex	U	1
2	Predict the shape of coordination complexes using VBT & CFT	An	1,2
3	Apply ligand field theory to understand the spectral and magnetic properties	U, A	1,2
4	Estimate the CFSE of any complex and predicts low spin/high spin nature	A, R	1,2,3
5	Derive the term symbol for any electronic configuration.	E	1,2,3
6	Analyse spectral and magnetic properties of coordination complexes	U, An	1,2,3
7	Draw Orgel diagrams and recognize the electronic transition in the spectra of any coordination complexes	An	1,2,3,6
8	Predict the products formed after electron transfer reaction between two coordination complexes.	An	1,3,6
9	Describe the stability of coordination complexes using formation constants and to calculate thermodynamic parameters from them.	An	1,2,3
10	Familiarize with applications of coordination compounds in daily life	U, Ap	6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Structural Aspects and Bonding** Structures and Isomers of Coordination Complexes, Classification of complexes based on coordination numbers and possible geometries, sigma and pi bonding ligands such as CO, NO, CN^-, R_3P, and Ar_3P, Stability of complexes, thermodynamic aspects of complex formation- Irving William order of stability, chelate effect.Werners cordination theory,Valence Bond theory, Crystal Field Theory, Splitting of d orbitals in octahedral, tetrahedral, square planar, square pyramidal and triagonalbipyramidal fields, LFSE, 10 Dq values, Jahn Teller (JT) effect, theoretical failure of crystal field theory, evidence of covalency in the metal-ligand bond, nephelauxetic effect, ligand field theory, molecular orbital theory- M. O. energy level diagrams for octahedral and tetrahedral complexes without and with π-bonding, experimental evidences for pi-bonding	18	1,2,3,4
2	**Spectral and Magnetic Properties of Metal Complexes** Electronic Spectra of complexes: Term symbols of dn system, Racah parameters, splitting of terms in weak and strong octahedral and tetrahedral fields, correlation diagrams for d1 and d9 ions in octahedral and tetrahedral fields (qualitative approach), d-d transitions, selection rules for electronic transitions. Interpretation of electronic spectra of complexes: Orgel diagrams and demerits, Tanabe Sugano diagrams, calculation of Dq, B and β (Nephelauxetic ratio) values, spectra of complexes with lower symmetries, charge transfer spectra, luminescence spectra. Magnetic properties of complexes: paramagnetic and diamagnetic complexes, spin only magnetic moment, Temperature dependence of magnetism- Curie's law, Curie-Weiss law, temperature independent paramagnetism (TIP), spin state cross over, antiferromagnetism- inter and intra molecular interaction, anomalous magnetic moments.	18	5,6,7
3	**Kinetics and Mechanism of Reactions in Metal Complexes** Thermodynamic and kinetic stability, kinetics and mechanism of nucleophilic substitution reactions in square planar complexes- trans effect-theory and applications. Substitution in tetrahedral and five-coordinate complexes ,Kinetics and mechanism of octahedral substitution- water exchange, dissociative and associative mechanisms, base hydrolysis, racemization reactions, solvolytic reactions (acidic and basic), Replacement reactions involving multidendate ligands- formation of chelates, effect of H^+ on the rates of substitution of chelate complexes, metal ion assisted and ligand assisted dechelation, Electron transfer reactions: Outer sphere mechanism-Marcus theory, inner sphere mechanism-Taube mechanism, mixed outer and inner sphere reactions, two electron transfer and intramolecular electron transfer	18	8,9
4	**Coordination Chemistry of Lanthanides & Actinides** Factors mitigating against the formation of lanthanide complexes, Coordination numbers and geometries, Electronic spectra, Covalency	18	6,9,10

	parameters, Hypersensitive transitions, Bonding in lanthanide complexes, Applications of lanthanide complexes, Comparison of electronic structures of actinide and lanthanides, Stereochemistry, Magnetic properties of lanthanides and actinides, Comparative study on complexes of lanthanides and actinides. Structural studies of complexes, Vibrational, electronic and ESR spectra, Magnetic studies, Thermal (TG, DTG, DTA) studies, Single crystal XRD studies.		

References

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2. *J.E. Huheey, R.A. Keiter, R.L. Keiter, Inorganic Chemistry-Principles of Structure and Reactivity, 4th Edn., Prentice Hall, 1997.*
3. *T. Moeller, International Reviews of Sciences, Inorganic Chemistry, Series-I, Vol.VII, Butterworth, 1972.*
4. *K. Nakamoto, Infrared and Raman spectroscopy of Inorganic and Coordination Compounds, 6th Edn., John Wiley & Sons, 2008.*
5. *R.S. Drago, Physical Methods in Chemistry, 2nd Edn., Saundres College, 1992.*
6. *E.A.V. Ebsworth, D.W.H. Rankin, S. Cradock, Structural Methods in Inorganic Chemistry, 2nd Edn., CRS Press, 1991.*
7. *J. D. Lee, Concise Inorganic Chemistry, 4th Edn., Wiley-India, 2008*
8. *R. G. Wilkins, Kinetics and Mechanisms of Reactions of Transition Metal Complexes, Wiley VCH, 2002*
9. *G. A. Lawrance, Introduction to Coordination Chemistry, John Wiley & Sons Ltd, 2010*
10. *E. Housecroft, A. G. Sharpe, Inorganic Chemistry, Pearson, 2012*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Chemical Thermodynamics**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC703CH**		
Name of Faculty			
Course Summary& Justification	An introduction to classical thermodynamics and surface Chemistry. Topics to be covered include: Zeroth law of thermodynamics, first law of thermodynamics, enthalpy, entropy, second and third law of thermodynamics, Helmholtz and Gibbs energies, chemical potential, phase diagrams, and surface chemistry. Chemical thermodynamics helps to establish and develop the principles those are used to explain and interpret many of the physical and chemical observations. Also, it explains many of the proposed hypotheses in terms of fundamental concepts. It imparts correctness and depth of sophistication of conceptual arguments in physical chemistry. Surface chemistry helps to understand surface phenomena and physical methods for studying surfaces		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90

Pre-requisite	Quantum theory, statistical mechanics, thermodynamics, and kinetics (Undergraduate level). Strong mathematical skill in Differential Equations and Linear Algebra.

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning domain	PSO No
1	Be able to describe the fundamental scientific principles of thermodynamics and apply these principles in assignments, discussions on/off line and new problems.	U	1
2	Obtain problem-solving skills in physical chemistry by solving assignments, quizzes and on/off-line discussions and lecture material.	A, E, S, I	1,7
3	Be able to apply the knowledge in order to predict and rationalize the physical and chemical properties of systems and the direction in which chemical and physical processes proceed.	A, Ap	2,4
4	Find the connection between statistics and thermodynamics and differentiate between different ensemble theories used to explain the behaviour of the systems.	U, A, An	2,4,6
5	Recognize assumptions and limitations in the scientific models and their possible impact on the results by training on case studies, lectures, assignments, quizzes	An	1
6	(i) Be able to work productively and collaboratively as a team member by solving problems with other students. (ii) Evaluate the potential impact of	An	2,3

	thermodynamics may have in daily life, health and environment.		

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Laws of Thermodynamics** Variables of thermodynamics, First law of thermodynamics, thermodynamic functions, Joule Thomson effect. Coefficient of thermal expansion, Application of First law to a cyclic process, Second law of thermodynamics, The Clausius inequality, Entropy changes accompanying expansion, phase transition and heating, Free energy functions, Relation between thermodynamic functions. Maxwell relations, Variation of entropy with temperature and pressure, third law of thermodynamics: Need for third law Calculation of absolute entropy, unattainability of absolute zero.	12	1,2,3, 6
2	**Partial Molar Quantities and Chemical Potential** Gibbs-Duhem equation, determination of partial molar volume and enthalpy, Fugacity, relation between fugacity and pressure, determination of fugacity of a real gas, variation of fugacity with temperature and pressure, Activity, dependence of activity on temperature and pressure, Thermodynamics of mixing, Gibbs-Duhem-Margules equation, Konowaloff's rule, Henry's law, Excess thermodynamic functions – free energy, enthalpy, entropy and volume, determination of excess enthalpy and volume.	15	3-6
3	**Chemical Equilibria** Chemical affinity and thermodynamic functions, effect of temperature and pressure on chemical equilibrium, vant Hoff reaction isochore and isotherm, Nernst heat theorem, Equilibrium in chemical reactions, Effect of temperature and pressure on chemical equilibrium- Van't Hoff reaction isochore and isotherm.	10	3-6
4	**Statistical Thermodynamics** Statistical Thermodynamics: Concepts of statistical thermodynamics, Micro canonical, canonical, and grand canonical ensembles, Ensemble averages, Most probable distribution, Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics, Ideal monatomic, diatomic and polyatomic gas.	13	4-6
5	**Partition functions** Partition functions: Equilibrium constant in terms of partition functions, Debye-Huckel theory, Statistical mechanics of ionic solutions, Flory-Higgins theory of polymer solutions, Specific heats of solids- Einstein and Debye models, Virial equation of state and virial coefficients, law of corresponding states.	12	4-6

References

1. *P. Atkins and J. de. Paula, Physical Chemistry, 8th Edition, Oxford University Press, 2006.*
2. *P. Atkins' Physical Chemistry, 11th Edition by P. Bolgar, H. Lloyd, A. North, V. Oleinikovas, S. Smith, J. Keeler, Oxford University Press, 2017*
3. *D. A. McQuarrie and J. D. Simon, Molecular Thermodynamics, University Science Books, 2004.*
4. *R. S. Berry, S. A. Rice and J. Ross, Physical Chemistry, 2nd Edition, Oxford University Press, 2007.*
5. *R. A. Alberty and R J Silbey, Physical Chemistry, 4th Edition, J. Wiley & Sons, 1994*
6. *F. Daniels and R. A. Alberty, Physical Chemistry, 8th Edition, Wiley, New York, 1994*
7. *P. W. Atkins, Physical Chemistry 8th Edn., Wiley, New York, 2006*
8. *A. W. Adamson, The Physical Chemistry of Surfaces, 2nd Edn., Wiley. New York, 1998*
9. *A. Somorjai, Chemistry of Surfaces, 3rd Edn. Wiley, New York, 2005*
10. *A. Alexander and P. Johnson, Colloid Science, Oxford University Press, Oxford, New York, 1996*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Organic Reaction Mechanisms**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC704CH**		
Name of Faculty			
Course Summary& Justification	Learning reaction mechanisms is very important for a chemistry student to have a basic knowledge about the course and the outcome of different reactions. A thorough understanding of organic reaction mechanism is extremely useful in predicting the products and improving the reaction efficiency. A student needs to know basic concepts of organic chemistry to be able to write reasonable reaction mechanisms. A mechanism cannot be considered valid unless there is experimental evidence to support it. The student needs to know basic experiments that can be used to validate reaction mechanisms.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Basic knowledge in organic chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Propose the mechanism of a given organic reaction	U, A	1
2	Predict the product formed in a reaction under specified conditions	A	1,2
3	Identify the change in the mechanism and the product formed with the change in reaction conditions	A, An	1,2,3
4	Predict the mechanisms of different molecular rearrangements	U, A, An	2,3,4
5	Describe reaction mechanisms in terms of energetics, reaction kinetics, and thermodynamics.	An	3,5
6	Correlate the reactivity of a compound with its structure	E, C	3,5,6
7	Evaluate the yield of a particular product in a mixture under a set of conditions	E	5,6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Basic Concepts in Organic Chemistry** Review of basic concepts in organic chemistry: Bonding, hybridization, Electron displacement effects: Inductive effect, electromeric effect, resonance effect, hyperconjugation, steric effect, Solvent polarity scales-Gurundwald-Winstein equation, methods to find reaction mechanisms.	14	1-7
2	**Nucleophilic Substitution Reactions** Nucleophiles and electrophiles, comparison between nucleophilicity and basicity, detailed study of S_N1, S_N2, S_Ni, SN11, SN21, and borderline mechanisms, nucleophilicity, Leaving group effect and solvent effects, neighbouring group participation, Phase transfer catalysis (PTC) and application of crown ethers, Rearrangement of carbocations, the norbornyl cation and other nonclassical carbocations, super acids.	18	2-7
3	**Addition and Elimination Reactions** Mechanism of addition reactions, addition of hydrogen halides to alkenes, addition of halogens, addition of metallic species-hydroboration, oxy-mercuration, elimination reactions (E1, E2 and E1cB mechanisms), dehydrohalogenation, dehydration of alcohols, substitution versus elimination	14	1-7
4	**Aromatic Substitution Reactions** Aromatic electrophilic substitution reactions-mechanism, partial rate factors, Nitration, halogenation, sulphonation and Friedel-Crafts reactions, Activating/deactivating, ortho-para and meta orienting effects in substituted benzenes, Aromatic nucleophilic substitution reactions-benzyne mechanism, Substitution on polynuclear aromatic systems	14	1-7
5	**Mechanisms of Nucleophilic Substitution of Carbonyl Compounds** Reactivity of carbonyl groups, addition and substitution reactions, hydrolytic reactions Ester and amide hydrolysis reactions –different mechanisms, Esterification, and trans-esterification reaction.	12	3-7

References

1. *Advanced organic chemistry part-A. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)*
2. *Advanced organic chemistry by J. March 6th Ed.*
3. *Organic Chemistry, J. Clayden, N. Greeves, S Warren, P. Wothers, Oxford University Press, Oxford, 2001*
4. *A Guidebook to Mechanism in Organic Chemistry Peter Sykes, Longman, New York 1985*
5. *Mechanism and theory in Organic Chemistry T. H. Lowing and K. S. Richard, 3rd Ed. HarperCollins Publishers. New York 1987*
6. *T.H. Lowry, K.S. Richardson, Mechanism and Theory in Organic Chemistry, 2nd Edn., Harper & Row, 1981*
7. *R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, Academic Press, 20021981*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Stereochemistry and Asymmetric Synthesis**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC705CH**		
Name of Faculty			
Course Summary& Justification	Stereochemistry is a fundamental topic to understand the nature, property and mechanism of organic substances and processes and is inevitable to learn modern organic chemistry. Learning this course will provide a key concept of the reaction mechanism of organic reactions. This course is designed to provide students with theoretical concepts of stereochemistry such as molecular geometry, stereoisomerism, Cahn-Ingold-Prelog systems, different notations, racemization, resolution, asymmetric synthesis, configuration, conformation, anomeric effect, conformational analysis of butane, cyclohexane, decalin, stereochemistry & reactivity, stereochemistry of various reactions, all kinds of chirality, Atropisomerism, conformation & reactivity, stereoselective & stereospecific reactions. Students will be able to use stereochemical aspects to understand reaction mechanisms and to predict the stereochemistry of the product formed.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90

Pre-requisite	Basics of Organic chemistry including basic concepts of hybridisation and reaction pathways

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basic concepts of symmetry elements and stereochemical aspects to assign notation of molecules and to predict the stereochemistry of products of reactions.	U	1
2	Assign R/S and E/Z notation for stereoisomers and to distinguish between enantiomers and diastereomers.	An	3
3	Calculate ee or de of stereoselective reaction to get a good understanding of asymmetric synthesis and absolute configuration	A	2
4	Distinguish between various kinds of chirality and predict the stereochemistry of cycloaddition reactions.	A	3
5	Able to predict the stereochemistry of products of asymmetric reactions.	A	6

6	Distinguish between stereoselective and stereospecific reactions and predict the regio- and stereochemistry of products of Aldol reactions.	S	6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Molecular Geometry and Stereoisomerism** Rotation around bonds, Concepts of dihedral angle, Torsion strain, Molecular symmetry and chirality, Symmetry operations, Symmetry elements, Stereoisomerism: Conformation and chirality, Molecules with a single chiral centre, D & L, R & S, E & Z configurations, Molecules with two or more chiral centres, Enantiomers and diastereomers.	18	1
2	**Racemization and Resolution** Asymmetric transformations and mutarotation-Optical purity and enantiomeric excess, Calculations of ee and de, Determination of configuration, Methods based on NMR spectroscopy, chemical transformations, Asymmetric Synthesis-Relative and absolute configurations, Relative configuration of diastereomers-NOE effects, Anomeric effect	18	2,3
3	**Conformational Analysis** Conformations of acyclic, cyclic and fused systems, Stereochemistry of addition and elimination, Axial chirality, Planar chirality and helicity, Stereochemistry of allennes, spiranes, biphenyls, Atropisomerism, Topicity and prostereoisomerism-Topicity of ligands and faces.	18	4,5
4	**Stereoselective Reactions** Stereoselective and stereospecific reactions, Enantioselective synthesis, Regio and stereochemical considerations of enolate formation, Alkylation of enolates-dianion formation and alkylations reactions, Reactions of silyl enol ethers-Enamines and imine anions, Conjugate addition of carbon nucleophiles, Aldol reactions-Regio and stereochemistry, Intramolecular aldol condensation. Organoboranes, Enantioselective hydroboration-hydroboration of alkynes, Asymmetric epoxidation, Sharpless epoxidation, Allylic oxidation.	18	5,6

References

1. *Stereochemistry of organic compounds E. L. Eliel, S. H. Wilen, L. N. Mander, John Wiley 2003*
2. *Stereochemistry of organic compounds D. Nasipuri: New age international publishesr, New Delhi 2004*
3. *Advanced Organic Chemistry Part A F. A. Carey and R. J. Sundberg (5th edition): Springer, 2007*
4. *Stereochemistry Conformation and mechanism P. S. Kalsi: Wiley Eastern New Delhi 1990*
5. *D.G. Morris, Stereochemistry, RSC, 2001*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Inorganic Chemistry Lab**		
Type of course	**Core**	**Credit Value**	**2**
Course code	**IMSC706CH**		
Name of Faculty			
Course Summary& Justification	The laboratory practical course enables the students to understand and apply the lab skills and laboratory safety procedures needed to carry out standard chemistry experimental techniques. This course will facilitate the students to apply the basic concepts of inorganic chemistry to analyze the metal ions in a given sample. Through this course, the students will learn to (i) separate and identify cations in a given mixture (ii) estimate the metal ions using colorimetry (iii) perform the preparation of complexes and their characterization using various spectroscopic techniques. This course will improve the analytical skill and critical thinking including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical analysis.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning independent learning			36	24	60
Pre-requisite	The students are expected to learn and follow the general safety guidelines to ensure a safe laboratory environment. Also, a basic knowledge of inorganic salt analysis and colorimetric estimations is preferred					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Perform basic chemical lab procedures by following appropriate lab safety measures & infer the experimental results with mathematical and analytical reasoning	U	1
2	Separation and identification of the mixture of cations in a given sample	An	1,2
3	Estimation of the amount of metal ion present in the whole of the given solution calorimetrically.	E	2,3
4	Preparation of metal complexes using solution phase synthesis.	A	3,4
5	Develop the skill to carry out quantitative analysis and handle spectroscopic techniques.	S	6,7
6	Develop the skills to carry out basic quantitative and qualitative analytical techniques.	S	7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Separation and Identification of a Mixture of Four Cations** A mixture of two familiar ions such as Ag^{+} , Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+} , Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+} , Na^{+} , K^{+} and NH_4^{+} and two less familiar metal ions such as Tl, W, Se, Mo, Ce, Th, Ti, Zr, V, U and Li), Anions which need elimination not to be given, Minimum eight mixtures to be given.	12	1,2,6
2	**Colorimetric estimation** Estimation of Ferric ion by thiocyanate method, Estimation of Copper by using diethyl dithiocarbamate, Estimation of Chromium by using diphenyl carbazide, 2.4. Estimation of Manganese by using potassium periodate	12	1,3,6
3	**Preparation and characterization complexes using IR, NMR and electronic spectra** (a) Tris (thiourea)copper(I) complex (b) Potassium tris (oxalate) aluminate (III), (c) Hexammine cobalt (III) chloride, (d) Tetrammine copper (II) sulphate, (e) Schiff base complexes of various divalent metal ions, (f) Bis(dimethylglyoximato) nickel (II) (g) Prussian blue.	12	1,4,5,6

References

1. *A.I. Vogel, G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn, Longman, 1996.*
2. *A. I. Vogel, A Text Book of Quantitative Inorganic Analysis, Longman. 1966.*
3. *M. Koltoff, E. B. Sandell, A Text Book of Quantitative Inorganic Analysis, 3rd McMillian, 1968.*
4. *V. V. Ramanujam, Inorganic Semimicro qualitative Analysis. The National Public Co. 1974.*
5. *J. Singh, R. K. P. Singh, J. Singh, LDS Yadav, I. R. Siddiqui, J. Shrivastava, Advanced Practical Chemistry, PragatiPrakashan, 7thEdn., 2017*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Contact classes, Tutorials, Seminar, Assignments Seminar, Authentic learning, Library work, independent studies Presentation by individual student
Assessment Types	**Mode of Assessment** Lab/Experiment skills • Lab record/Report • Viva-voce • Lab Discipline (participation, punctuality, accuracy)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Chemistry of Main Group Elements**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE707CH-1**		
Name of Faculty			
Course Summary& Justification	This course is structured to introduce students to the descriptive chemistry of the main group elements and its wide range of applications. The elements will be considered by the group by reviewing concepts and theory principles that help to make sense of their reactivity and range of application. Students will be able to utilize periodic trends and anomalous behaviors of elements, to understand the specific and individual nature of each element; Also, they will be able to identify the relationship between the position in the periodic table and molecular properties which helps the students to analyses the structural composition of atoms and molecules. The learners will be able to apply, analyze and evaluate the structure and bonding aspects of inorganic and organometallic compounds derived from main group elements.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-		24	60
Pre-requisite	Basic knowledge about the periodic table and arrangements of elements under Groups and Periods.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the classification of elements in the periodic table: general trends and properties of elements and structure of molecules	U	1
2	Build a perspective on the origin, occurrence and extraction of group I and group II elements and their different compounds	U, An	2,3
3	Understand the Chemistry of group III elements and apply Wade's rule and STYX number in rationalizing the structure of main group clusters	U, A	4,7
4	Understand the diversity of oxides, sulfides, halides and hydrides of group IV, V and VI elements	E	6,7
5	Understand the preparation and properties of Halogens, Noble gas compounds, Cyclic ethers, Crown ethers and Clathrates.	U	7

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Classification of Elements in the Periodic Table** General trends in the properties of the elements, Anomalous behaviour of the first member of the group elements, Diborane, Wades's, Isolobal principle, molecular geometry and molecular symmetry, electronic configuration of the di and tri atomic systems, Bond types, bond properties, electron deficient, precise, and rich compounds	6	1,2
2	**Group I and Group II Elements** Occurrence and extraction; Group I and II elements and their compounds: hydrides, halides, oxides, hydroxides, sulphides, selenides, tellurides and related compounds, Compounds of Oxo- acids, Nitrides and Carbides, Solubility and Hydration,.Solutions in liquid ammonia, . Alkali and alkaline earth metals and its complexes,Grignard reagents.	6	1,2
3	**Chemistry of Group III Elements: Inorganic Chains, Rings and Cages** Boranes, Boron halides, Diborane, Borazines, Borates, Boron clusters, Higherboranes and borohydrides, Organoboranes: carboranes and metallocarboranes, STYX numbers and WADE's rule, . Isolobal concept: molecular geometry and molecular symmetry, Main group clusters: Cyclic and crown ethers	6	1,3
4	**Oxides of Group IV Elements** Silicon-oxygen compounds, Silicates, Silicons, Zeolites, Silanes, Silylamines and extended Silicon- Oxygen compounds, Carbides and Silicides, Complexes of Ge, Sn and Pb, Diamond, graphite and other forms of carbon	6	1,4
5	**General Structure and Characteristics of Group V and VI Elements** Hydrides of group V and VI elements, Phosphanes, phosphorous halides and phosphazenes, Oxyhalides and Oxoacids of P, S, Se and Te	6	1,4
6	**Halogens and Noble gases** Oxoacids of halogens, Interhalogen compounds and polihalides, Chemistry of noble gases, Compounds of Xenon (structure and reactivity), Clathrates	6	1,5

References

1. *W. Henderson, Main Group Chemistry, Royal Society of Chemistry, 2000.*
2. *F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6thEdn. John Wiley and Sons, 2007.*
3. *J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4thEdn. Pearson Education, 2000.*
4. *D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 5thEdn., Oxford University Press, 2010.*
5. *N.N. Greenwood, A. Earnshaw, Chemistry of the Elements, Pergamon Press, 1984.*
6. *K.F. Purcel, J.L. Kotz, An Introduction to Inorganic Chemistry, Saunders College, 1980.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Direct Instruction: Lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group ssignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests, Assignments, Seminar Presentation, Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Advanced Polymer Chemistry**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE707CH-2**		
Name of Faculty			
Course Summary& Justification	This course is designed to provide students with concepts of polymer blends, composites, and nanocomposites. In-depth knowledge of miscibility, compatibility, compatibility, compatibilization techniques. Concept on short fibre composites, long fibre composites and critical fibre length. Knowledge on composite fabrication techniques, nanocomposite preparation and characterization techniques. This course aims to impart basic knowledge on nanocomposites materials. To introduce the basic concepts on composite materials and manufacturing processes. To familiarize different types of blends based on their morphology. To give the concept of improvement of material properties by blending. Understanding the concept of blending and the preparation of composites is important as it helps to develop various products for different applications.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-		24	60

Pre-requisite	Basic knowledge about chemistry at the Bachelores level.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the knowledge of polymer blends, composites, and nanocomposites.	U	1
2	To learn about various composite manufacturing techniques	U, An	2,4
3	Understand the concept of improving material properties by blending.	U, An, A	3
4	To impart the knowledge of nanocomposite materials	A	6-8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to polymer blends** Definition and importance of blending, blending techniques, solution mixing, mechanical mixing, latex blending, mechano chemical blending, compatibility of polymer in solution, determination of mutual solubility of polymers, miscibility through specific interactions. copolymer effect, phase diagrams of polymer- polymer systems, LCST and UCST behavior, binodal and spinodal curves, critical point, thermodynamic treatment of phase behavior of polymer mixtures. Flory-Huggins theory, blend morphology-generation and control, capillary number, characterization techniques, commercial blends and their applications	8	1
2	**Compatibilization of blends** Compitibilization of immiscible blend: addition of graft or block copolymers, reactive compitibilization by low molecular weight additives, types of compatibilisers, in situ-formed, separately added copolymers, compatibilization theory.	7	1,3
3	**Characterization techniques** Methods for determining polymer-polymer miscibility, criteria for establishing miscibility, dielectric microscopic, mechanical, cloud point, rheological, dialatometric and viscosity methods, free volume measurement, volume of mixing, fluorescence spectroscopy, IR, FIR, NMR, mutual solvent method, heat of mixing, melting point depression, inverse gas chromatography	7	1,3
4	**Polymer composites** Definition and classification, role of fiber and matrix in improving composite properties, mechanics of short and long fibre composites, bonding between fiber and matrix and functions of bonding agents, critical fiber length in short fiber composites, failure mechanism in composites, composite fabrication techniques- open mould processes such as hand lay-up, vacuum and bag molding, pressure bag molding centrifugal casting, pultrusion, closed mould processes such as matched de-molding, resin transfer molding and thermo forming	7	2
5	**Polymer Nanocomposites** Intercalated, exfoliated nanocomposites, Nanofillers, carbon nanotubes (CNTs), Reduced Graphene Oxide, Hummer's method, Modified Hummers method, Nanofiller modifications, Characterization of Nanocomposites, SEM, TEM, XRD, FTIR, Applications of polymer Nanocomposites.	7	3,4

References

1. *D.R. Paul, S. Newman, Polymer Blends Vol 1-2, Academic Press, 1978*
2. *O. Olabisi, L.M. Robeson, M.T. Shaw, Polymer-Polymer Miscibility, Academic Press, 1979.*
3. *K.K. Chawla, Composite Materials, 2nd Edn., Springer, 1998.*
4. *F.R. Jones, Hand Book of Polymer-Fibre Composites, Longman Scientific and Technical, 1994.*
5. *P.K. Mallick, Fiber-reinforced Composites, 3rd Edn., CRC Press, 2008.*
6. *L A Utracki, Polymer Blends Handbook, Springer, 2003.*
7. *Vajtai, Robert, Handbook of Nanomaterials, Springer 2013.*
8. *F L Matthews and R D Rawlings, Composite materials engineering and science Champman and Hall, London, 1994*
9. *D. Hull, T. W. Clyne, An Introduction to Composite Materials, Cambridge University Press, 1996*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five-year Integrated M.Sc. (Chemistry)**					
Course Name	**Material Chemistry**					
Type of course	**Elective**	**Credit Value**	**2**			
Course code	**IMSE707CH-3**					
Name of Faculty						
Course Summary& Justification	The primary objective of this course is to provide students with an in-depth understanding of the fundamental principles that govern materials chemistry. It will empower them with the capacity to classify various materials according to their structural characteristics and functionalities. The curriculum also encompasses an exploration of the surface attributes of nanoscale materials, establishing a link between nanostructures and their surface energies. Through this course, students will gain exposure to a wide array of subjects, including nano-optics, nanotechnological materials, and the development of devices tailored for both industrial and commercial utility. By honing these skills, participants will be well-prepared to apply their acquired knowledge to practical, real-world scenarios, particularly within the realm of energy-related applications.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-		24	60
Pre-requisite	Basic knowledge about chemistry at the bachelor's level					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Gain an insight about the surface properties of nanomaterials with special emphasis on spherical cluster approximation, packing fraction and structural magic numbers.	U, An	2,3
2	Analyze and predict how specific structural features influence the properties and behaviors of materials.	U, A	3,4
3	Develop the ability to critically evaluate and compare the properties and potential uses of different materials for specific applications.	E, A	4,5,6
4	Build a perspective on nano-optics, Surface Plasmon Resonance (SPR), colour generation from nanoparticles and quantum dots.	U, R	7,8
5	Describe the role of materials chemistry in advancing energy storage and conversion technologies.	A, E	6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Materials, Structure and the Nanosurface** Particle shape and the surface: Exterior surface and particle shape, interior nanoscale surface area. Surface and Volume: Specific surface area, Spherical cluster approximation, Atomic Structure: Packing fraction and density, Structural magic numbers	7	1
2	**Classification Based on Structure** Various molecular solids, layered materials, 3D-materials, nanostructures materials with specific examples.	7	2
3	**Classification Based on Function:** Porous materials, optical materials, semiconductors, ionic conductors, superconductors, thermoelectric and magnetic materials.	7	3
4	**Nano-optics** Introduction to nano-optics; Interaction of light with nanoparticles. Surface Plasmon Resonance (SPR), colour generation from nanoparticles. Quantum dots	8	4
5	**Focus on Energy Applications:** Batteries, supercapacitors, fuel cells, solar cells, LEDs**.**	7	5

References

1. *C. N. R. Rao and J. Gopalakrishnan, New Directions in Solid State Chemistry, 2ed, Cambridge University Press, 2010.*
2. *P. A. Cox, The Electronic Structure and Chemistry of Solids, Oxford Science Publications, 1987.*
3. *The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C. N. R. Rao (Editor), Achim Müller (Editor), Anthony K. Cheetham (Editor), 2004, Wiley-VCH*
4. *Molecules Into Materials: Case Studies in Materials Chemistry - Mixed Valency, Magnetism and Superconductivity, 2007, World Scientific.*
5. *G. A. Ozin, A. C. Arsenault and L. Cademartiri, Nanochemistry- A Chemical Approach to Nanomaterials, RSC Publishing, 2009.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Structural Inorganic Chemistry**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC801CH**		
Name of Faculty			
Course Summary& Justification	The study of Structural and Solid-State Chemistry unravels the basic composition, structures, and properties of solids. Through this learning, it is possible to acquire relevant conceptual and procedural knowledge and to develop an understanding and appreciation of progress in various scientific and technological fields. Learning this course will provide a strong foundation in the key concepts of Solid-State Chemistry, which will help the students to develop a holistic view of elemental composition, structure and material design in science and technology. Understanding this subject will enable the students to work in frontier areas of multidisciplinary sciences		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Basic knowledge about chemistry at the bachelor's level					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the fundamentals of crystallography, crystal systems as an introduction to the concepts of underlying Solid-State Chemistry	U	1
2	Analyze and understand the structure of AX, AX2, AO2, AO3, A2O3, ABO3, AB2O4 type compounds, perovskites, spinels and inverse spinels	U, An	1,2,3
3	Gain insight into the crystal structure, close packing, and crystal defects in solids	An	2,3
4	Understand the formation and properties of isopoly and heteropoly acids	U, R	3,4
5	Relate the structural features of phosphate esters to their functions in biological systems.	An	4,5,6
6	Describe the structures and bonding in phosphorus-sulfur and sulfur-nitrogen compounds.	E	1,2,6
7	Explain the formation of dinuclear metal clusters and the nature of metal-metal multiple bonding.	U, A	6,7

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Solid State Chemistry** Crystal defects and non-stoichiometry in solids: Perfect and Imperfect Crystals, intrinsic and extrinsic defects- Point defects, line and plane defects, Vacancies- Schottky and Frenkel defects. Thermodynamics of Schottky and Frenkel defects formation, Colour centres. Structure of compounds of AX (Zinc blende, Wurtzite), AX2 (Rutile, fluorite, antifluorite), AmX2 (Nickel Arsenide), ABX3 (Perosvskite, Ilmenite). Spinels. Inverse spinel structures. Solid state reactions-diffusion coefficient, mechanisms, vacancy diffusion, thermal decomposition of solid-Type I reactions, Type II reactions. Phase transition in solids: classification of phase transitions-first and second order phase transitions, Martensitic transformations, order-disorder transitions and spinodal decomposition. Kinetics of phase transitions, sintering. Growing single crystals-crystal growth from solution, growth from melts and vapor deposition technique.	24	1,2,3
2	**Inorganic Chains and Rings** Isopoly acids of vanadium, molybdenum and tungsten. Heteropoly acids of Mo and W. Condensed phosphates-preparation, structure, and applications. Phosphate esters in biological systems. Polythiazil-one dimensional conductors. Heterocyclic inorganic ring systems-structure and bonding in phosphorous-sulphur and sulphur-nitrogen compounds. Homocyclic inorganic ring systems-structure and bonding in sulphur, selenium, and phosphorous compounds.	24	4,5
3	**Inorganic Cages and Metal Clusters** Cages: synthesis, structure, and bonding of cage like structures of phosphorous. Boron cage compounds-Wade Mingos Lauher rules, MNO rule, boranes, carboranes, metallacarboranes. Metal clusters**:** dinuclear compounds of Re, Cu and Cr, metal-metal multiple bonding in (Re2X8)2- , trinuclear clusters, tetranuclear clusters, hexanuclear clusters. Polyatomic zintl anion and cations. Infinite metal chains.	24	6,7

References

1. *L.V. Azaroff, Introduction to Solids, Mc Graw Hill, 1984.*
2. *A.R. West, Solid State Chemistry and its Applications, Wiley-India, 2007.*
3. *D.K. Chakrabarty, Solid State Chemistry, New Age Pub., 2010.*
4. *C.N.R. Rao, K.J. Rao, Phase Transitions in Solids, McGraw Hill, 2010.*
5. *A. Earnshaw, Introduction to Magnetochemistry, Academic Press, 1968.*
6. *J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, 4th Edn., Harper Collins College Pub.,1993.*
7. *F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th Edn., Wiley-Interscience,1999.*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**				
Programme	**Five-year Integrated M.Sc. (Chemistry)**				
Course Name	**Molecular Spectroscopy**				
Type of course	**Core**	**Credit Value**	**3**		
Course code	**IMSC802CH**				
Name of Faculty					
Course Summary& Justification	Spectroscopy is a multidisciplinary subject and spectroscopic tools are significant to characterize the structure and properties of new compounds designed for various applications. This course is designed at providing students with theoretical concepts of various spectroscopic techniques., such as Atomic, Molecular, Vibrational, Raman, NMR, EPR, Mossbauer and electronic to analyses the molecular and electronic structure of atoms and molecules. Thus, spectroscopy is inevitable in areas of chemistry, physics, biochemistry, medical fields, chemical industry, etc. Learning this course will provide a strong foundation in the key concepts of spectroscopy and will help the students to identify the use of appropriate spectroscopic techniques for the characterization of various molecules. Understanding this subject will enable the students to work in frontier areas of multidisciplinary sciences.					
Semester	**VIII**				
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Basic knowledge about the interaction of electromagnetic radiation with matter involving either absorption, emission, or scattering of radiation					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	After Completion of this course, the student should be able to: Understand the interaction of light with matter and the key concepts of spectroscopy to probe the structure of molecules.	U	1
2	Apply quantum mechanics and group theory principles to understand molecular spectra	A	3
3	Identify the relationship between molecular spectra and molecular properties	Ap	2,4,5
4	Analyses and explain the structure of atoms and molecules using various spectral data.	A	2,4,5
5	Evaluate the utility of various spectroscopy as a qualitative and quantitative method.	U	6

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to Spectroscopy** Origin of different spectra, intensity of absorption, Signal to noise ratio, natural line width Influencing factors spectral intensity-transition probability, maxwell-boltzmann distribution Contributing factors-Doppler broadening, Lamb dip spectrum, Beers-Lamberts law, Born Oppenheimer approximation, Energy dissipation from excited states, relaxation time.	8	1
2	**Microwave Spectroscopy** Principal moments of inertia and classification (linear, symmetric tops, spherical tops and asymmetric tops), rigid and non-rigid rotators, Selection rules, Intensity of rotational lines, relative population of energy levels, derivation of J max, effect of isotopic substitution, Calculation of intermolecular distance, Stark effect and its application, nuclear and electron spin interaction	10	2,3,4,5
3	**Infrared Spectroscopy** Vibrational energy of Diatomic molecules, Harmonic Oscillator, selection rules, Anharmonicity, Morse potential energy diagram, fundamentals, overtones and hot bands, Determination of force constants, diatomic vibrating rotator, breakdown of the Born-Oppenheimer approximation, effect of nuclear spin, Vibrational spectra of polyatomic molecule, Normal modes of vibrations, combination and difference bands, Fermi resonance, finger print region and group vibrations, overtones, hot bands, Effect of H-bonding on group frequency, FTIR	12	2,3,4,5
4	**Raman Spectroscopy** Introduction to Raman spectroscopy, Classical and quantum theories of Raman effect, Rotational and vibrational Raman spectrum, Complementarities of Raman and IR spectra, mutual exclusion principle, Polarized and depolarized Raman lines, Resonance Raman scattering and resonance fluorescence.	8	2,3,4,5
5	**Electronic Spectroscopy** Term symbols and electronic spectra of diatomic molecules, Selection rules, Franck-Condon principle, predissociation, calculation of heat of dissociation-Birge and Sponer Method, fortrat diagram, electronic spectra of polyatomic molecules, radiative and non-radiative decay, Jablonski diagram, Different types of lasers-solid state, continuous wave, gas and chemical lasers, frequency doubling	10	2,3,4,5
6	**NMR Spectroscopy** Nuclear spin interaction with magnetic field, nuclear energy levels and its population, Larmor precession, Relaxation methods, Factors affecting nuclear relaxation, chemical shift, exchange phenomenon, factors influencing coupling, karplus relationship. variation of coupling constant with dihedral angle, FTNMR, second order effects on spectra, spin systems (AB, AB2), Simplification of second order spectra-shift reagents, The contact and pseudo contact shifts, High field NMR, double irradiation, selective decoupling, Double resonance, NOE effect, two-dimensional NMR-COSY and HETCOR, Resonance of other nuclei ^{13}C NMR-chemical shift and structure correlation, ^{13}C coupling constants, Solid state NMR, Magic angle spinning, Elementary NQR spectroscopy.	12	2,3,4,5

7	**EPR and Mossbauer Spectroscopy** Electron spin interaction with magnetic field, Hyperfine coupling, spin-orbit coupling,g factor, significance of g factor, determination of $g_{\parallel}$ and $g_{\perp}$, Fine and hyperfine structures, Kramers' degeneracy, McConnell equation. Basic principles of Mossbauer Spectroscopy, Doppler Effect, Chemical shift, application to metal complexes	12	2,3,4,5

References

1. *C.N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edn., Tata McGraw Hill, 1994.*
2. *G. Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall of India, 2001.*
3. *H. Kaur, Spectroscopy, 6th Edn., Pragati Prakashan, 2011*
4. *R.S. Drago, Physical Methods in Chemistry, Saunders College, 1992.*
5. *K.J. Laidler, J.H. Meiser, Physical Chemistry, 2nd Edn., CBS, 1999.*
6. *D.N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques, Universities Press, 2001*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five-year Integrated M.Sc. (Chemistry)**					
Course Name	**Advanced Physical Chemistry**					
Type of course	**Core**	**Credit Value**	**3**			
Course code	**IMSC803CH**					
Name of Faculty						
Course Summary& Justification	Basic concept, possible interactions in sensors. Monitoring and optimization of a sensor. Selectivity of sensors. Design and fabrication of molecular sensors and devices. Upon completion of the course students will learn the basic principles and design of chemical sensors with specific selectivity towards analytes and different approaches for monitoring selectivity.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Basic Knowledge in physical chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	To know the importance of molecular recognition and nature of bindings involved in biological systems.	U	1
2	To get familiarize with the principles and possible interactions in sensing technology	A	3
3	To investigate the sensor analyte interaction using various approaches.	Ap	1,2
4	To introduce students to have knowledge in the development of sensors.	A	1
5	Understand and analyze the performance factors of sensors	U, An	1,2
6	Applications of sensors in the miniaturization of molecular devices	A	4

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Sensors** Introduction to sensors, Transduction elements- Electrochemical transducers Potentio- metry and ion selective electrodes, Voltametry and Amperometry, Field effect transi- stors, Modified electrodes, thin film and Screen-printed electrodes, photometric sensors.	18	1,2
2	**Sensing Element** Ionic recognition, Molecular recognition- chemical recognition agents, Spectroscopic recognition, biological recognition agents, immobilization of biological components	18	1,2,3
3	**Performance Factors of Sensors** Selectivity, sensitivity, response time, recovery time, lifetimes, Precision, Accuracy and Repeatability, Basic principle, Instrumentation and application of Mass sensitive and thermal sensor, optical sensors, Potentiometric Biosensors. Examples of recent developments from current literature.	18	3,4,5
4	**Molecular Devices** Molecular Electronic devices, Molecular wires, Molecular rectifiers, Molecular switches, and Molecular logic gates. Examples of recent developments from current literature.	18	5,6

References

1. *Brain R. Eggin; Chemical Sensors Bio sensors; Wiley India Pvt. Ltd, 2002*
2. *Potyrailo R. A; Vladimir M. Mirsky; Combination Method for Chemical and Biological Sensors; Springer, 2009*
3. *Jiri Janata; Principles of Chemical Sensors; Plenum; New-York 1989*
4. *Otto S. Wolfbeis; Fiber Optic Chemical Sensors and Biosensors; CRC Boca Raton FL, 1991*
5. *Lehn, J. M., Supramolecular Chemistry-Concepts and Perspectives, Wiley –VCH (1995).*
6. *Beer, P.D., Gale, P. A., and Smith, D. K., Supramolecular Chemistry, Oxford University Press (1999).*
7. *Steed, J. W., and Atwood, J. L., Supramolecular Chemistry, Wiley (2000).*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five-year Integrated M.Sc. (Chemistry)**					
Course Name	**Reactions & Reagents in Organic Synthesis**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC804CH**					
Name of Faculty						
Course Summary& Justification	Understanding reactions and reagents are the core of organic chemistry study. This enables to understand the various reagents and reactions needed to carry out a reaction and is inevitable to understand modern organic chemistry. Learning this course will provide a key concept of the reaction mechanism. Understanding this subject will enable the students to work in frontier areas of multidisciplinary sciences. This course is designed to provide students with a good understanding of organic reactions and their applications. This knowledge will be very beneficial in medicinal chemistry, especially drug discovery.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Basics of Organic chemistry including basic concepts of stereochemistry and reaction pathways.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Acquires the ability to design reactions.	U, A	1
2	Acquires the skill to propose the mechanism of reactions	S	3
3	Students will be able to predict suitable reaction conditions to carry out organic reactions.	A	2,3,4
4	Acquires the knowledge to transform molecules using functional group inter conversions.	U, A	4,5
5	Work in the interdisciplinary and multidisciplinary areas of chemical sciences and its applications.	A	6,7
6	Be able to work productively and collaboratively as a team member by solving problems with other students.	S	5,6,7,8
7	Provide students with the skills required to succeed in master program and enrich them with a basic skill to perform at R & D chemical industrial level.	S, A	4-8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Carbanion Chemistry** Robinson annulation-Condensation involving imine and iminium ions-Mannich and Knoevenagel Reactions-Acylation of trimethylsilyl carbanions-Peterson carbanions-Wittig reaction- Sulfur ylides- Darzens Reaction-Acyl anion equivalents-lithio-1,3-dithianaes-Umpolung.	13	1,2
2	**Organometallic Chemistry** Organo- lithium and magnesium reagents-Formation and reactions-Organozinc reagents-Reformatsky reaction-Organocopper intermediates-Organopalladium reagents-Vinylation of aryl and alkenyl halides. Use of Organo Li, Cu, Cd, Hg, B, P, Si reagents in organic synthesis	14	2,3
3	**Electrophilic Reactions** Electrophilic reactions of C-C multiple bonds-Oxymercuration-Iodolactonization-selenolactonization-Cycloaddition induced by electrophilic sulfur reagents- a-halogenation, sulfenylation and selenylation of carbonyl compounds-Hydration of alkynes.	13	4,5
4	**Oxidation Reactions** Oxidation of C-C and C=C to oxiranes, 1,2-diols and carbonyl compounds-Oxidative cleavage- Ozonolysis- Singlet oxygen-Oxidation of alcohols to ketones-Oxidative rearrangements to ketones-Considerations of the selectivity of common reagents for oxidation-B_2H_6/H_2O_2 peracids, SeO_2, Quinones, Tl^{3+}, CrO_3, $KMnO_4$, MnO_2, OsO_4, $AgOAc/I_2$, $Cu(OAc)_2$, $NaIO_4$, DMSO.	16	5,6, 7
5	**Reduction Reactions** Catalytic hydrogenation, Hydrogenation of C-C multiple bonds-Birch reduction-Diborane and alkyl boranes-Reduction of aldehydes, ketones and carboxylic acid derivatives with hydrides-Reduction with N_2H_4 and N_2H_2-Wolff-Kishner type reduction-Barton olefin synthesis-Mc Murry coupling-Pinacol coupling-General consideration on the selectivity of common reagents for reduction.	16	5,6, 7

References

1. *Advanced Organic Chemistry Part A, F. A. Carey and R. J. Sundberg, Springer, 2007*
2. *Advanced Organic Chemistry Part B, F. A. Carey and R. J. Sundberg, Springer, 2007*
3. *Modern Synthetic Reactions (2nd Edition) H. O. House, W. A. Benjamin Inc, Mento Park, 1972.*
4. *Advanced Organic Chemistry (4th Edition) J. March, Wiley India, New Delhi, 2005*
5. *Principles of Organic Synthesis (3rd Edition) R O C Norman, J. M. Coxon Blackie Academic, 1993*
6. *Reagents for Organic Synthesis M. Fieser, J. G. Smith, Wiley New York, 1988, All volumes*
7. *Oxidations in Organic Chemistry M. Hudlicky, American Chemical Society 1990*
8. *Reductions in Organic Chemistry M. Hudlicky, Ellis Horwood 1986*
9. *Organic Chemistry, J. Clayden, N. Greeves, S. Warren, Oxford University Press, 2014*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Direct Instruction: Lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%)-Internal Tests, Assignments Seminar Presentation, Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Physical Chemistry Lab**		
Type of course	**Core**	**Credit Value**	**2**
Course code	**IMSC805CH**		
Name of Faculty			
Course Summary& Justification	To have hand-on experiences of techniques for verifying physical and chemical properties.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning independent learning			36	24	60

Pre-requisite	Bachelor's degree in chemistry, with physics and mathematics as subsidiaries.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	To conduct the experiment on various instrumental techniques.	A	1,4,6
2	To measure various physical and chemical properties.	A	2
3	To describe the principles behind the experiment performed in the laboratory.	Ap	1
4	To interpret the experimental results obtained by various techniques.	An	4
5	To understand the principles behind the experiment performed in the laboratory.	U	5
6	The students will acquire knowledge of experimental techniques for controlling the chemical reactions.	C, S	1,3,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Surface Chemistry** Study the adsorption of acetic acid by activated charcoal and verify the Langmuir and Freundlich adsorption isotherms	5	1,2,6
2	**Chemical Kinetics** Study the kinetics of the acid-catalysed hydrolysis of methyl acetate and evaluate the value of the rate constant, Evaluate the activation energy for the acid catalysed hydrolysis of methyl acetate	5	1-6
3	**Phase Equilibria** Determine the transition temperature of the given salt hydrate, Determine the CST of phenol-water system, Role of an electrolyte on the CST of phenol-water system.	5	1-6
4	**Thermodynamic Properties of Solution** Determine the partition coefficient for the distribution of succinic acid between water and 1-butanol, Determination of partition coefficient of benzoic acid between toulene and water.	5	1-6
5	**Conductometry** Determination of cell constant, Verification of Onsager equation and determine the equivalent conductance at infinite dilution of strong electrolyte, Determine the concentration of the given strong acid by conductometric titration with a strong base	5	1-6
6	**pH Measurements** Determine the concentration of the given acid by pH measurements, Determine the isoelectric point of the given amino acid by pH measurements	5	1-6
7	**Optical Measurements in Chemistry** Determine the refractive index of the given liquid by Abbe refractometer, and hence the specific and molar refraction, Determine the molar refractivity of water, methanol, acetic acid, ethylacetate , 1,4-carbon tetrachloride and calculate the refraction, equivalents of C, H , O and Cl, Determine the specific, molecular and intrinsic rotations of the given optically active substance, Determine the concentration of the unknown solution of the optically active compound by polarimetric measurements, To study kinetics of inversion of cane sugar by optical rotation measurement	6	1-6

References

1. Experiments in Physical Chemistry, Third Editon, Shoemaker, Garland and Steinfeld, McGraw-Hill,1967.

2. Practical Physical Chemistry, B. Viswanathan and P. S. Raghavan, Viva Books Pvt. Ltd., N. Delhi, 2005

3. *Advanced Practical Physical Chemistry, J. B. Yadav, 29th edn., 2010, Krishna Prakashan Media Pvt. Ltd., Meerut*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Contact classes, Tutorials, Seminar, Assignments Seminar, Authentic learning, Library work, independent studies Presentation by individual student
Assessment Types	**Mode of Assessment** Lab/Experiment skills • Lab record/Report • Viva-voce • Lab Discipline (participation, punctuality, accuracy)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Organic Chemistry Lab**		
Type of course	**Core**	**Credit Value**	**2**
Course code	**IMSC806CH**		
Name of Faculty			
Course Summary& Justification	This course is designed to give the student awareness about the safety measures to be taken in the lab, familiarize the different glassware and equipment used, separation of the components presents in the given binary mixture organic compounds using appropriate separation methods and analyzing the separated components using standard procedure. Students will be introduced to the structure, reactivity, and analysis of organic molecules. Preparation of different organic molecules from simple molecules is also included in the course.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning independent learning			36	24	60
Pre-requisite	Basic knowledge in practical organic chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Learn how to handle organic chemicals, glassware and precautions to be taken for safety in a Chemistry lab	U	1,2,3
2	Able to separate the components from a mixture using suitable methods and analyse the components using various reagents and reactions.	U, A	1,4,5
3	Able to perform experiments individually and gain knowledge about principles and techniques involved in various experiments	An	2,3
4	Evaluate the properties of synthesized compounds through spectroscopic and analytical data	U, An, E	2,3,7
5	Analyze the mechanisms of the reactions in the experiment performed.	C, S, Ap	3,6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Organic Analysis** Organic analysis-separation of two-component mixtures, Identification of individual components, Separation, Purification and analysis of the components, Preparation of their derivatives, Determination of physical constants of the components and its derivatives, Preparation of simple organic molecules and identification using Physical methods	18	1-5
2	**Organic Preparations** Preparation of simple organic molecules, characterisation of the prepared compounds by determining m.p/b.p, chromatographic and spectroscopic techniques	18	1-5

References

1. *I. Vogel, B. S. Furniss, Vogel's Text Book of Practical Organic Chemistry, 5th Edn. 1989.*
2. *2. B. Dey, M. V. Sitaraman, T. R. Govindachari, Laboratory Mole of Organic Chemistry, Allied Publishers, 1992.*
3. *2. M. P. Doyle, W. S. Mungall, Experimental Organic Chemistry, John Wiley & Sons, 1980.*
4. *3. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th Edn. Pearson Education, 2009*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Contact classes, Tutorials, Seminar, Assignments Seminar, Authentic learning, Library work, independent studies Presentation by individual student
Assessment Types	**Mode of Assessment** Lab/Experiment skills • Lab record/Report • Viva-voce • Lab Discipline (participation, punctuality, accuracy)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Photochemistry and Pericyclic Reactions**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE807CH-1**		
Name of Faculty			
Course Summary& Justification	This course essentially encompasses two components. The first component is the advanced course materials on photochemical and photophysical processes and their applications. Here some modern instruments which work under the principle of photochemistry are discussed to get an understanding of the present and possible future applications of photochemistry. In addition, a concise discussion on reactive intermediates like singlet oxygen, carbenes and nitrenes is also included as an application of photochemistry. In the second part, pericyclic reactions are discussed with an emphasis on light-initiated and heat-initiated reactions and their different outcomes. Most common and complex pericyclic reactions are discussed to get an understanding of the synthetic utility of this technique while designing complex molecules. Therefore, the second part gives an advanced know-how on synthetic organic chemistry with an added stress on photochemical pathways		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-		24	60

Pre-requisite	Basics of Organic Chemistry, stereochemistry, and reaction mechanisms

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Learn basic concepts of organic photochemistry and pericyclic reactions	U	1,2
2	Understand the reaction mechanism of organic photochemical reactions and pericyclic reactions	U, An	1,2
3	Predict the product of a reaction under photochemical or thermal conditions	A	2,3
4	Develop the skill to propose the possible mechanism of a given photochemical or pericyclic reaction	S	2,5,6
5	Gain knowledge of the synthetic applications of organic photochemical reactions and pericyclic reactions.	Ap	5,3,6

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Photochemical Reactions** Photochemical reactions involving *cis- trans* isomerisation, Saturated and unsaturated ketones, Enones and Dienones, di-p -methane rearrangement,Rearrangement of aromatic compounds Barton's Reaction, Photofragmentation, Photoaddition, Photosubstitution, Cycloaddition, Paterno- Buchi reaction, DeMayo reaction, Singlet oxygen generation, Structure and applications, Photoinduced electron transfer and energy transfer reactions (PET), Marcus theory of photochemistry, Photochemical Generation, Structure and reactivity of carbenes and nitrenes, Photochemistry of nanomaterials and quantum dots, Single molecule photochemistry	18	1,2,5
2	**Pericyclic Reactions** Classification of Pericyclic reactions- electrocyclic, cycloaddition and sigmatropic reactions, Symmetry properties of molecular orbitals, Correlation diagrams, Woodward Hoffman rules, Analysis of Pericyclic reactions using Frontier Molecular Orbital (FMO), Perturbational Molecular Orbital (PMO) theories, Exo–Endo selectivity in Diels-Alder reactions	18	2,3,4,5

References

1. *R.B.Woodward and R. Hoffmann, 'The Conservation of Orbital Symmetry'.Verlag Chemie, Weiheim and Academic Press, New York, 1970*
2. *G.B.Gill and M.R. Wills, Pericyclic Reactions. Chapman and Hall Chemistry Text Book Series 1974*
3. *Fleming, Frontier Orbitals and Organic Chemical Reactions, Wiley, London 1976.*
4. *S.M. Mukerji and Mac Millan, Pericyclic Reactions - A Mechanistic Study, New Delhi, 1979.*
5. *Roland E. Lehr and Alan P. Marchand, Orbital Symmetry, A Problem solving Approach, Academic Press, 1972*
6. *K.K. Rohatgi Mukherjee, Fundamentals of Photochemistry, Wiley Eastern Ltd., New Delhi, 1978*
7. *Photochemistry: A Modern Theoretical Perspective (Theoretical Chemistry and Computational Modelling) by Maurizio Persico (Author), Giovanni Granucci (Author) (2018 edition)*
8. *Literature reviews*

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Bioinorganic Chemistry**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE807CH-2**		
Name of Faculty			
Course Summary& Justification	This course provides the students a detailed knowledge on fundamental aspects of the bioinorganic chemistry. The students will understand the role of metal ions and inorganic complexes in biological processes. They will learn about metal toxicity as well as the application of inorganic complexes as therapeutics. This course will give a strong foundation to carry out research on metalloenzyme applications, inorganic biomaterials, and pharmaceutical development.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-	-	24	60
Pre-requisite	Basic knowledge in Inorganic Chemistry and Biology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Apply the basic principles in inorganic and general chemistry to bioinorganic chemistry.	A	1
2	Understand the importance of metals in biological systems.	U	3
3	Remember the structure and functions of metalloproteins and Metalloenzymes	R	1
4	Explain the role of metal ions which are involved in electron transfer reactions in biological systems.	R	1
5	Identify the metal centers involved in oxygen transport in living organisms and comprehend the mechanism of this process.	E	1,7
6	Understand the biological role of Iron, copper, zinc and Molybdenum	U, An	1,6,7
7	Know the medical applications of bioinorganic compounds	U, A	1,2,3

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Bioinorganic Chemistry of Alkali and Alkaline Earth Metals** Essential elements in biological systems, Transport of ions across biological membranes, Na^+/K^+ pump, Transport and structural role of calcium	5	1,2
2	**Bioinorganic Chemistry of Iron** Myoglobin, Hemoglobin, Cytochromes, Cytochrome P-450, Cytochrome c oxidase, Transport, and storage of Iron: Ferritin, Transferrin, Siderophores, Catalase and peroxidase, non-heme protein: Hemerythrin and Fe-S clusters, Model compounds of these proteins/enzymes.	8	3-6
3	**Bioinorganic Chemistry of Copper, Zinc and Molybdenum** Type I, II and III Copper proteins, Zn-containing enzymes, Zn-finger proteins,Alcohol dehydrogenase, Xanthine oxidase, Aldehyde Oxidase, Model compounds of these proteins/enzymes.	7	3-6
4	**Nitrogen Fixation, Photosynthesis and Vitamin B_{12}** Nitrogen fixation and nitrogenase enzyme, Photosynthesis, Vitamin B_{12} and B_{12} coenzymes, Model compounds of these proteins/enzymes.	4	3,4,6
5	**Metal Ions and Diseases** Role of Mn, Ni, Mo and Cr in biology, Metallothioneins, Metal toxicity, Thalassaemia, Wilson disease and Sickle-cell anemia.	5	6
6	**Medicinal Bioinorganic Chemistry** Metal ion based (Pt, V, Au) drugs, Chelation therapy, Macrocyclic antibiotics, Photodynamic therapy, MRI imaging and contrast agents.	3	7
7	**Biomimetics and Supramolecular Chemistry** Biomimetic compounds, Picket-fence porphyrin, Crown ethers, Cryptands and cryptates, Calixarenes and cyclo-dextrins	4	1,7

References

1. *J. E. Huheey, R. A. Keiter, R. L. Keiter, Inorganic Chemistry-Principles of Structure and Reactivity, 4th Edn., Prentice Hall, 1997.*
2. *F. A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th Edn., Wiley-Interscience, 1999.*
3. *P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver and Atkins Inorganic Chemistry. 4th Edn., Oxford University Press, 2006.*
4. *J. D. Atwood, Inorganic and Organometallic Reaction Mechanism 2nd Edn., Wiley-VCH, 1997*
5. *B. E. Douglas, D.H. McDaniel, J. J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edn., Wiley-India, 2007.*
6. *W. Kaim, B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, John Wiley & Sons, 1994.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Polymer Materials**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE807CH-3**		
Name of Faculty			
Course Summary& Justification	Polymer materials course is designed to provide a detailed knowledge and idea about various types of polymer materials and to investigate their properties to obtain desired applications. The syllabus covers the fundamental understanding of all the important types of polymers and related topics so as to enable the learners to acquire sufficient knowledge and awareness about different classes of polymer materials. This course commences with highlighting the relevance of polymers in the development of human civilization. The syllabus mainly covers the synthesis, properties and applications of important polymeric materials including natural, synthetic, and semi synthetic polymers. This course further offers an awareness of the recent trends and advancements in the field of polymeric material research and related applications. After completion of this course, students are expected to have detailed understanding about almost all-important polymeric materials and to acquire sufficient knowledge and ability to identify and differentiate between them in terms of its properties and applications.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-	-	24	60

Pre-requisite	Basic knowledge in different types of polymers.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	To familiarize with various types of polymers	R, U	1,6
2	To Acquire a sound knowledge about the fundamentals and importance of Polymer materials	U, I	1,3,6
3	To classify the polymers based on structure, functionality, and properties.	U, An	1,2,4
4	To understand the peculiarities of individual polymer materials and compare each other	U, A, E	1,4,7
5	To Evaluate and correlate various polymer properties for specified applications	A, An, E	3,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Polyolefins** Polymer as plastics, rubbers and fibres, Comparison of polymers with other engineering materials such as metals and ceramics, LDPE, LLDPE, HDPE. UHMWPE, chlorinated and chlorosulphonated polyethylenes, polypropylene, Vinyl polymers: PVC, polyvinyl acetate, polyvinyl alcohol.	10	1,2,3
2	**Acrylic and Styrenic polymers** PMMA, polyacrylonitrile, polyacrylic acid, cyanoacrylates, Polystyrene, high impact polystyrenes-rubber modified polystyrenes, SAN, ABS, foamed polystyrene-thermocole.	6	1,2,3,4
3	**Fluorocarbon Polymers and Other Thermoplastics** PTFE, PCTFE, PVF, PVDF, Polycarbonate, polyacetal resin, Thermoplastic condensation polymers: Polyesters-PET, PBT, Silicon based polymers.	6	3-5
4	**Fibers and Thermosets** Acetate rayon, viscous rayon, polyester, nylon, acrylics, and Kevlar. Unsaturated polyester-epoxy resins, PF, UF and MF, Various prepolymer products, curing agents for these resins.	8	4,5
5	**Elastomers** NR latex, dry rubber, technically specified and classified rubbers, SBR, BR, IIR, IR, EPDM, special purpose rubbers such as CR, NBR, fluorocarbon rubbers and silicone rubbers.	4	4,5

References

1. *J. A. Brydson, Plastic Materials, Newness-Butterworth*
2. *F.W.Billmeyer, Text Book of Polymer Science, Wiley interscience, 1976.*
3. *J. M. G. Cowie, Polymers: Chemistry & Physics of Materials, Int. Text Book Company Ltd,1974.*
4. *D. Feldman, A. Barbalata, Synthetic Polymers, Springer, 1996.*
5. *R.W. Hyson, specialty polymers, Chapmann and Hall, 1987*
6. *Frazer A.H. High temperature resistant polymers.. Wiley inter science,1963*
7. *C.M. Blow, C. Hepburn, Rubber Technology and Manufacture, 2nd Edn., Butterworth Scientific, 1982*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests, Assignments, Seminar, Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Natural Products Chemistry**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE807CH-4**		
Name of Faculty			
Course Summary& Justification	This course introduces the broad field of Natural Products Chemistry by reviewing the major classes of Natural Products. The students will study the isolation, classification, identification and synthesis of natural products.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-	-	24	60
Pre-requisite	Basic knowledge of organic chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Provide an overview of the field of natural product chemistry	U	1
2	Identify the different classes of natural products	An	2
3	Explain the different methods used for the isolation and purification of natural products	A	2,6
4	Discuss the various degradation techniques employed in the structure elucidation of natural products	R	6
5	Outline the synthesis of typical compounds belonging to different classes of natural products	Ap	7,8
6	Understand the pharmacological effects of natural products and their applications in the field of medicinal and drug chemistry.	U	1,4
7	Design alternate routes for the synthesis of some terpenes and alkaloids	C	6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Alkaloids** General introduction on natural products, Methods for the isolation and purification of natural products Alkaloids- classification, Isolation and purification, Methods for the structure elucidation of alkaloids Synthesis of atropine, quinine, reserpine and morphine	8	1-7
2	**Terpenes** Terpenoids- general properties and classification, Methods for the isolation and purification of terpenoids, Structure elucidation and synthesis of citral, α-pinene, camphor, carotenoids and longifolene. Structure of taxol, synthesis, Biosynthesis of terpenes	8	1-7
3	**Lipids and Steroids** Fatty acids and triglycerides- occurrence, and isolation, Classification, Membrane lipids Soaps and micelles, Biosynthesis of lipids Steroids- Nomenclature, stereochemistry, Physical methods of characterization and properties, Cholesterol, ergo sterol, vitamin D, progesterone, testosterone and cortisone, Biosynthesis of cholesterol.	8	1,2,3
4	**Flavanoids and Prostaglandins** Structure and properties of Flavonoids and Isoflavanoids, Tests for Flavanoids, 5.3 Isolation and Purification of Flavanoids Prostaglandins – Structure, classification and biological functions, 6.2 Types of Prostaglandins, nomenclature, biosynthetic pathway, *Prostaglandins* E2 and F2.	6	1,2,3,6
5	**Pheromones** Pheromones: ***introduction***, ***examples, and importance in IPM synthesis of juvabione bombycol***, grandisol, and disparlure,Structure and Biological Functions, Types of Pheromones	6	2,3,6

References

1. *I.L. Finar, Organic Chemistry, Vol. 2, 5th Edn., ELBS, 1995.*
2. *N.R. Krishnaswamy, Chemistry of Nat. Products: A Laboratory Handbook, CRC Press, 2012.*
3. *J. Clayden, N. Greeves, S. Warren, P. Wothers, Org. Chemistry, Oxford Uni. Press, 2000.*
4. *F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry Parts A & B, 5th Edn., Springer, 2007.*
5. *P.S. Kalsi, Chemistry of Natural Products, Kalyani Publishers, 2001.*
6. *S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Springer, 2005.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests, Assignments, Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Instrumental Methods of Chemical Analysis**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC901CH**		
Name of Faculty			
Course Summary& Justification	The study of Instrumental Methods of chemical analysis provides adequate knowledge of the principles, instrumentation, and applications of common analytical methods. Through this learning, it is possible to acquire the necessary skills, to enable students to select a particular analytical technique to solve a problem and to select the most appropriate methodologies for analysis. Learning this course will also provide good laboratory practices and design an analytical experience to solve a real problem. Understanding this subject will enable the students to work as a team and interpret and communicate the analytical results of various analyses.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc.	54	18		18	90

Pre-requisite	Basic knowledge about chemistry and material science at the bachelor's level.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basic principles, and instrumentation of IR, UV and spectrophotometry.	U	1
2	Understand the principles of XRD analysis. Elucidate the crystal structure using X-ray diffraction and correlate the XRD information with the crystal structure.	A	1
3	Understand various thermal analytical techniques. Apply this tool to characterize and interpret thermograms and phase diagrams of various systems.	U, An	2,3,4
4	Gain insight into different microscopic techniques and apply this tool to evaluate the different structures.	E, A	6,8
5	Explain and rationalize the structural, thermal and morphological properties of solids	An	7
6	Explain the applications of various spectroscopic techniques as an analytical tool to evaluate the properties of structures.	U, An, A	2,3,4,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to Instrumentation** Principles of Instrumentation: Characteristics of measurement system: Introduction- Functional units -Classification (automatic/manual type, self-operated/power operated, analogue/digital)-Performance characteristics (Static/dynamic characteristics) –Zero order instrument and first order instrument. Signal and noise- types of noises- chemical noise- instrumental noise -thermal-shot – flicker and environmental noise- S/N ratio and its significance- techniques for S/N enhancement – hardware and software methods	15	1,2
2	**Spectrophotometry** Spectrophotometry: Interaction of electromagnetic radiation with matter- classification of methods- Beer Lambert law- Deviation from Beer Lambert law, UV- Visible spectrometry**:** Origin of absorption spectra, components of typical instrument – Source- Tungsten filament lamp, Hydrogen and Deuterium discharge lamps. Wavelength selectors- filters, prisms, and grating -Sample cell - Detectors Single and double beam spectrophotometers	14	1,2
3	**I.R spectrophotometry** I.R spectrophotometry: classification of the types-Sources – Nernst glower, globar, Nichrome wire-Wavelength selectors-Sample cell – characteristics- sample preparation- solvent selection-Detectors – thermal, pneumatic and pyroelectric-NDIR instruments	10	1,2
4	**Analytical Techniques** Potentiometry, polarography, amperometry, bi-amperometry, spectrophotometry, flame photometry, atomic absorption spectroscopy. Atomic spectroscopy: (1) AAS – Principle- typical instrumentation (2) AES: Excitation techniques- arc, spark and ICP, Principles of ion-exchange, solvent extraction, and chromatographic techniques.	13	3,4
5	**Thermal Method of Analysis** Principles and applications of thermogravimetry (TG), differential thermal analysis (DTA), differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA).	10	3,4,5
6	**Material Characterization techniques** Applications of X-ray diffraction, small angle X-ray scattering (SAXS), scanning electron microscopy (SEM), transmission electron Microscopy (TEM) and scanning probe microscopy (SPM).	10	2,4,5, 6

References

1. *Vogel's Texbook of Quantitative Inorganic Analysis, 6th Edn., Prentice Hall, 2000.*
2. *D.A. Skoog, D.M. West, F.J. Holler, Fundamentals of Analytical Chemistry, 7th Edn., Sauders College, 1996.*
3. *W.W. Wendlandt, Thermal Analysis, 3rd Edn., Wiley, 1986.*
4. *G. Cao, Y.Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific, 2010.*
5. *D.Patranabis, Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw-Hill Company Delhi.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Organometallic Chemistry**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC902CH**		
Name of Faculty			
Course Summary& Justification	This course introduces the basic concepts of organometallic chemistry with an emphasis on transition metal complexes. The students will understand the structure and bonding of organometallic complexes bearing various σ-bonded and π-bonded ligands. They will learn about the unique reactions shown by organometallic compounds and their mechanisms. This course highlights the application of organometallics in catalysis that is industrially important.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90
Pre-requisite	Basic knowledge of Inorganic Chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the fundamental concepts of organometallic complexes such as the 18-electron rule.	U	1
2	Explain and rationalize the structure and bonding of organometallic compounds with σ- and π-bonded ligands	An	1
3	Apply spectroscopic techniques to characterize organometallic compounds	A	2,7
4	Identify the fundamental reactions of organometallic compounds and its mechanism.	An	3,6
5	Understand the fundamental concepts of metal clusters.	A	3,7
6	Design new organometallic complexes that have application in catalysis.	C	6,7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Structure and bonding in organometallics** Classification and nomenclature, Concept of hapticity, Structure prediction based on 18-electron rule,16-electron compounds, Synthesis, structure, bonding and IR spectra of metal carbonyls, Carbonylate ions, Carbonyl Hydride Complexes, Polynuclear carbonyls, Metal nitrosyls, Metal cyanides, Metal phosphines and biphosphines, Metal dioxygen and dinitrogen complexes	12	1,2
2	**Organometallic Compounds of Linear and Cyclic π-Systems and characterization of these compounds using spectroscopic techniques** Structure and bonding of complexes with chain pi-donor ligands: olefins, acetylenes, pi-allyl complexes, Metal-carbenes and metal-carbynes, Structure and bonding of complexes with cyclic pi-donors: cyclobutadiene, cyclopentadiene, benzene, cycloheptatriene and cyclooctatetraene, Structure, bonding and reactions of ferrocene, Metallocenes-Sandwich and half-sandwich compounds, Stereochemically non-rigid molecules, Fluxionality in organometallic compounds and characterization using NMR spectroscopy	15	1,2,3
3	**Metal Clusters** Dinuclear clusters, Multinuclear clusters: low and high nuclearity clusters, Electron counting schemes of multinuclear carbonyl clusters, Capping rules, The isolobal concept, Structural prediction of organometallic clusters.	10	1,2,5
4	**Reactions of Organometallic Complexes** Ligand substitution reactions in organometallic complexes, Oxidative addition and reductive elimination reactions, Migratory insertion reactions: 1,1-migratory insertion reaction and 1.2-insertion,4β-hydride elimination reactions, Cyclometallation reactions, orthometallation, oxidative coupling and metallacycles, Nucleophilic attack of coordinated ligands	13	4
5	**Catalysis by Organometallic Compounds** Alkene hydrogenation (Wilkinson's catalyst), Mosanto process, Cativa process, Water-gas shift reaction, Hydro-formylation reactions, Wacker process, Ziegler-Natta polymerization of alkenes, Fischer-Tropsch process, Alkene metathesis, Oligomerisation of alkenes and alkynes	12	4,5
6	**Applications of Organometallic Chemistry** Organometallics in industry, Organometallics in medicine-drugs, radiopharmaceuticals, tracers, Organometallics in agriculture, Organometallics in environmental science.	10	4-6

References

1. *R. H. Crabtree, The organometallic Chemistry of Transition Metals 4th Edition, John Wiley, 2005.*
2. *J. P. Collman, L. G. Hegedus, J. R. Norton and R. G. Finke. Principles and Applications of Organotransition Metal Chemistry. Oxford University Press, 2nd Edition.*
3. *J.E. Huheey. R.A. Keiter, R.L. Keiter, Inorganic Chemistry-Principles of Structure and Reactivity, 4th Edn., Prentice Hall, 1997.*
4. *F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6thEdn., Wiley-Interscience, 1999.*
5. *P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver and Atkins Inorganic Chemistry, 4th Edn., Oxford University Press, 2006.*
6. *J.D. Atwood, Inorganic and Organometallic Reaction Mechanism, Wiley-VCH, 1997.*
7. *B.E. Douglas, D.H. McDaniel, J. J. Alexander. Concepts and Models of Inorganic Chemistry, 3rd Edn., Wiley-India, 2007.*
8. *M. Bochmann, Organometallics and Catalysis : An Introduction, Oxford University Press, 2014.*
9. *W.K. Li, G.D. Zhou, T. Mak, Advanced Structural Inorganic Chemistry, Oxford University Press, 2008.*
10. *B.D. Gupta, A. J. Elias, Basis Organometallic Chemistry, Universities Press, 2013*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Advanced Organic Synthesis**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC903CH**		
Name of Faculty			
Course Summary& Justification	In this course, in addition to learning some new reactions and concepts in organic synthesis, the reactions learned in the previous semesters are applied, especially to complex organic molecules. This course enables the student to independently analyse a synthetic problem and arrive at a viable solution. Also equips the student to bring forth a plausible synthetic route to complex organic molecules of importance. Understanding this subject will enable the students to work in frontier areas of multidisciplinary sciences. This course is designed to provide students with a comprehensive understanding of organic reactions and their applications. This knowledge will enable the students to come up with synthetic strategies for organic transformations as well as equip them to design synthetic routes for complex organic molecules of natural and unnatural origin.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90

Pre-requisite	Common reactions and reagents in organic chemistry, Stereochemistry of organic compounds.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Acquires the ability to do chemical transformations.	U	1
2	Acquires the skill to propose the mechanism of reactions.	E, S	1,3
3	Equip the students to synthesize complex natural and unnatural compounds of importance by practicing retrosynthetic analysis.	A	2,3,4
4	Acquires the knowledge to transform molecules using functional group interconversions.	U, A	4,5
5	Work in the interdisciplinary and multidisciplinary areas of chemical sciences and their applications.	A	3,5
6	Be able to work productively and collaboratively as a team member by solving problems with other students.	S	6,7
7	Provide students with the skills required to succeed in master program and enrich them with basic skills to perform at R & D chemical industrial level.	A, S	7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Organometallics** Organometallics: Application of organotransition metal complexes in Organic synthesis with special reference to organopalladium chemistry-Heck reaction, Stille coupling, Kumada coupling, Suzuki coupling, Negishi coupling, Hiyama coupling, Sonogashira coupling and Cadiot-Chodkiewicz reaction.	14	1, 2
2	**Protection and Deprotection** Protection, activation and deprotection process in organic synthesis, Protection and deprotection of hydroxyl, carboxyl, carbonyl and amino groups.	12	1-4
3	**Metallocarbenes** Reactions and reagents in organic synthesis: Macrolactonization-Mitsunobu reaction-Metallocarbenes-Metathesis Reactions-Different types of metathesis reactions-Grubb and Schrock catalysts.	12	3,4
4	**Multicomponent reactions (MCR) and Combinatorial chemistry** Multicomponent reactions (MCR) and Combinatorial chemistry: Survey of multicomponent reactions-Passerini-Ugi-Biginelli-Introduction to Combinatorial chemistry	10	2
5	**Name reactions in organic synthesis** Name reactions in organic synthesis: Bamberger, Baylis-Hillman, Bergmann, Buchwald-Hartwig, Click, Dakin, Demjanov, Di-pi-methane, 1,3-dipolar, Mannich, Michael, Nazarov, Neber, Nef, Noyori, N-H-K, Pauson-Khand, Pechmann, Ritter, Sakurai, Shapiro, Stobbe, Tebbe and Vilsmeier reactions.	14	2-6
6	**Rearrangement reactions** Rearrangement reactions: Beckmann, Benzilic acid, Claisen, Curtius, Dienone-Phenol, Favorskii, Fischer-Hepp, Fries, Hoffmann, Lossen, Orton, Schmidt, Smiles, Sommelet-Hauser, Stevens, Von Richter, Wagner-Meerwein, Wittig and Wolff rearrangements.	10	4-7

References

1. *Advanced Organic Chemistry Part B F. A. Carey and R. J. Sundberg (5th edition): Springer, 2007*
2. *The Organometallic Chemistry of the Transition Metals R. H. Crabtree (2nd edition): John Wiley, 1994*
3. *Protective Groups in Organic Synthesis T. W. Greene, P. G. M. Wuts: John Wiley, 1999*
4. *Multicomponent Reactions J. Zhu, H. Bienayme (Ed), Wiley VCH, Weinheim 2005*
5. *Strategic Applications of Named Reactions in Organic Synthesis L. Kurti, B. Czako: Elsevier Academic Press 2005*
6. *Organic Synthesis J. Fuhrhop, G. Penzlin: VCH, Weinheim, 1994*
7. *Classics in Total Synthesis K. C. Nicolaou, E. J. Sorensen: Wiley VCH Weinheim 1996*
8. *Chemistry of Natural Products S. V. Bhat, B. A. Nagasampagi, M. Sivakumar: Narosa publishing New Delhi 2005*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Chemical Kinetics and Catalysis**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC904CH**		
Name of Faculty			
Course Summary& Justification	In chemical kinetics, the students will learn the rate laws of chemical transformations and experimental methods of determining the rate of a reaction. Also, they will be able to understand different types of Complex reactions and Applications of the method of integration, Differential method, Half-life method and Graphical method to solve for the concentration of chemical species during a reaction of different orders. After completion of this course, the students will be able to understand the collision frequency, kinetic energy and orientation of colliding reactant molecules affect the rate of a chemical reaction and, explain how enzymes act as biological catalysts and how they interact with specific substrate molecules.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	54	18		18	90

Pre-requisite	Concept of reaction rate, General form of the rate law for any chemical reaction, The relationship between the order of a reactant and the stoichiometric coefficient for the reactant in the overall balanced chemical equation, How the order of each reactant appearing in the rate law is determined, Distinguish between instantaneous rates and average rates.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	After Completion of this course, the student should be able to; Understand the concept of rate of change associated with chemical change, recognizing that the rate of change and how it can be measured	U	1,2
2	Identify the reaction order for a chemical change	S	6,7,8
3	Recognize the integrated rate laws and evaluate the order of the reaction from plots of concentration versus time, ln(concentration) versus time, and 1/(concentration) versus time	Ap	3,4,5,6
4	Apply integrated rate equations to solve for the concentration of chemical species during a reaction of different orders	A	3,4,5
5	Analyses and explain how enzymes act as biological catalysts and how they interact with specific substrate molecules.	An	1,2

6	Interpret potential energy profiles and use them to determine the activation energy and potential energy changes for a reaction.	C	7,8
7	Understand the differences between the kinetics of reactions in the gas phase, compared with those in liquid solutions	U, An	1,2,3
8	Evaluate and explain the distinction between diffusion-control and activation control of reaction rates in solutions	E	4,7
** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Reaction rates and order of reactions** Reaction rates and order of reactions, determination of order of reactions, Complex reactions (Free radical chain reactions, branching reactions, hydrogen-oxygen and Hydrogen –Halogen reactions.), Reversible, consecutive and opposing reactions, The Analysis of kinetics results: the method of integration, Graphical methods, half-life methods, Guggenhiem's method, the differential method, Reactions of variable order- steady state treatment, free radical reactions-the Rice Herzfeld Mechanism, Studies of fast reactions by flow method, Relaxation method and flash photolysis, Theories of unimolecular reaction and their treatments (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus (RRKM) theory.	18	1, 2, 3,8
2	**Reaction Dynamics** Collision theories of reaction rates, steric factor, Arrhenius equation, activated complex theory, Collision cross section and reaction cross section, Collision theory. Potential energy surfaces and reaction coordinate, Transition state theory, Comparative study of the theories of reaction rates, Thermodynamic treatment of Reaction rates, Kinetic theory of gases, Transport properties in gases	18	3,4,6
3	**Kinetics of reactions in solution** Diffusion controlled reactions, Effect of solvent on rates of reactions, lonic reactions and effect of ionic strength, Kinetic Salt effect, Dynamics of barrier-less chemical reactions in solutions, Effect of pressure on velocity of gas reactions, Homogeneous catalysis and Heterogeneous catalysis, Enzyme kinetics-Enzyme catalysis and its mechanism, Michelis –Menten equation, effect of pH and temperature on enzyme catalysis, Surface phenomena and physical methods for studying surfaces	18	4,5,7
4	**Kinetics of Polymerisaation** Cationic and anionic reactions, explanation of copolymerization in terms of kinetics, copolymerization equation	18	1,7, 8

References

1. *K.J.Laidler,Chemical Kinetics,4th Edn., Harper & Row ,*
2. *P.j .Flory, Principles of polymer Science, Cornel University*
3. *J. Rajaram, J.C. Kuriakose, Kinetics and Mechanisms of Chemical Transformations, Macmillan India, 2000.*
4. *K.J. Laidler, Chemical kinetics, 3rd Edn., Harper & Row, 1987.*
5. *Kalidas , Chemical Kinetic Methods: Principles of Fast Reaction Techniques and Applications, New Age International, 2005.*
6. *J.W. Moore, R.G. Pearson, Kinetics and Mechanisms, John Wiley & Sons, 1981.*
7. *P.W. Atkins, Physical Chemistry, ELBS, 1994*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Advanced Characterization lab**		
Type of course	**Core**	**Credit Value**	**2**
Course code	**IMSC905CH**		
Name of Faculty			
Course Summary& Justification	Chemical analyses and characterization techniques have an important role in modern science and technology. This course provides a solid theoretical background and advanced characterization techniques with a strong laboratorial component. After completing this course, students can solve characterization problems and develop skills in the scope of validation and implementation of analytical methods.		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	-	-	108	12	120
Pre-requisite	Basic knowledge in chemical analytical methods.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	To know the importance of instrumental techniques and its applications.	U	1
2	To experiment on various instrumental techniques.	A	1,2
3	To establish and develop the principles those are used to explain and interpret many of the physical and chemical observations.	A, Ap	2,3,4
4	To describe the principles behind the experiment performed in the laboratory.	Ap	4,6
5	To interpret the experimental results obtained by various techniques.	An	2,3,7
6	The students will acquire knowledge of experimental techniques for controlling chemical reactions.	S, C	7,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Surface Chemistry** Validation of Freundlich and Langmuir Adsorption Isotherm	13	1-6
2	**Kinetics, Photochemistry** Kinetics-Inversion of Sucrose and Mutarotation of Glucose Using Polarimetry	17	1-6
3	**Spectroscopy** Construction of Jablonski Diagram of Polyaromatic Compounds Estimation of Quantum Yield of Perylene and Pyrene Excimer Formation	18	1-6
4	**Computational Chemistry** Theoretical Estimation of Vibrational Frequencies	15	1-6
5	**NMR Spectroscopy** a. To Identify the Amino Acids Using COSY Spectrum b. Demonstration of the Application of the NMR Technique to Chemical Exchange Processes-Hydration of Pyruvic Acid	20	1-6
6	**Synthesis and Characterization of the following compounds** Synthesis of imine, Reduction of imine, Acetylation of glucose, Synthesis of dipicolinic acid	25	1-6

References

1. *M. Halpern and G. C. McBane, Experimental Physical Chemistry: A Laboratory Text Book, 3rd Edition, W. H. Freeman, 2006*
2. *D. P. Shoemaker, G. W. Garland and J. W. Nibler, Experiments in Physical Chemistry, 5th Edition, McGraw Hill, London*
3. *Vogel's Text book of Practical Organic Chemistry - Revised by Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, and Austin R. Tatchell, - 5ed., John Wiley & Sons, 1991.*
4. *Relevant literature*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five-year Integrated M.Sc. (Chemistry)**					
Course Name	**Cheminformatics**					
Type of course	**Elective**		**Credit Value**		**2**	
Course code	**IMSC907CH -1**					
Name of Faculty						
Course Summary& Justification	This course provide introduction to cheminformatics which is an interdisciplinary area on the interface of chemistry, informatics and biology. The students are expected to achieve a good grasp of the concepts and applications of cheminformatics. It is often used to relate the structures,chemical,physical properties and biological activities of molecules.					
Semester	**IX**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	-	-	24	60
Pre-requisite	Basic knowledge in chemical analytical methods.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Able to explain basic concepts of cheminformatics.	U	1
2	Define different methods of cheminformatics and provide examples in modern drug design.	A	1,2
3	To understand how the structures of chemicals influence their biological activities.	U, A	7
4	To know the most important data bases in chemistry for commercial use.	Ap	4
5	To understand the principles behind drug designing in cheminformatics.	U	8
6	The students will acquire knowledge to analyse chemical design strategies.	An, C	3

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Stereo Chemistry** Basic Stereochemistry, Amino acids and Proteins and Properties; pKa, pH and ionization of acids and bases; Protein structure - Primary structure, Secondary structure - helix & sheet; Tertiary structure; Quaternary structure; covalent and non-covalent forces that maintain structures. Introduction to drug action, pro drug design and applications	10	1-6
2	**Chemical Information** History of scientific information communication-chemical literature-chemical information chemical information search-chemical information sources-chemical name and formula searching-analytical chemistry-chemical history-biography-directories and industry sources. Chemical Structure: Databases, Formats, Drawing Tools and Structure Visualizations.	10	1-3
3	**Database Management** Introduction to data and Database; Data Type; Experimental sources of biological data; Publicly available databases; Database Management; Gene expression monitoring; Genomics and Proteomics; Metabolomics; Visualization of sequence data; Visualization of structures using Rasmol or Pymol or CHIME; Genetic basis of disease; Personalised medicine and gene-based diagnostics	10	1-4
4	**Structure based drug design** Introduction to drugs, Chemical structural data files, Structure-based drug design, Protein, structure, Drug action & enzymes. Drug action & receptors, Drug Design, Ligand-Based Design and De Novo Drug Design Virtual screening/docking of ligands. Pharmacophore Design, Molecular similarity and molecular descriptors. Prediction of Binding Modes, Protein–Ligand binding free energies, ADMET prediction, QSAR and 3D-QSAR Methods	6	5,6

References

1. *"Mathematical Methods for Physicists" Arfken, Academic Press 1985*
2. *Schaum's Outline of Probability and Statistics, Murray R Spiegel, John J. Schiller, R. Alu Srinivasan*
3. *Stereochemistry, by David G. Morris, Eddie Abel*
4. *Introduction to Protein Structure: Second Edition, Carl Branden , John Tooze*
5. *Combinatorial Chemistry and Molecular Diversity in Drug Discovery, Eric M. Gordon, James F. Kerwin*
6. *Computer-Aided Drug Design: Methods and Applications, T.J. Perun C.L. Propst*
7. *Chemical Information Sources (Mcgraw-Hill Series in Advanced Chemistry) ,Gary Wiggins*
8. *Introduction to Bioinformatics, Teresa K. Attwood, David Parry-Smith*
9. *Molecular Modeling: Basic Principles and Applications, 3rd Edition,Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Analytical & Nuclear Chemistry**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE907CH-2**		
Name of Faculty			
Course Summary& Justification	This course essentially encompasses two components. The first component is the advanced course materials on general analytical chemistry instruments, operation, sampling, and their applications. In addition, a concise discussion on specific sampling methods and titrations in non-aqueous media are also included as an application of analytical chemistry. In the second part nuclear reactions are discussed with an emphasis on nuclear activation techniques, light initiated and heat-initiated reactions and their different outcome. Most common and complex nuclear interactions with matter are discussed to get an understanding on the synthetic utility of this technique while designing such processes. A special emphasis is given to the importance of nuclear medicine owing to its importance in cancer research, towards the end of the discussion. Therefore, the second part basically gives an advanced know how on nuclear chemistry with an added stress on procedure and applications of nuclear radiations in the medical field.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36			24	60

Pre-requisite	Basic knowledge in inorganic chemistry.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the methods used in sampling for various analytical methods.	U	1
2	Learn about the general instrumentation in thermal analysis, chromatography, and microscopy	U, A	1,2
3	Identify the utility and specificity of each analytical instrument and will be able to generate and explain the output data from the analytical instruments.	An	2,3,7
4	Critically understand the nuclear reactions, methods of detection and quantification, the scope and limitations of nuclear reactions	U, An	1,2

5	Evaluate the utility of fluorescence spectroscopy and nuclear radiation therapy for qualitative and quantitative methods of analysis particularly in medicine.	E	2,3,7,8
* *Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Electro analytical techniques** Preparation of sample for analysis, Errors and treatment of data, solubility and solubility product, Common ion effect, Precipitation phenomena, Homogeneous precipitation, Organic reagents in inorganic analysis. Titrations in non-aqueous media, Potentiometry, Polarography, Amperometry, Bi-amperometry, Spectrophotometry, Flame photometry, atomic absorption spectroscopy.	10	1,3
2	**Instrumentation Techniques** Principles of ion-exchange, Solvent extraction, Chromatographic techniques, Thermal method of analysis: Principles and applications of thermogravimetry (TG), Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Dynamic mechanical analysis (DMA). Applications of X-ray diffraction, small angle X-ray scattering (SAXS), Scanning electron microscopy (SEM), Transmission electron Microscopy (TEM), Scanning probe microscopy (SPM).	10	2,3
3	**Nuclear Chemistry** Nuclear Chemistry: Nuclear reactions fission and fusion, Spontaneous and induced fission, Q-value, Cross sections, Working of nuclear reactors, Fission energy, Transuranic, Applications of radioactivity, Carbon dating.	8	4,5
4	**Radioactive techniques** Radioactive techniques: Neutron activation analysis, Tracer techniques, GM counter, Interaction of high energy radiation with matter, Radiation chemistry of water, Aqueous solutions and organic compounds	8	4,5

References

1. *I. Vogel, J. Mendhan, Vogel's Texbook of Quantitative Inorganic Analysis, 6thEdn., Prentice Hall, 2000.*
2. *D.A. Skoog, D.M. West, F.J. Holler, Fundamentals of Analytical Chemistry, 7th Edn., Sauders College,1996.*
3. *W.W. Wendlandt, Thermal Analysis, 3rd Edn., Wiley,1986.*
4. *G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific, 2010.*
5. *H.R. Arnikor, Essentials of Nuclear Chemistry, Wiley- Eastern, 1983.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five-year Integrated M.Sc. (Chemistry)**		
Course Name	**Heterocyclic Chemistry**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSE907CH-3**		
Name of Faculty			
Course Summary& Justification	The study of the chemistry of heterocyclic compounds introduces the basic idea of heterocyclic chemistry. Through this learning, it is possible to acquire relevant knowledge about various heterocyclic compounds, their preparation and properties. The syllabus also discusses the conformational studies of those compounds. Understanding this subject will enable the students to work in frontier areas of heterocyclics**.**		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36			24	60
Pre-requisite	Basic knowledge about chemistry at the bachelor's level					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Gain a theoretical understanding of the fundamentals of Heterocyclic compounds	U	1,6
2	Classify and write the nomenclature of various heterocyclic molecules	U, An	1,2,4
3	Explain the reactivity and other properties of heterocyclic compounds.	U, An	4,5
4	Develop synthetic strategies for heterocyclic compounds.	An, E	2,6,7
5	Application of heterocycles in drug synthesis.	Ap	7,8
6	Gain an idea of the reactions in heterocyclic compounds.	U, An	1,3,4

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction** Heterocycles- aromatic and non-aromatic, synthesis of pyridines, quinolines, isoquinolines, pyrroles, furans, thiophenes, indoles, pyrimidines, imidazoles, pyrazoles, aziridines, fused heterocycles, basicity of heterocycles.	8	1, 2,3
2	**Synthesis of heterocyclic compounds** Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions. Saturated heterocycles, synthesis of 3-, 4-, 5- and 6 membered rings, aromatic heterocycles in organic synthesis. Benzo-Fused Five - Membered Heterocycles: Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes. Six Membered Heterocycles: Synthesis and reactions of pyrylium salts, pyrones, quinolizium and benzopyrylium salts, coumarins and chromones, diazines, triazines, tetrazenes and thiazines.	10	1-6
3	**Synthetic approaches in heterocyclic chemistry** Different approaches towards the synthesis of three, four, five and six-membered rings. Photochemical approaches for the synthesis of four membered ringsoxetanes and cyclobutanes, ketene cycloaddition (inter and intra molecular), Pauson-Khand reaction, Volhardt reaction, Bergman cyclization, Nazarov cyclization, Mitsunobu reaction, cation-olefin cyclization and radical-olefin cyclization, Inter-conversion of ring systems (contraction and expansion)-Demjenov reaction, Reformatsky reaction. Construction of macrocyclic rings-ring closing metathesis.	10	1-6
4	**Name reactions in heterocyclic chemistry** Name reactions in heterocyclic chemistry: Bartoli reaction, Corey Chykovsky reaction, Darzen condensation, Jacobsen Katzuki reaction, Paterno Buchi reaction, Paal Knorr pyrrole synthesis, Paal Knorr furan synthesis, Fischer indole synthesis, Bischler Napieralski reaction, Pictet Spengler Synthesis.	8	1-6

References

1. *T.L. Gilchrist, Heterocyclic Chemistry, 3rd Edn., Longman, 2007*
2. *T. Laue, A. Plagens, Named Organic Reactions, 2nd Edn., John Wiley and Sons, 2005*
3. *M.B. Smith, Organic Synthesis, 3rd Edn., Wavefunction Inc., 2010.*
4. *F.A. Carey, R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edn., Springer, 2007.*
5. *S. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd Edn., Wiley, 2008.*
6. *. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th Edn., Cambridge University Press, 2004.*
7. *J. Clayden, N. Greeves, S. Warren,P. Wothers, Organic Chemistry, Oxford University Press, 2001*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Chemistry)**		
Course Name	**Major Research Project**		
Type of course	**Core**	**Credit Value**	**16**
Course code	**IMSC100PR**		
Name of Faculty			
Course Summary& Justification	As part of this course student is expected to carry out an Internship/ project work under the guidance of a research supervisor, in a reputed research/academic Institutions. This course will provide extensive training on methods and methodology of research in the area of study. Accordingly, the student shall acquire updated knowledge, skill and training on the area of research. At the end of this course student has to submit a detailed project report and present a seminar. It will be evaluated by the Examination Board consisting of both Internal and External Examiners.		
Semester	**X**		
Total Student Learning Time (SLT)	Total Learning Time		
	5-6 months		
Pre-requisite	Theoretical knowledge in chemistry and Basic laboratory skills.		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Acquire sufficient Knowledge, training and skills to undertake independent, original and critical research on a relevant topic.	U, A, S, E, C	1-8
2	Gain expertise in Scientific literature survey and academic writing and develop interest for further research	S, I, AP	2,7,8
3	Skills to effectively present the objectives, methodology, analysis, and results of the research study.	S	2,3,5,6
4	Familiarize with advanced and modern research topics/trends	U, Ap	1,2,4,8
5	Capability to plan and use adequate methods to conduct specific tasks in given frameworks	A,An	2,4,5,6,7
6	Gain a consciousness of the ethical aspects of research	U, An	2,3,6
7	Create, analyze and critically evaluate different problems and their solutions	An, E, C	1,2,7

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Course Description	Months	CO No.
Student shall carry out a 5 to 6 months of Research Project in a relevant area related to chemistry and submit the project report/dissertation at the end of the course.	5-6	1-7

Teaching and Learning Approach	**Laboratory Procedure (mode of transaction)** • Direct Instruction: Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training, Journal Club
Assessment Types	**Mode of Assessment** • Evaluation of the Project by the Examination Board consisting of the Chairman, both Internal and External Examiners based on the quality and quantity of the project work done, Report, and 30 minutes presentation at the End of the Semester (100 %)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Chemistry)**		
Course Name	**Comprehensive Viva Voce**		
Type of course	**Core**	**Credit Value**	**4**
Course code	**IMSC100VV**		
Name of Faculty			
Course Summary& Justification	The comprehensive viva-voce shall be conducted by the Examination Board consisting of Chairman, Internal Examiner and External Examiner. A thorough understanding of all the M.Sc. level course contents and recent trends in the broad area of chemical sciences are evaluated.		
Semester	**X**		
Total Student Learning Time (SLT)	Total Learning Time		
	-		
Pre-requisite	Thorough knowledge on all the M.Sc. level course contents		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Reproduce acquired knowledge/ understanding about the subject of study	R, U, A	1,2,4,7
2	Acquire more in-depth knowledge of the major subject of study and apply this knowledge in diverse contexts.	U, A, I	1-8
3	Develop problem solving ability by promptly analyzing /evaluating a problem	An, E, S	2,7,8
4	Increase communication skill and confidence of students by question answering and discussion.	S, I, Ap	2,5
5	Able to contribute to research and development work	I	2,3,8

** Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

Assessment Types	**Mode of Assessment** • A thorough understanding of all the M.Sc. level course contents and recent trends in the broad area of chemical sciences are evaluated through questions and discussions by the board of examiners at the End of the Semester (100%)