

Sant Gadge Baba Amravati University, Amravati
Faculty: Science and Technology
Programme: MSc Chemistry (Choice Based Credit System)

Program Outcomes

By the end of the Programme, students would be able to

PO1	Deep subject Knowledge and intellectual breadth	Apply the subject knowledge to the solution of real-world problems.
PO2	Professional Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the standard practices.
PO3	Creative & Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO4	Innovation, Research and Problem Solving	Identify, formulate, review research literature, and analyze complex problems reaching substantiated and innovative conclusions. Design solutions for complex problems with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. Use research-based knowledge and research methods to provide valid conclusions. Demonstrate the knowledge of, and need for sustainable development.
PO5	Team work and Communication Skills	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. Present/communicate research at national/international level, write effective articles, reports and design documentation, make effective presentations, and give and receive clear instructions. Communicate disciplinary knowledge to the community and broader public.
PO6	Professionalism and Leadership Readiness	Demonstrate personal accountability and effective work habits, e.g., punctuality, working productively with others, and time as well as workload management. Demonstrate integrity and ethical behavior, act responsibly with the interests of the larger community in mind, and to learn from his/her mistakes. Use the strengths of others to achieve common goals, and use interpersonal skills to coach and develop others. Assess and manage his/her emotions and those of others; use empathetic skills to guide and motivate; and organize, prioritize, and delegate work.
PO7	Lifelong learning	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
PO8	Competence for Digital World	Prepare well for living, learning and working in a Digital Society; Create, select, and apply appropriate techniques, resources, and modern ICT tools to complex activities with an understanding of the limitations. Use existing digital technologies ethically and efficiently to solve problems, complete tasks, and accomplish goals. Demonstrate effective adaptability to new and emerging technologies.
PO9	Global Citizenship	Act with an informed awareness of global issues. Engage in initiatives that encourage equity and growth for all.

Program Specific Outcomes:

On completion of M.Sc. Chemistry programme, graduates would be able to:

PSO-1: observe, analyze and interpret chemical phenomena and process

Sant Gadge Baba Amravati University, Amravati

PSO-2: design and develop new molecules/processes with industrial and societal applications

PSO-3: formulate new ideas/concepts in chemical sciences and test them

PSO-4: communicate effectively the principles and practice of chemical sciences

PSO-5: address issues of environment, health and development from a chemical perspective

PSO-6: follow professional ethics in all spheres of activity

PSO-7: function effectively as a member/leader in diverse teams/groups

PSO-8: engage in independent learning in the broadest context of scientific advancement

Employability Potential of MSc (Chemistry):

The scope of M.Sc Chemistry is very diverse when taking into consideration the various avenues that are available for students after graduation. The program MSc (Chemistry) offers the necessary knowledge, skills and attitude to nurture creativity. Some important skills and abilities honed by chemistry learners include:

- Cutting-edge scientific and numerical skills
- Curiosity to understand and solve
- Attention to collect and analyse details
- Patience and determination
- Research and development skills
- Analytical skills
- Use of ICT enabled techniques
- Written and oral communications skills

Apart from the technical and specific skills, a chemistry graduate also acquires fundamental professional skills throughout the degree program to pursue careers not directly related to the field. These skills include:

- Effective listening and communication skills
- Presentation and interaction skills
- Data collection, analysis and reporting skills
- Modern ICT enabled skills
- Aptitude to work proficiently independently or in a team

Equipped with a bunch of requisite knowledge, skills and attitude, a degree in chemistry is recognized as a symbol of quality and commitment by employers within and outside the realm of chemical industries.

The thriving and widely recognized branches of chemistry like Organic, Inorganic, Physical, Analytical, etc. not only expand critical thinking and the ability to understand other scientific and engineering concepts more easily, but also open new horizons to pursue career in different fields.

- Organic chemistry offers research and development of organic materials, modify and study carbon-based materials to develop a product having a specific purpose for wider use. They also accomplish various scientific studies to identify or find applications for compounds for society. Many industries like pharmaceuticals, agriculture, paints, dyes, and many more prefer to employ organic chemists.
- Inorganic chemistry has a greater potential in the fields of metallurgy, synthesis of new materials from different elements, bioinorganic, etc. It focusses on solving the fundamental problems associated with structure of atoms, molecules and their properties. Analytical chemists find their role for toxicology examinations, quality control and assessment, analysis of pharmaceuticals, investigations for forensic analysis, development of equipment, etc.
- Analytical chemists work for a particular private or government laboratory or organization, and also develop particular specialties like food technology, forensics or toxicology, to name a few.
- Physical chemistry enhances critical ability and inculcates problem solving skills among the learners. All industries rely heavily on physical parameters for manufacturing and quality assurance of products

Apart from the core branches of Chemistry, auxiliary branches like medicinal, industrial, petrochemical, geochemistry etc also offers a vast array of employability opportunities. Chemistry graduates apply their skills within the areas of environmental sciences, medical fields, scientific equipment sales, science communication, teaching or academic research, a few to mention. Thus, a degree in chemistry widens numerous prospects and opportunities for a wide variety of careers in many different fields like science, research, business and health care, etc.

Some of the areas of work available to students after the M.Sc Chemistry course are public relations, blog writing, research centres, synthetic labs, chemical firms, academic institutions etc.

The scope of M.Sc Chemistry is available in both the public and the private sector, with both displaying demands for M.Sc Chemistry graduates. MSc Chemistry promises huge career scope to candidates. After completing the course, candidates can work as professionals in Pharmaceutical Companies, Laboratories, Research Centers, Medical Colleges, private clinics, etc. and also opt for the teaching profession as a professor or a teacher

Mentioned below are some of the sectors which offers potential employability to M.Sc Chemistry graduates

- Academic Institutions
- Pharmaceutical Industry
- Chemical Firms
- Research Centers
- Public Relations

Some of the employability potentials for M.Sc. Chemistry graduates are listed below: after completing MSc Chemistry,

- Students can take teaching jobs at Universities or Sr. colleges by clearing SET or NET-LS examinations.
- Students can take teaching jobs at Jr. Colleges, Kendriya Vidyalaya, Navodaya Vidyalaya, High Schools after completing B.Ed. or respective eligibility criteria.

- Students can do Ph.D. at IIT, NIT, IISER, IISc, BARC, TIFR, Universities, Colleges by clearing NET-JRF, GATE or PET examinations.
- Students can do Ph.D. from foreign Universities, students may get scholarships.
- Students can get jobs as Jr. Scientists, Sr. Scientists, Technicians at BARC, Mumbai
- Research Scientists in various Public Sector Units like ONGC, IOCL, NTPC and Private sector industries.
- Students can become Content Developer for IT industries.
- Students can become Quality Control Chemists/ Food Inspector at Food Co-operation of India, Food Safety and Standards etc
- Student can become Drug Inspector
- Officer at Geological Survey of India
- Laboratory technicians to look after sophisticated instruments like NMR, Mass Spectrometer, UV-Visible Spectrophotometer, Single crystal machines, XRD, SEM, AAS, TEM etc
- Technician for repairing sophisticated instruments
- Lab Technologist/ Lab Chemist
- Synthetic Lab Scientist: Many industries and startups have come up in the recent times to cater the need of R & D and production. These industries hire skilled chemists with a lucrative package.
- Solid State Chemistry Expert : Students skilled in crystallography are hired by the organo- electronics and semiconductor producing industries
- Chemistry/Biochemistry Research Officer : in R& D units of industries
- Analytical Chemistry Application Specialist in industry
- Chemists at Medical colleges, pathologies
- Research Scientist/ Operations Manager/ Chemists / Quality Manager / Research Manager at various industries like Pharmaceuticals, Cement, Plastic, Drugs, Paint, Dyes, Agricultural sector, etc.
- Student can become Small or medium scale entrepreneur (own industry)
- Students can become Government officers by clearing UPSC, MPSC, Bank Probationary officers, other competitive examinations
- Employee at Security Printing and Minting co-operation of India
- Employee at Office of Controller general of Patent design and trade work
- Free-lancer as educational you tube videos maker
- Educational-aid maker
- Free-lancer for creating awareness about superstition eradication
- Free-lancer to create awareness among farmers about soil testing, pesticides uses etc
- Students can work as come up with NGOs for superstition eradication.

Government jobs:

There are a variety of career prospects waiting to be tapped at the government level. Because there is also a wide scope of research. Some of the government positions that can be considered are-

- Senior Research Associate
- Laboratory Technologist
- Research Analyst
- Research Officer
- Warehouse Supervisor
- Chemists
- Assistant Professor
- Development Supervisor
- Quality Management Analyst

Future Outlook and Scope:

1. If the candidates do not wish to pursue job opportunities after M.Sc Chemistry, they can opt for higher education to polish their skills and gain a higher level of experience. They can pursue PhD at premier institutes in India and abroad. They can appear for various competitive exams like NET/ GATE (in India) and JRE/ TOEFEL (Abroad) and avail fellowship for PhD. A significant amount of fellowship is available for pursuing PhD.
2. Candidates can acquire education in management and then can join industry or can start their own business or industry.

Sant Gadge Baba Amravati University, Amravati

APPENDIX – A-1, A-2

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning & Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years ... Four Semesters Degree Course- C.B.C.S)

(M.Sc. Part-I) Semester- I, Subject: Chemistry/Industrial Chemistry

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks				Minimum Passing		
			L	T	P	Total	Theory L/T	Internal Ass.	Practical	Total		Theory + M.C.Q External	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	DSC-I (Inorganic Chemistry)	CY101	04	--	--	04	04		--	04	03	80	20	--	--	100	40	P
2	DSC-II (Organic Chemistry)	CY102	03	--	--	03	03		--	03	03	80	20	--	--	100	40	p
3	DSC-III (Physical Chemistry-I)	CY103	04	--	--	04	04		--	04	03	80	20	--	--	100	40	P
4	DSC-IV (Analytical Chemistry-I)	CY104	04	--	--	04	04		--	04	03	80	20	--	--	100	40	P
5	AEC-I on DSC-II (Structural Chemistry)	CY105		01		01	01			01	01		25		--	25	10	P
6	Lab-I (Physical Chemistry)	CY106			09	09			4.5	4.5	06		--	--	100	100	50	p
7	Lab-II (Organic Chemistry)	CY107			09	09			4.5	4.5	06			--	100	100	50	p
8	#Internship/Field Work/Work Experience@ Open elective/GIC/Open skill/MOOC*																	
9																		
	Total		15	01	18	34	16		09	25						625		

- L: Lecture, T: Tutorial, P: Practical

- # Students may complete their internship/field work/work experience in first or second or third semester of M.Sc. (Chemistry/Industrial) according to their convenience; @denotes non-examination credit

Sant Gadge Baba Amravati University, Amravati

- **Note: Internship/Apprenticeship/field work/work experience (During vacations of semester I to semester III) for duration of minimum 60 hours to maximum 90 hours mandatory to all the students, to be completed during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.**
- **OEC (optional) can be studied during semester I to IV.**

Suggested Activities for assessment for AEC:

Mini-project, internal evaluation: Class test or surprise test, Demonstration of task or activity assigned, assignment, seminar, or any other innovative pedagogical method.

APPENDIX – A-1,A-2

Sant Gadge Baba Amravati University, Amravati

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning & Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years ... Four Semesters Degree Course- C.B.C.S)

(M.Sc. Part-I) Semester- II , Subject : Chemistry/Industrial Chemistry

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks					Minimum Passing	
			L	T	P	Total	Theory L/T	Internal Ass.	Practical	Total		Theory + M.C.Q External	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	DSC-V (Advance Inorganic Chemistry)	CY201	04	--	--	04	04	--	--	04	03	80	20	--	--	100	40	P
2	DSC-VI (Organic Reaction Mechanism)	CY202	03	--	--	03	03	--	--	03	03	80	20	--	--	100	40	p
3	DSC-VII (Physical Chemistry-II)	CY203	04	--	--	04	04	--	--	04	03	80	20	--	--	100	40	P
4	DSC-VIII (Analytical Chemistry-II)	CY204	04	--	--	04	04	--	--	04	03	80	20	--	--	100	40	P
5	AEC- II on DSC-VI (Acid and Bases and Virtual Lab)	CY205	--	01	--	01	01	--	--	01	01	--	25	--	--	25	10	P
6	Lab-III (Physical Chemistry)	CY206			09	09			4.5	4.5	06			--	100	100	50	p
7	Lab-IV (Inorganic Chemistry)	CY207			09	09			4.5	4.5	06			--	100	100	50	p
8	#Internship/Field Work/Work Experience@																	
9	Open elective/GIC/OpenSkill/MOOC*																	
	Total		15	01	18	34	16		09	25						625		

- L: Lecture, T: Tutorial, P: Practical

- # Students may complete their internship/field work/work experience in first or second or third semester of M.Sc. (Chemistry/Industrial) according to their convenience; @denotes non-examination credit

- Note: Internship/Apprenticeship/field work/work experience (During vacations of semester I to semester III) for duration of minimum 60 hours to maximum 90 hours mandatory to all the students, to be completed during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.

- OEC (optional) can be studied during semester I to IV.

Sant Gadge Baba Amravati University, Amravati

Suggested Activities for assessment for AEC:

Mini-project, internal evaluation: Class test or surprise test, Demonstration of task or activity assigned, assignment, seminar, or any other innovative pedagogical method.

Sant Gadge Baba Amravati University, Amravati

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning & Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years ... Four Semesters Degree Course- C.B.C.S)

(M.Sc. Part-II) Semester- III , Subject : Chemistry/Industrial Chemistry

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks				Minimum Passing		
			L	T	P	Total	Theory L/T	Internal Ass.	Practical	Total		Theory + M.C.Q External	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	DSC-IX (Spectroscopy-I)	CY301	03	--	--	04	04		--	04	03	80	20	--	--	100	40	P
2	DSC-X (Selected topics in Chemistry-I)	CY302	04	--	--	04	04		--	04	03	80	20	--	--	100	40	p
3	DSE-I (Bio-inorganic Chemistry/ Organic Synthesis-I /Physical chemistry-I / Heat Transfer, Mass Transfer and unit processes)	CY303	04	--	--	04	04		--	04	03	80	20	--	--	100	40	P
4	DSE-II (Solid state Chemistry /Natural Products /Physical Chemistry-II /Fuels and heavy chemicals)	CY304	04	--	--	04	04		--	04	03	80	20	--	--	100	40	P
5	AEC-III on DSC-IX	CY305		01		01	01			01	01		--	25	--	25	10	P
6	Lab-V	CY306			09	09			4.5	4.5	06		--	--	100	100	50	p
7	Lab-VI	CY307			09	09			4.5	4.5	06		--	--	100	100	50	p
8	#Internship/Field Work/Work Experience@																	
9	Open elective/GIC/Open skill/MOOC*																	
	Total		16	01	18	35	17		09	26						625		

Sant Gadge Baba Amravati University, Amravati

- **L: Lecture, T: Tutorial, P: Practical**
- **# Students may complete their internship/field work/work experience in first or second or third semester of M.Sc. (Chemistry/Industrial) according to their convenience; @denotes non-examination credit**
- **Note: Internship/Apprenticeship/field work/work experience (During vacations of semester I to semester III) for duration of minimum 60 hours to maximum 90 hours mandatory to all the students, to be completed during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.**
- **OEC (optional) can be studied during semester I to IV.**

Suggested Activities for assessment for AEC:

Mini-project, internal evaluation: Class test or surprise test, Demonstration of task or activity assigned, assignment, seminar, or any other innovative pedagogical method.

Sant Gadge Baba Amravati University, Amravati

APPENDIX – A-1,A-2

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning & Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years ... Four Semesters Degree Course- C.B.C.S)

(M.Sc. Part-II) Semester- IV , Subject : Chemistry/Industrial Chemistry

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks					Minimum Passing	
			L	T	P	Total	Theory L/T	Internal Ass.	Practical	Total		Theory + M.C.Q External	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	DSC –XI (Spectroscopy-II)	CY401	03	--	--	04	04	--	04	03	80	20	--	--	100	40	P	
2	DSC-XII (Selected topics in Chemistry-II)	CY402	04	--	--	04	04	--	04	03	80	20	--	--	100	40	p	
3	DSE-III (Photoinorganic & Organometallic Chemistry or Material chemistry /Organic Synthesis- II /Physical Chemistry-III /Polymer dyes and paints)	CY403	04	--	--	04	04	--	04	03	80	20	--	--	100	40	P	
4	SEC (interpenetration of spectra and Insilico approaches in chemistry)	CY404	04	--	--	04	04	--	04	03	80	20	--	--	100	40	P	
5	AEC-IV on DSC -XI	CY405		01		01	01		01	01		--	25	--	25	10	P	
6	Lab-VII (Project)	CY406			09	09		4.5	4.5	06		--	--	100	100	50	p	
7	Lab-VIII (Project)	CY407			09	09		4.5	4.5	06		--	--	100	100	50	p	
8	#Internship/Field Work/Work Experience@ Open elective/GIC/Open skill/MOOC*																	
9																		
	Total		16	01	18	35	17		09	26					625			

- L: Lecture, T: Tutorial, P: Practical

- # Students may complete their internship/field work/work experience in first or second or third semester of M.Sc. (Chemistry/Industrial) according to their convenience; @denotes non-examination credit

Sant Gadge Baba Amravati University, Amravati

- **Note: Internship/Apprenticeship/field work/work experience (During vacations of semester I to semester III) for duration of minimum 60 hours to maximum 90 hours mandatory to all the students, to be completed during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.**
- **OEC (optional) can be studied during semester I to IV.**

Suggested Activities for assessment for AEC:

Mini-project, internal evaluation: Class test or surprise test, Demonstration of task or activity assigned, assignment, seminar, or any other innovative pedagogical method.

Part B**Syllabus Prescribed for Two Year PG Programme****Programme: MSc (Chemistry)**

The examination in theory courses (DSC and DSE) of MSc (Chemistry) shall comprise a theory paper per course and internal assessment.

The internal assessment will carry 20 marks based on attendance, participation in cocurricular activities (Group discussion, seminar, industrial visit or visit to academic institutions or any other innovative pedagogical activity) and performance in unit/internal tests.

Each Theory paper will be of 3 Hrs duration and carry 80 marks.

Each theory paper has been divided into 4 units with equal weightage

There shall be one question of 20 marks on each unit with internal choice

Semester I

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY101	Inorganic Chemistry (DSC-01)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. predict the nature of bond and its properties through various electronic structural methods; bonding models
2. recognize and assign symmetry characteristics to molecules and objects,
3. understand and analyze structure-property correlation of coordination compounds
4. correlate magnetic properties of complexes with strength of ligand field
5. design new coordination compounds based on a fundamental understanding of their electronic properties
6. appreciate specialized and advanced topics in inorganic and coordination chemistry
7. Correlate structure and bonding with reactivity of boron clusters
8. analyze ligation of diatomic ligands with metals.

UNIT 1: Structure of molecules**15 hrs**

A) VSEPR theory: Postulate of VSEPR theory, the "AXE method" of electron counting in VSEPR, Recap of shapes of regular geometries. Predicting types of hybridization of central atom in a molecules/ions (Shape or Geometry and bond angles) (with and without lone pair of electrons) like SbF_4^- , SF_5^- , SeF_3^- , ICl_2^- , ICl_4^- , IF_4^- , IOF_4^- , NH_2^- , NH_4^+ , I_3^- , PCl_2^+ , PCl_6^- , SO_4^{2-} , ClF_3 , IF_6^- , BrF_5 , XeOF_4 , XeF_4 , XeO_3 , SOF_2 , IF_5 , $[\text{BF}_4]^-$, $[\text{I}_5]^+$, $[\text{Br}_3]^+$, BCl_3 , SNF_3 , XeF_2O_2 , ClO_3^- , $[\text{TeF}_5]^-$, $[\text{BeF}_4]^-$, $[\text{SbCl}_6]^{3-}$, $[\text{PF}_6]^-$ etc Advantages and disadvantages (Drawbacks) of VSEPR theory, Energetic of hybridization, Bent's rule, d-orbital participation by non-metals, example showing $\text{p}\pi\text{-p}\pi$, $\text{p}\pi\text{-d}\pi$ and $\text{d}\pi\text{-d}\pi$ bonds. Some simple reaction of covalently bonded molecule: atomic inversion and Berry pseudorotation).

B) Molecular Orbital Theory: Molecular orbital representation of polyatomic molecules with special reference to CH_4 , NH_3 , H_2O , PF_5 , SF_6 , B_2H_6 and CO and delocalised molecular orbital of ozone, carbon dioxide, nitrite, nitrate and benzene.

C) Hypervalent (expanded octet) inorganic species/molecules/ions/compounds, Iso-structural and iso-electronic pair/species/ions: General idea with examples

UNIT 2: Bonding in metal complexes – I:**15 hrs**

Crystal Field Theory: Salient features of CFT. d-orbital splitting patterns in regular Octahedral, tetragonally distorted octahedral, Jahn-Teller theorem, trigonal bipyramidal, trigonal planar, Pentagonal bipyramidal, and linear geometries. Concept of weak field and strong fields. - Calculation of crystal field stabilization energies (CFSE's) in six and four coordinate complexes. Types of magnetic behavior– magnetic susceptibility – calculation of magnetic moment from magnetic susceptibility spin only formula,- Quenching of orbital angular momentum –Determination of magnetic moment from Guoy's method.. Applications of magnetic moment data for the determination of oxidation states, bond type and stereochemistry. Spin crossover: High spin, low spin cross over phenomenon in $[\text{Fe}(\text{Ophen})_2(\text{NCS})_2]$ and $[\text{Fe}(\text{R}_2\text{NCS}_2)_3]$. Spinels.

UNIT 3: Symmetry of Molecules:**15 hrs**

Symmetry Operations – Symmetry Elements: Rotational Axis of Symmetry and Types of Rotational Axes, Plane of Symmetry and types of Planes, Improper Rotational Axis of Symmetry, Inversion Center and Identity Element –More about Symmetry Elements – Molecular Point Groups: Definition and Notation of Point Groups, Classification Molecules in to C_1 , C_s , C_i , C_n , C_{nv} , C_{nh} , $\text{C}_{\infty v}$, D_n , D_{nh} , D_{nd} , $\text{D}_{\infty h}$, S_n ($n=\text{even}$), T_d , O_h , I_h , K_h Groups. Descent in Symmetry with Substitution – Exercises in Molecular Point Groups – Symmetry and Dipole moment – Symmetry criteria for Optical activity. Group multiplication table, matrix representation of symmetry elements. Reducible and irreducible representation, character of representation, character of matrix, Conjugate matrix, Properties of irreducible representations, Great orthogonality theorem (without proof) and its importance, construction of character table of C_{2v} & C_{3v} point group. Mulliken symbolism rules for irreducible representations and its applications with examples.

UNIT 4: Cage and metal cluster**15 hrs****A) Boron Cage compounds**

I) Boron Hydride: IUPAC nomenclature, classification (closo, nido, arachno and klado), structure, bonding and topology of boranes, 4- digit coding (STYX rule and/or Lipsocomb rule) numbers for B₂H₆, B₃H₈, B₃H₉, B₄H₁₀, B₅H₉, B₅H₁₁, B₆H₁₀, B₆H₁₂, B₇H₁₁, B₈H₁₂, B₁₂H₁₄ etc, polyhedral skeletal electron pair theory (WADE'S rule), Bronsted acidity of higher boranes.

II) Carboranes and Metallocarboranes: Classifications, nomenclatures, types, cage and geometry according to WADE'S rule

B) Metal and non-metal carbonyl cluster

I) Metal Carbonyl cluster: Basic idea of (18 electron counting rule, hapticity, ligand contribution to electron counting including CO as a ligand), preparation, classification and calculation of number of M-M bonds A/C to WADES rule of metal carbonyl cluster, MO's of CO; modes of ligation (bonding modes) by CO as a ligand (Terminal, unsymmetrical, symmetrical and triply bridging), bond order of CO and IR spectroscopy, metal carbonyl and EAN rule. Iso-electronic and iso-structural properties of metal carbonyl and its related compounds or cluster of complexes

II) Non-Carbonyl metal cluster: General idea of multiple metal-metal bonds, Quadruple bonding in Di and/or binuclear cluster (including MO diagrams, bond order, structure, symmetry, conformation and electronic transition selection rule) Ex: [Mo₂Cl₈]⁴⁻, [Mo₂(SO₄)₄]⁴⁺, [Os₂Cl₈]²⁻, [Re₂Cl₉]⁻, [Re₂Cl₈]²⁻, [Re₂(Me₂PPh)₄ Cl₄], [Re₂Cl₄(PMe₂Ph)₄]⁺, [(Bu₄N)₂Re₂Cl₈], [W₂(OPh)₆], [W(CH₃)₈]⁴⁺ etc, Preparation, properties and structures (A/C to Wades rules) of Zintl (Naked cluster) anions & cation of the metal Ge, Sn, Pb, Sb, Bi.

Course Material/Learning Resources**Text books:**

1. Selected Topics In Inorganic Chemistry: W.U. Malik, G.D. Tuli & R.D. Madan (S. Chand Publications)
2. Symmetry and Spectroscopy of Molecules: K Veera Reddy New Age International publishers, 2014.
3. Group Theory and its Chemical Applications - P.K. Bhattacharya (Himalaya Publishing House) 2003
4. Concise Coordination Chemistry : R Gopalan and V Ramalingam (Vikas publishing House Pvt Ltd)
5. B.R. Puri, L.R Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Vishal publication, 2016
6. Advanced Inorganic Chemistry - Volume I - Satya Prakash, G.D. Tuli, S K Basu & R.D. Madan (S. Chand Publications)
7. Advanced Inorganic Chemistry - Volume II - Satya Prakash, G.D. Tuli, S K Basu & R.D. Madan (S. Chand Publications)

Reference Books:

1. Symmetry and Group theory in Chemistry, Mark Ladd, Marwood Publishers, London (2000).
2. Molecular Symmetry and Group Theory, Robert L. Carter, John Wiley & Son (1998).
3. Inorganic Chemistry, 5th Edition: Gary L. Miessler, Paul J. Fischer and Donald A. Tarr Pearson Publication.
4. Advanced Inorganic Chemistry. F.A.Cotton, G.Wilkinson, C.A.Murillo and M.Bochmann, 6th Edition, Wiley Interscience, N.Y (1999)
5. Inorganic Chemistry, J.E. Huheey, K.A.Keiter and R.L.Keiter 4 th Edition Harper Cottens College Publications (1993).
6. Homogeneous Catalysis by Metal complexes Vol I, M M Taqui Khan and A E Martell, Academic Press NY (1974).
7. Inorganic Chemistry, Keith F.Purcell and John C.Kotz, Holt-Saunders International Editions, London (1977).
8. Advanced Inorganic Chemistry 3rd, 5th & 6th Editions.: F.A. Cotton& G. Wilkinson:
9. Theoretical Approach in inorganic chemistry: A.F. Willims
10. Atomic Structure and chemical Bonding: Mannas Chanda

Weblink to Equivalent MOOC on SWAYAM if relevant:

1. Basics of Inorganic Chemistry - <https://nptel.ac.in/courses/104101121>
2. VSEPR- <https://nptel.ac.in/courses/104101090>
3. Symmetry and Group Theory: https://onlinecourses.nptel.ac.in/noc22_cy40/preview
4. Co-ordination chemistry (chemistry of transition elements)- <https://nptel.ac.in/courses/104105033> and <https://nptel.ac.in/courses/104105085>
5. Ligational Aspects of Diatomic molecules- <https://nptel.ac.in/courses/104106064>

Weblink to Equivalent Virtual Lab if relevant: NA

Any pertinent media (recorded lectures, YouTube, etc.) if relevant: NA

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester 1**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY102	Organic Chemistry (DSC-02)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Implement rules of aromaticity to organic molecules
2. Sketch organic molecules in different projection formula and assign its configuration.
3. Apply their understanding about the organic reactions of industrial significance with respect to the chemo-selectivity, regioselectivity and enantioselectivity.
4. Analyze the product distribution and the stereochemistry of various organic products.
5. Evaluate the organic reactions based on the influence of the substituents on substrate molecules
6. Design organic reactions in order to achieve the required product(s)

Unit-I:**15 h**

A) Nature and Bonding in Organic Molecule: Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyper-conjugation, Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons Huckel's rule, energy level of π -molecules orbitals, annulenes, antiaromaticity, homo-aromaticity. Aromatic character and chemistry of cyclopentadienyl anion, tropylium cation, tropone and tropolone, Frost Circles (The Polygon Method) for drawing energy levels in cyclic pi systems.

B) Carbenes: Types of carbenes, Structure and reactivity of carbenes, Generation, structure and reactions, insertion, addition, rearrangement reactions of carbenes, nucleophilic attack on carbenes, Simmons-Smith reaction, Reimer-Tiemann reaction, Carbylamine reaction, Shapiro reaction, Bamford-Stevens reaction and Wolff rearrangement

C) Nitrene: Generation, structure and reactions.

Unit-II:**15 h**

Stereochemistry: Conformational analysis of cycloalkanes (5-8 membered rings), substituted cyclohexanes, mono substituted, disubstituted and trisubstituted cyclohexanes, decalin system, effect of conformation on reactivity, Conformational analysis of n-butane and its derivatives, ethylene glycol, 1,2-dihaloethane and related compounds Elements of symmetry, Concept of chirality and molecular dissymmetry, molecules with more than one chiral center, meso compounds, threo and erythro isomers, method of resolution, optical purity, topicity of ligands, enantiotropic and distereotopic atoms, groups and faces, prochirality, Cahn-Ingold-Prelog System to describe configuration at chiral centers. Inter conversion of Newman, Sawhorse and Fischer projection.

Asymmetrical synthesis, optical activity in absence of chiral carbon (biphenyl, spiranes and allenes), Chirality due to helical shape. Chirality of heteroatoms, stereospecific and stereoselective synthesis.

Unit-III:**15 h**

A) Reaction mechanism: Types of reaction, Types of mechanism, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, trapping of intermediates, checking for common intermediate, competition and cross-over experiments, isotope effects, Hard and soft acids and bases.

B) Effect of Structure on reactivity: Resonance and field effects, Steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft Equation.

C) Aromatic electrophilic substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The o/p ratio, ipso attack, orientation in benzene ring with more than one substituents, orientation in another ring system. Friedel-Crafts reaction, Vilsmeier-Hack reaction, Gatterman-Koch reaction, Pechman reaction, Diazonium coupling, Blanc chloromethylation, Kolbe-Schmitt reaction

Unit IV:**15h**

A) Aliphatic nucleophilic substitution: The S_N1 , S_N2 , mixed S_N1 , S_N2 and SET and S_{Ni} mechanisms. Nucleophilicity, effect of leaving group, ambient nucleophiles and ambient substrates regioselectivity, substitution at allylic and vinylic carbon atoms, Mitsunobu reaction.

B) Concept of neighbouring group participation: Anchimeric assistance with mechanism, neighboring group participation by π and σ bonds, classical and non-classical carbocations, Intramolecular displacement by hydrogen, oxygen, nitrogen, sulphur and halogen. Alkyl, cycloalkyl, aryl participation, participation in bicyclic system, migratory aptitude.

C) Aromatic Nucleophilic Substitution: A general introduction to different mechanisms of aromatic nucleophilic substitution S_{NAr} , S_{N1} , benzyne and $S_{RN}1$ mechanisms, arynes as reaction intermediate, Reactivity - effect of substrate structure leaving group and attacking nucleophile. The Von Richter and Smiles rearrangements, Chichibabin amination reaction. Benzyne: Structure, methods of generations and reactions

Course Material/Learning Resources**Text books:**

1. D. Nasipuri, Stereochemistry of Organic Compounds Principles and Applications, New Age International Publishers, 3rd Edition, 2011
2. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2013.

3. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th Edition, Pearson Education Ltd., England, 2013

Reference Books:

1. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st edition, Oxford University Press, 2001
2. Stereochemistry of Organic Compounds: Ernest Eliel Wiley Publication
3. Stereochemistry of Organic Compounds: V K Ahluwalia Springer Publication
4. K. Peter C. Vollhardt and N. E. Schore, Organic Chemistry, W. H. Freeman and Company 1999
5. Organic Chemistry as a Second Language: David R Klein, Jon Wiley and Sons, 2004
6. L. Finar, Organic Chemistry Vol. I & Vol. II, Longman (Cambridge), 2011.
7. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry Part B: Reaction and Synthesis, Springer, 5th Edition, 2010.
8. Organic Chemistry (7th edition) : R.T. Morrison and R.N. Boyd. Pearson Publication

Weblink to Equivalent MOOC on SWAYAM if relevant:

Introductory Organic Chemistry I- <https://nptel.ac.in/courses/104106119>

Mechanisms in Organic Chemistry- https://onlinecourses.nptel.ac.in/noc22_cy42

Mechanisms in Organic Chemistry : https://onlinecourses.nptel.ac.in/noc20_cy26/preview

Stereochemistry- <https://nptel.ac.in/courses/104105086>

Stereochemistry and Applications- <https://nptel.ac.in/courses/104106127>

Structure, Stereochemistry and Reactivity of Organic Compounds and Intermediates: A Problem solving Approach- <https://nptel.ac.in/courses/104105127>

Weblink to Equivalent Virtual Lab if relevant: NA**Any pertinent media (recorded lectures, YouTube, etc.) if relevant:**

Stereochemistry: <https://chem.ucr.edu/sites/default/files/2019-10/Chapter4.pdf>

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme

Programme: MSc (Chemistry)

Semester 1

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY103	Physical Chemistry (DSC-03)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Understand basic concepts and theories for quantum mechanics, surface chemistry, thermodynamics and electrochemistry
2. Apply the concepts of quantum mechanics to solve higher order problems associated with shapes, size and energy of atomic entities.
3. Develop the methodologies to identify and use colloidal substances and micelles.
4. Implement and build theoretical and experimental processes using thermodynamics and electrochemical concepts
5. Solve numerical problems associated with quantum mechanics, thermodynamics, and electrochemistry

Unit-I Quantum Chemistry

- A) The Basic Principles of Quantum Mechanics:** The Uncertainty Principle, Wave Mechanics, Functions and Operators, The General Formulation of Quantum Mechanics (i.e. Postulates), Expansion Theorems, Eigenfunctions of Commuting Operators, Hamiltonian Operator.
- B) The Quantum Mechanics of Some Simple Systems:** The Free Particle, The Particle in a Box, Quantum Mechanical Tunneling, The Harmonic Oscillator and Rigid Rotor. The Hydrogen Atom, Hydrogen-like Atoms, Shape of Atomic Orbitals.

Unit-II Quantum Chemistry

- A) Approximate Methods of Quantum Mechanics:** The Variation theorem, linear variation principle, perturbation theory up to second order in energy, application of variation and perturbation theory to the Helium and Heliumlike atoms.
- B) Angular Momenta:** Ordinary angular momentum, generalized angular momentum, eigenfunctions, and eigenvalues of angular momentum operator, Ladder operator, addition of angular momenta. Spin, antisymmetry, Pauli exclusion principle, Slater determinantal wave functions.

Unit-III Surface Chemistry

- A) Adsorption :** Freundlich adsorption isotherm, Langmuir adsorption isotherm, Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids, and catalytic activity at surfaces.
- B) Micelles :** micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass models, solubilization, micro emulsion, reverse micelles. Numericals.

Unit-IV Thermodynamics and Electrochemistry

- A)** The first and second law of thermodynamics, Carathéodory's principle and its equivalence to the Kelvin Plank and Clausius statement of the Second law of Thermodynamics, extensive and intensive properties, derivation of thermodynamic equations of state, Maxwell's relations, Third law of thermodynamics, Nernst Heat Theorem, unattainability of absolute zero, calculation of entropy based on third law of thermodynamics, residual entropy and its application.
- B) Ideal and Non-ideal Systems:** Partial molar properties. Partial molar free energy, Chemical Potential, Partial molar volume and Partial molar heat content and their significances. Determination of these quantities Concept of fugacity, determination of fugacity, excess functions for non-ideal solutions, Entropy of mixing, Enthalpy of mixing, Activity and activity coefficients, Concept of ion atmosphere and electrophoretic effect, Debye Hückel theory for activity coefficients of electrolytic solutions, determination of activity and activity coefficients, ionic strength and dependence of activity coefficients on ionic strength, numerical.

Course Material/Learning Resources

Text books:

1. Elementary Quantum Chemistry by F. L. Pilar, Dover Publications, Inc. NY, 1990. 2nd Ed.
2. Molecular Quantum Mechanics by P. W. Atkins and R. S. Friedman, 3rd Ed., Oxford Univ. Press, 1997.
3. Quantum Chemistry by H Eyring, J Walter, and G E Kimball, John Wiley & Sons 1944
4. J.O'M Bockris and A.K.N Reddy, Modern Electrochemistry 2A: Fundamentals of Electroics, Vol II, 2001.
5. D. Skoog and D. West, Principles of Instrumental Analysis, Cengage Learning; 6th edition, 2006

Reference Books:

1. Physical Chemistry - P.W. Atkin, ELBS fourth edition.
2. Physical Chemistry – R.A. Alberty, R.I. Bilby, John Wiley – 1995
3. Physical Chemistry – G.M. Barrow, Tata Mc – Graw Hill – 1988
4. Quantum Chemistry, - I. Levine, Fifth edition, Prentice Hall- 1995. Physical Chemistry – Thomas Engel, Philip Reid
5. Molecular quantum mechanics, Vol. I & II, P. W. Atkins, Oxford University Press, 1970.
6. Statistical thermodynamics, by T.L.Hill, Addison Wesley, 1060
Chemical thermodynamics, by F.T. Wall, W.H.Freeman & Co. 1965

7. Irreversible thermodynamics, Theory and applications, by K.S.Forland, T. Forland, S.KRatje, Jonny Wiley, 1988.
8. Chemical Kinetics, by K. J. Laidler, 3rd Edition, Harper and row, 1987.
9. Chemical Kinetics-A study of reaction rate in solution, K.Conors, V.C.H.Publkatkm 1990.
10. Chemical Kinetics and Dynamics, By J.I.Streinfeld, J.S. Francisco & W.I.Hase, Pritice Hall, 1989. Kinetics and Mechanism of Chemical transformation, J.Rajraman, J. Kucriacose, Mc-Million Molecular reaction Dynamics and chemical reactivity, R.D.Levine and R.B. Benstin, Oxford University Press. 1987.
11. Physical Chemistry by Alberty and Silby, Jolly Wiley
12. Quantum Chemistry by Ira N. Levine, Prentice Hall,
13. Introduction to Quantum Chemistry by A. K. Chandra, Tata McGraw Hill.
14. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, 2009
15. D.R. Crow, Principles and Applications of Electrochemistry, John Wiley & Sons (New York) 2nd edition, 2001.
16. Bard, A. J.; Faulkner, L. R.; Electrochemical Methods: Fundamentals and Applications, Wiley, 2nd edition, 2000.

Weblink to Equivalent MOOC on SWAYAM if relevant:

Quantum Chemistry of Atoms and Molecules: <https://nptel.ac.in/courses/104101124>

Chemistry and Physics of Surfaces and Interfaces: <https://nptel.ac.in/courses/104104130>

Introduction to Chemical thermodynamics and kinetics: https://onlinecourses.nptel.ac.in/noc22_cy58/preview

Concepts of Thermodynamics: https://onlinecourses.nptel.ac.in/noc22_me103/preview

Thermodynamics: https://onlinecourses.nptel.ac.in/noc22_me88/preview

Weblink to Equivalent Virtual Lab if relevant: NA

Any pertinent media (recorded lectures, YouTube, etc.) if relevant: NA

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme

Programme: MSc (Chemistry)

Semester 1

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY104	Analytical Chemistry-I (DSC 04)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Appraise specific analytical technique based on sample and target analyte
2. Develop analytical ability and critical thinking in selection of statistics and their use in making interpretation meaningful and productive.
3. Understand the principles of chromatographic techniques.
4. Select proper chromatographic technique among the available techniques.
5. Correlate the use of indicator used in different types of titration
6. Explore electroanalytical techniques based on conductance and emf measurements.
7. Design buffer systems of the required pH

Unit I: Introduction and statistical analysis

15h

A] Introduction to analytical chemistry: Types of analysis-qualitative and quantitative. Classification of analytical methods- classical and instrumental, basis of their classification with examples.

B] Statistical analysis and validation: Errors in chemical analysis. Classification of errors systematic and random, additive and proportional, absolute and relative. Accuracy and precision. Mean, median, average deviation and standard deviation. Significant figures and rules to determine significant figures. Calculations involving significant figures. Confidence limit, correlation coefficient and regression analysis. Comparison of methods: F-test and T-test. Rejection of data based on Q-test. Least squares method for deriving calibration graph. Application of Microsoft Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel). Validation of newly developed analytical method. Concepts and difference between sensitivity, limit of detection and limit of quantification, role of noise in determination of detection limit of analytical techniques. Certified reference materials (CRMs). Numerical problems.

Unit II: Separation techniques

15h

A] Chromatography: Definition and Classification. Techniques used in Paper, Thin Layer and Column chromatography. Applications in qualitative and quantitative analysis.

B] Ion exchange: Principle and technique. Types of ion exchangers. Ion exchange equilibria. Ion exchange capacity. Effect of complexing ions. Zeolites as ion-exchangers. Applications.

C] Solvent extraction: Principle and techniques. Distribution ratio and distribution coefficient. Factors affecting extraction efficiency: Ion association complexes, chelation, synergistic extraction, pH. Numericals based on multiple extractions. Role of chelating ligands, crown ethers, calixarenes and cryptands in solvent extraction. Introduction to Solid phase extraction (SPE) and Microwave assisted extraction (MAE), Applications.

Unit III: Classical methods of analysis

15h

A] Volumetric analysis: General principle. Criteria for reactions used in titrations. Primary standards and secondary standards. Theory of indicators. Types of titrations with examples- Acid-base, precipitation, redox and complexometric. Titration curves for monoprotic and polyprotic acids and bases. Indicators used in various types of titrations. Masking and demasking agents.

B] Gravimetric analysis: General principles and conditions of precipitation. Concepts of solubility, solubility product and precipitation equilibria. Steps involved in gravimetric analysis of barium and nickel. Purity of precipitate: Co-precipitation and post-precipitation. Fractional precipitation. Precipitation from homogeneous solution. Crystalline, gelataneous and curdy precipitate, peptization phenomena.

Unit IV: Electrochemical methods of analysis-I

15h

A] Conductometry: Concepts of electrical resistance, conductance, resistivity and conductivity. Specific, molar and equivalent conductance and effect of dilution on them. Measurement of conductance. Kohlrausch's law, Applications of conductometry in determination of dissociation constant, solubility product. Conductometric titrations of different

types. High frequency titrations. Numerical problems.

B] Potentiometry: Circuit diagram of simple potentiometer. Indicator electrodes: hydrogen electrode, quinhydrone electrode, antimony electrode and glass electrode. Reference electrodes:

Calomel electrode and Ag/AgCl electrode. Theory of potentiometric titrations. Acid-base, redox, precipitation and complexometric titrations. Nernst equation, standard electrode potential, Determination of cell potential, n , K_f and K_{sp} . pH titrations. Buffers and buffer capacity. Calculation of pH of buffer mixtures based on Henderson-Hasselbalch equation.

Course Material/Learning Resources

Text books:

1. Analytical Chemistry: Problems and Solution- S. M. Khopkar (New Age International Publication)
2. Basic Concepts in Analytical Chemistry: S. M. Khopkar (New Age International Publication)

Reference Books:

1. Quantitative analysis: Day and Underwood (Prentice-Hall of India)
2. Vogel's Text Book of Quantitative Inorganic Analysis-Bassett, Denney, Jeffery and Mendham (ELBS)
3. Analytical Chemistry: Gary D. Christian (Wiley, India).
4. Instrumental Methods of Analysis: Willard, Merrit, Dean, Settle (CBS Publishers, Delhi, 1986)
5. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
6. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
7. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
8. Fundamentals of Analytical Chemistry: S. A. Skoog and D. W. Wes

Weblink to Equivalent MOOC on SWAYAM if relevant:

Analytical Chemistry: https://onlinecourses.nptel.ac.in/noc22_cy61/preview

Weblink to Equivalent Virtual Lab if relevant: NA

Any pertinent media (recorded lectures, YouTube, etc.) if relevant: NA

Ability Enhancement Course on DSC CY102 : 01

Code of the Course/Subject CY105	Title of the Course/Subject Structural Chemistry (AEC-1)	(Total Number of Periods) 15 hrs
-------------------------------------	---	-------------------------------------

After completion of this course successfully, the students would be able to

1. Provide basic insights into concept of resonance and three dimensional arrangement of molecules
 2. Draw and compare the significant resonance contributor, help to assign the correct configuration
 3. Draw and name structure using structure drawing software
 4. Prepare and present report on a particular topic
 5. Develop imagination of molecule in three dimensional space.
- A. Use of structure drawing software like Chemoffice, Chems sketch, Kingsdraw, etc. for
- B. **Resonance:** use of arrows in resonance, Formal charges in Resonance structures, Drawing Resonance structures for molecules/intermediates, benzenoid and non-benzenoid compounds etc.
- C. **Stereochemistry:** Drawing of different projection formulae (Newman, Sawhorse, Fischer), chemical structures for Conformations of cycloalkanes, Chiral (molecule with chiral carbon and also other atoms) and Asymmetric molecules (biphenyl, spiranes and allenes)

Suggested Activity:

1. Draw and name 10 compounds using any of the structure drawing software.
2. Assignment to be submitted drawing chemical structure with correct configuration in suitable projection formulae (10 molecule)
3. Seminar on any topic as decided by the instructor

Course Material/Learning Resources

Reference Books:

Organic Chemistry as a Second Language: David R Klein, Jon Wiley and Sons, 2004

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester 1**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY106	Physical Chemistry (Lab-01)	90 hrs (9 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Select the proper indicator for a titration
2. Improve scientific skill of data collection and analysis.
3. Create methods for estimation of concentration of electrolytes in mixture using potentiometry.
4. Correlate nature of graphs in conductometric titrations
5. Get awareness about laboratory skills of handling electroanalytical instruments.
6. Apply concept of critical micellar concentration to cleaning power of detergents.

Familiarity with word processing, electronic spreadsheets, data processing, mathematical packages, chemical structure drawing and molecular modeling.

Part A

1. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the Initial Rate Method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.
2. Compare the strengths of hydrochloric acid and sulphuric acid by studying the rate of hydrolysis of methyl acetate.
3. Study the saponification of ethyl acetate with sodium hydroxide volumetrically
4. Determine the Critical Micelle Concentration (CMC) of surfactant by surface tension measurements.
5. Determine the Critical Micelle Concentration (CMC) of ionic surfactants by conductivity measurements.
6. Determination of Critical Micelle Concentration (CMC) and Surface Excess concentration of surfactant using Gibbs adsorption Isotherm
7. To find out the molecular surface energy and association factor of ethyl alcohol
8. Determination of molecular mass of a polymer by viscometry method.
9. To measure refractometrically average polarizability of some common solvents.

Part B

1. Determine the Cell Constant of the given conductivity cell at room temperature and study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).
2. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.
3. Determine the equivalent conductance of strong electrolyte at several concentrations and verification of Debye - Huckel Onsagar principle conductometrically.
4. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in a commercial sample of soda ash.
5. Study the conductometric titration of potassium sulphate solution vs. barium chloride solution
6. Study the conductometric titration of (i) Acetic acid vs. sodium hydroxide, (ii) Acetic acid vs. ammonium hydroxide, (iii) HCl vs. NaOH and comment on the nature of the graphs.
7. Study the stepwise neutralization of a polybasic acid e.g. oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the plots.
8. Determine the dissociation constant of acetic acid potentiometrically.
9. Titrate a mixture of (i) Strong and weak acids (Hydrochloric and acetic acids), (ii) Weak acid (acetic acid) and dibasic acid (oxalic acid) (iii) Strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodium hydroxide and comment on the nature of the graph
10. To determine the indicator constant (pK_{in}) of methyl orange/red spectrophotometrically

CY106 Physical Chemistry (Lab 01)

Time : 6-8 Hrs. (One day Examination)

Total Marks : 100

(1) Exercise-1 (Part A) -	40 Marks
(2) Exercise-2 (Part B) -	40 Marks
(3) Record -	10 Marks
(4) Viva-Voce -	10 Marks

Total -100 Marks**Course Material/Learning Resources****Books Suggested:**

1. J. B. Yadav, Practical Physical Chemistry
2. Das and Behra, Practical Physical Chemistry
3. Carl W. Garland, Joseph W. Nibler and David P. Shoemaker, Experiments in Physical Chemistry, Mc-Graw Hill, 8th Edition, 2009.
4. Farrington Daniels, Joseph Howard Mathews, John Warren Williams, Paul Bender, Robert A. Alberty, Experimental Physical Chemistry, Mc-Graw Hill, Fifth Edition, 1956.

5. John W. Shriver and Michael George, Experimental Physical Chemistry, Lab Manual and Data Analysis, The University of Alabama in Huntsville, Fall 2006
6. Jahgirdar D.V: Experiments In Chemistry

Weblink to Equivalent Virtual Lab

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester 1**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY107	Organic Chemistry (Lab-02)	90 hrs (9 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Design the methodologies to develop ecofriendly and green technology for industry and research.
2. Develop methods and remedies for reactions with environmental pollution.
3. Improve scientific practical information orally and in writing.
4. Get awareness about laboratory safety and handling of chemicals.
5. Apply different purification techniques recrystallization, thin layer chromatography, distillation and solvent extraction.

Part-A

In the beginning of the chemistry practical 9 hrs will be given for

- Laboratory safety: what precautions should be taken while working in chemistry laboratory (working with acids and bases)
- Where to get chemicals information (MSDS)
- Introduction of equipment used for chemistry practical.
- Making apparatus for experiments, correct laboratory techniques.
- Introduction to Use of computer, software's in chemistry, use of OER for virtual practical approach.
- Introduction about Pre lab preparation for every experiment.

Part-B

Organic synthesis will be carried out on reactions involving protection and deprotection, oxidation, reduction, carbon-carbon multiple bonds, Metals/ metal salts catalyzed coupling reactions, Diels-Alder reactions, aromatic substitution reactions, diazotization reactions, condensation reactions, hydrolysis reactions etc.

Organic Synthesis: Single Stage Preparations (8 Laboratory Session)

1. Benzaldehyde to cinnamic acid (Perkin Reaction)
2. p-nitrobromobenzene from bromobenzene. (Nitration)
3. m-di-nitrobenzene to m-nitroaniline (Reduction).
4. Diel's Alder reaction of anthracene and maleic anhydride (furan and maleic acid in water).
5. Adipic acid by nitric acid oxidation of Cyclohexanol.(Oxidation)
6. p- Chlorotoulene from p-Toluidine.(Sandmeyer reaction)
7. Mannich Reaction (reaction of primary amine, formaldehyde and carbonyl compound)
8. Synthesis of dihydropyrimidinone by Green Method (Begenneli reaction)
9. Preparation of 1,1-bis-2-naphthol by Green Synthesis (Radical Coupling Reaction)
10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
11. Synthesis of Paracetamol
12. Synthesis of indigo/Dye and dyeing of cloth
13. Synthesis of biodiesel.
14. Preparation of soap.
15. Synthesis of zeolites and its application as a catalyst for any one reaction.
16. Preparation of urea-formaldehyde resin and Determination of molecular weight by viscometry

Important Note:

- i) The preparations should be carried out using (0.02 to 0.05 mole) of the starting material.
- ii) The yield, melting point and TLC of the recrystallized product should be recorded.
- iii) The sample of the purified product and TLC plate should be submitted for inspection. Draw TLC in the journal and also calculate the R_f value.
- iv) Use of Computer - Chem Draw Chem-Sketch, ISI – Draw: Draw the structure of product synthesized. Get the correct IUPAC name and interpret of its ¹HNMR as obtained from software.

Part-C**Qualitative Organic Analysis: (10 Mixtures)**

Separation, purification and identification of binary mixtures by Chemical and physical methods.

The two components may be solid-solid, solid- liquid and liquid-liquid (volatile/nonvolatile). The water soluble solid/liquid should also be given. Student should purify separated compounds from the mixture and prepare a suitable derivative of the two compounds to confirm.

CY106 Organic Chemistry (Lab 02)

Time : 6-8 Hrs. (One day Examination)

Total Marks : 100

- | | |
|---|----------|
| (1) Exercise-1 (Organic Synthesis) - | 40 Marks |
| (2) Exercise-2 (Qualitative Analysis) - | 40 Marks |
| (3) Record - | 10 Marks |
| (4) Viva-Voce - | 10 Marks |

Total -100 Marks**Course Material/Learning Resources**

Books Suggested:

1. Experiments and technique in organic experiments- D. Pasto, C. Johnson and M. Miller prentice Hall.
2. Macro- scale and micro-scale organic experiments-K.L. Williaman, D. C. Heath.
3. Systematic quantitative organic analysis – H. Middleton, Edward Arnold.
4. Vogel's Textbook of practical organic chemistry Fifth Edition-Brain S. Furniss, Antoy J. Hannaford, Peter W,G. Smith, Austin R. Tatchell.
5. Qualitative organic Chemical analysis-A.I. Vogel.
6. Experiment organic chemistry Vol.I &II –P.R. Singh, D. S. Gupta and K.S. Bajpai.
7. The Golden book of chemistry experiments- Robert Brent

Weblink to Equivalent Virtual Lab

1. Detection of functional group: <https://vlab.amrita.edu/index.php?sub=2&brch=191&sim=345&cnt=1>
2. Detection of element: <https://vlab.amrita.edu/index.php?sub=2&brch=191&sim=344&cnt=1>
3. Purification by fractional distillation/crystallization-
<https://vlab.amrita.edu/index.php?sub=2&brch=191&sim=340&cnt=1>
4. Preparation of soap: <http://amrita.olabs.edu.in/?sub=73&brch=3&sim=119&cnt=2>

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

1. Procedure for synthesis : <http://orgsyn.org/Default.aspx>
2. Preparation of urea-formaldehyde resin: <https://www.youtube.com/watch?v=K9XehILO5E>

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester II**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY201	Advanced Inorganic Chemistry (DSC 06)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course, student would be able to

1. recollect the principles of electronic structure, bonding and reactivity of coordination complexes
2. understand the concept of synthesis and stability of transition metal organometallic complexes
3. develop the possible catalytic pathways leading to desired products
4. apply the principles of transition metal coordination complexes in understanding functions of biological systems
5. identify the medicinal applications of inorganic compounds
6. unravel and interpret the photochemical properties of coordination complexes

Unit I Reaction mechanisms of transition metal complexes:**15 hrs**

A) Ligand substitution reactions: Energy profile of a reaction – Transition state or Activated Complex. Types of substitution reactions (S_E , S_N , S_{N1} , S_{N2}). Langford and Grey classification – A mechanism, D Mechanism, Ia, Id, and Intimate mechanism. Ligand substitution reactions in octahedral complexes: Aquation or Acid hydrolysis reactions, Factors effecting Acid Hydrolysis, Base Hydrolysis, Conjugate Base Mechanism, Evidences in favour of S_{N1CB} Mechanism. Substitution reactions without Breaking Metal-Ligand bond. Anation reaction

B) Ligand Substitution reactions in Square-Planar complexes: Mechanism of Substitution in Square-Planar complexes- Trans-effect, Theories of trans effect [Grienberg's Polarization theory and pi-bonding theory], cis effect, cis effect series i.e. cis-influence (ligand effect), uses/ applications of cis and trans-effect in synthesis of Pt (II) complexes, Kurnakov's test, synthesis of anti-cancer drug cis-platin, factors affecting the rate of substitution reaction in Pt(II)square planar complexes.

C) Electron Transfer Reactions (or Oxidation-Reduction Reactions) in Coordination compounds: Mechanism of One-electron Transfer Reactions: Atom (or group) Transfer or Inner Sphere Mechanism, Direct electron Transfer or Outer Sphere Mechanism. Factors affecting direct electron transfer reactions, Cross reactions and Marcus-Hush theory.

Unit II Bonding in metal complexes –II - Electronic spectra:**15 hrs**

A) Ligand Field Theory and MO theory: types of complexes - sigma - pi bonding of complexes, back bonding (carbonyls) - Nephelauxetic effects.

B) Free ion terms and Energy levels: Configurations, Terms, States and Microstates – Formula for the calculation of Microstates p^n and d^n configurations – L-S (Russel-Saunders) coupling scheme – j-j coupling scheme – Determination of terms for various p^n and d^n configurations of metal ions. Hole formalism – Energy ordering of terms (Hund's rules) Inter – electron repulsion Parameters (Racah parameters) Evaluation of Dq , B' and β parameters (Konig method), Numericals. – Spin-Orbital coupling parameters. Effect of weak cubic crystal fields on S, P, D and F terms- Orgel diagrams (d^1 - d^9 states) and Tanabe-Sugano diagrams of d^2 and d^8 configurations of an octahedral environment. Charge transfer spectra & its mechanism, Intensity of charge transfer bands.

Unit III Organometallics and Catalysis**15 hrs**

A) Types of ligands in organometallic compounds - eighteen Electron rule, isolobal concepts. Chemistry of σ -Bonded transition metal-alkyls, - aryls, -alkenyls (vinyls), -alkynyls (acetylides), metal-carbenes, -carbynes, and their reactions.

B) Concept of hapticity, transition metal complexes of alkenes, Ziese salt, allenes, alkynes, allyls, butadienes; cyclic π -metal complexes of cyclobutadienes, cyclopentadienyls, arenes, cycloheptatrienyls and cyclooctatetraenes; reactions Metallocenes: Ferrocene, structure & bonding non-rigidity in organometallic compounds and fluxional compounds, bimetallic and cluster complexes.

C) Catalytic cycles-oxidative addition and reductive elimination. Hydrogenation of olefins - hydroformylation of olefins - oxidation of olefins to aldehydes and ketones, polymerisation of alkenes - cyclooligomerization of acetylene and Fischer - Tropsch process, olefin metathesis, Willkinsons catalyst, Vaska's complex.

Unit IV Bioinorganic chemistry:**15 hrs**

A) Overview of Bioinorganic chemistry-biological role of alkali metal ions, ligands, ion transport across the membrane, Classification as enzymatic and non-enzymatic metals, enzymatic redox metals such as Cu(SOD) and enzymatic non redox metals such as Zn(Hydrolase).

B) Electron Transfer- Metal-sulfide proteins - Cytochromes, Ferredoxins, Rieske proteins and Rubredoxins - Hydrogenases and Nitrogenases Hydrolytic Enzymes - Metal-dependent Zn hydrolase enzymes - Carbonic anhydrase - Carboxypeptidase - Alcohol dehydrogenase. Porphyrin systems:

C) Dioxygen Transport - Hemoglobin, hemerythrin and hemocyanin. Cooperativity in O_2 binding, O_2 and CO discrimination. Inorganic model compounds. Oxygen Metabolism - Oxygen atom transfer by cytochromes-P450, tyrosinase.

D) Metals in photosynthesis- Metal complexes in medicine- cisplatin and its mode of action. Gold and Lithium compounds as drugs - Metal complexes as probes of nucleic acid, metal ions in genetic regulations, metal DNA and RNA interaction – Potential binding sites.

Course Material/Learning Resources

Text books:

1. Selected Topics In Inorganic Chemistry: W.U. Malik, G.D. Tuli & R.D. Madan (S. Chand Publications)
2. B.R. Puri, L.R Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Vishal publication, 2016
3. Advanced Inorganic Chemistry - Volume I - Satya Prakash, G.D. Tuli, S K Basu & R.D. Madan (S. Chand Publications)
4. Advanced Inorganic Chemistry - Volume I - Satya Prakash, G.D. Tuli, S K Basu & R.D. Madan (S. Chand Publications)
5. Organometallic & Bioinorganic Chemistry (4th edition): Ajai Kumar; Aaryush Education

Reference Books:

1. D.F. Shriver and P.W. Atkins, Inorganic Chemistry, Oxford University Press, 5th Edition, 2010.
2. J. D. Lee, Concise Inorganic Chemistry, Oxford University Press, 5th Edition, 2014. Dieter Rehder. Bioinorganic Chemistry: An Introduction, Oxford University Press; 1st Edition, 2014
3. D. Rehder, E. Nordlander, Bioinorganic chemistry, Oxford University Press India, 2014.
4. Inorganic Chemistry: Catherine E., Housecroft and Alan G Sharp (5th edition) Pearson publication
4. Inorganic Chemistry, 5th Edition: Gary L. Miessler, Paul J. Fischer and Donald A. Tarr Pearson Publication.
5. Advanced Inorganic Chemistry. F.A.Cotton, G.Wilkinson, C.A.Murillo and M.Bochmann, 6th Edition, Wiley Interscience, N.Y (1999)
6. The Organometallic Chemistry of the transition metals (7th Edition): Robert H Crabtree Willey publications.
7. Inorganic Chemistry, J.E. Huheey, K.A.Keiter and R.L.Keiter 4 th Edition Harper Cottens College Publications (1993).
8. Homogeneous Catalysis by Metal complexes Vol I, M M Taqui Khan and A E Martell, Academic Press NY (1974).
9. Inorganic Chemistry, Keith F.Purcell and John C.Kotz, Holt-Saunders International Editions, London (1977).
10. Advanced Inorganic Chemistry 3rd, 5th & 6th Editions.: F.A. Cotton& G. Wilkinson:
11. Bioinorganic chemistry: Lippard S J Jeremy M Berg Stephen J Lippard, University Science Books ,Mill Valley, California, 1994.

Weblink to Equivalent MOOC on SWAYAM if relevant:

Introduction to Organometallic Chemistry- <https://nptel.ac.in/courses/104101006>

Advanced Transition Metal Organometallic Chemistry- <https://nptel.ac.in/courses/104101100>

Advanced Transition Metal Chemistry- https://onlinecourses.nptel.ac.in/noc22_cy60/course

Bioinorganic chemistry - <https://nptel.ac.in/courses/104105130>

Inorganic Chemistry of Life: Principles and Perspectives- <https://nptel.ac.in/courses/104101093>

Weblink to Equivalent Virtual Lab if relevant: NA

Any pertinent media (recorded lectures, YouTube, etc.) if relevant: NA

Syllabus Prescribed for Two Year PG Programme

Programme: MSc (Chemistry)

Semester II

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY202	Organic Reaction Mechanism (DSC 06)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Predict the orientation and stereochemistry of the product of addition reaction
2. Predict the orientation and stereochemistry of the product of elimination reaction
3. Apply enolate chemistry to achieve molecular complexity
4. Design organic reactions in order to achieve the required product(s).
5. Formulate green chemistry synthesis to increase atom economy

Unit-I **15 h**

A) Addition to carbon-carbon multiple bond: Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, Orientation and stereochemistry, Addition to cyclopropanes, Hydrogenation of double bond and triple bonds. Hydrogenation of aromatic rings, hydroboration-oxidation, epoxidation, Michael addition

B) Elimination reactions: The E1, E2 and E1CB mechanisms. Stereochemistry of E2 elimination. Orientation of the double bond, Saytzeff and Hoffman's rule, Effect of substrate structure, attacking base, leaving group and medium, Mechanism and orientation in pyrolytic elimination involving selenium oxide, Cope and Chugaev elimination

Unit II: **15 h**

Addition to carbon-hetero atom multiple bond: Ionization of carbon hydrogen bond and prototopy, Base and acid catalysed halogenation of ketones, keto-enol equilibria, structure and rate in enolisation, concerted and carbanion mechanism for tautomerism, geometry of carbanions, kinetic and thermodynamic control in the generation of enolates, Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters, and nitriles, Wittig reaction, Mechanisms and synthetic applications of condensation reactions involving enolates- Aldol, Knoevengel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction, Robinson annulation, Hydrolysis of esters and amide and Baylis-Hillman reactions.

Unit III: Free radical reactions **15 h**

I) Free radical reactions: Introduction of free radical, generation types, structure and stability of free radical reactions (using ARIO thumb rule), free radical initiator (heat/light/benzoyl or dibenzoyl peroxide/AIBN) and abstracting reagents (Tributyl tin hydride/triphenyl tinhydride/trimethyl silyl hydride/NBS/SmI₂).

II) Free radical related named reactions: Hunsdiecker reaction, allylic and benzylic bromination (Wohl-Ziegler), methane and vinylic bromination (using NBS), Sandmeyer, Fentons reagents and its applications. The Bergman cyclization reaction, chlorosulphonation (Reed Reaction)

III) Photo-fragmentation/rearrangements reactions: Barton-nitrite reaction, hypohalite reaction, Barton-McCombie deoxygenation reaction, Barton-radical decarboxylation reaction, Hoffmann-Loeffler Freytag reaction.

IV) Free radical dimerisation/coupling reactions: i) Ullman reaction, ii) McMurry coupling reaction, iii) Pinacol type coupling reaction.

V) Applications of tributyltin hydride (TBTH): i) Dehalogenation followed by intramolecular radical addition to carbon-carbon double and triple bonds, Tandem or Cascade radical cyclization, ii) Inter and intramolecular dehalogenation (Reduction of halides), iii) Reduction of carbonyl to alcohols, iv) opening of the cyclopropane and epoxide ring

Unit IV **15h****A) Molecular rearrangements and fragmentation reactions:**

Molecular rearrangements: Definition and classification of molecular rearrangements involving:

1. electron deficient carbon: Pinacol-Pinacolone, Semi-Pinacol Wagner- Meerwein, Tiffenev –Demjnov ring expansion, and Arndt-Eistert synthesis, Dienone-phenol rearrangement
2. electron deficient nitrogen: Hofmann, Lossen, Curtius, Schmidt Neber, Stieglitz and Beckmann rearrangements
3. electron deficient oxygen: Baeyer-Villiger oxidation, Dakin reaction
4. Base catalysed rearrangements: Benzil-Benzilic acid, Favorskii, Sommelet-Hauser and Smiles rearrangement

Fragmentation reactions: Electron push and pull requirement, Beckmann, Eschenmoser, Alicyclic-Grobb fragmentation.

B) Green Chemistry: Designing a green synthesis: Choice of starting material, choice of solvents. Basic principle of green chemistry, Concept of atom economy with suitable examples, Green Synthesis of styrene, urethane, caprolactum, paracetamol, Synthesis of Ibuprofen. Microwave induced green synthesis, Ionic liquids as Green Solvents, Chemical reactions involved in Bhopal gas tragedy, Minamata disease, Seveso (Italy) disaster

Course Material/Learning Resources**Text books:**

1. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2013
2. Electrophilic Additions to Carbon-Carbon Multiple Bonds Part B Reactions & Synthesis Francis A. Carey & Richard J. Sundberg (Springer)
3. Free Radical in Organic Chemistry Jacques Fossey, Daniel Lefort & Jannie Sorba Willey Publication.
4. Radical Reactions in Organic Synthesis Samir Z.Zard. Oxford Chemistry Masters.
5. Molecular Rearrangements in Organic Synthesis - Christian M. Rojas
6. Green Chemistry A Text Book-V.K.Ahluwalia
7. Introduction to Green Chemistry- Albert S.Matlack, Second Edition

Reference Books:

1. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st edition, Oxford University Press,

- 2001
2. Modern methods of Organic Synthesis W.Carruther & I.Coldham 4th Edition Cambridge
 3. Modern Organic Synthesis 1st edition by George S. Zweifel, Michael H. Nantz
 4. Clayden Organic Chemistry (2nd Edition) Solution Manual
 5. Organic Chemistry (7th edition) : R.T. Morrison and R.N. Boyd. Pearson Publication
 6. Organic Chemistry by I. L. Finar Vol.I Pearson Publication
 7. Molecular Orbitals and Organic Chemical Reactions: Student Edition-Ian Fleming Second Edition.

Weblink to Equivalent MOOC on SWAYAM if relevant:

Essentials of Oxidation, Reduction and C_C Bond Formation. Application in Organic Synthesis-

<https://nptel.ac.in/courses/104101127>

Environmental Chemistry- <https://nptel.ac.in/courses/105107176>

Principles Of Organic Synthesis- <https://nptel.ac.in/courses/104103110>

Introductory Organic Chemistry II- https://onlinecourses.nptel.ac.in/noc21_cy46/preview

Weblink to Equivalent Virtual Lab if relevant: NA

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

Introduction to Rearrangement Reactions- https://www.youtube.com/watch?v=QhY7tncG_gU

Radical Chain Polymerization- https://www.youtube.com/watch?v=RwmXApb_KXk

Wagner-Meerwein rearrangement, Pinacol rearrangement, Benzilic acid rearrangement-

<https://www.youtube.com/watch?v=dnam2PHjuwQ>

Rearrangement to electron-Rich carbon- <https://www.youtube.com/watch?v=4CjTT5CQ-Jw>

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester II**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY203	Physical Chemistry-II (DSC 07)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Understand basic and advanced level statistical thermodynamics, reaction kinetics, photochemistry and nuclear-chemistry
2. Apply the concepts of statistical thermodynamics and reaction kinetics to solve complex problems.
3. Demonstrate the ability to use chemical dynamics to solve problems associated with enzyme kinetics, fast reactions and complex reactions
4. Implement and build theoretical models for reaction rates, thermodynamics and nuclear phenomena
5. Solve numerical problems associated with statistical thermodynamics, reaction kinetics, photochemistry and nuclear chemistry

Unit – I : Statistical Thermodynamics**15Hrs**

- A)** Statistical entropy, microcanonical and canonical ensembles. Ideal monoatomic and diatomic gases Thermodynamic probability, most probable distribution. Maxwell-Boltzmann distribution law Fermi-Dirac statistics, distribution law and applications to metals. Bose-Einstein statistics-distribution law and application to helium. Heat capacities - Einstein theory and Debye theory Applications of statistical thermodynamics to activated complex theory
- B)** Partition function- Translational, rotational, vibrational and electronic partition functions, calculations of thermodynamic properties in terms of partition functions. Applications of partition functions. Numericals

Unit-II : Chemical Dynamics**15 Hrs**

- A) Kinetics of Complex reactions:** Chain reaction ($H_2+Br_2 \rightarrow 2 HBr$ thermal and photo chemical reaction), Homogeneous catalysis (acid-base and enzymes), oscillating reactions (BelousovZhabotinsky reaction, Lotka-Volterra mechanism, the brusselator and the oregonator).
- B) Enzyme kinetics** – Michaelis-Menten kinetics, Multi-substrate reactions, Lineweaver-Burk plot; Kinetics of fast and complex reactions: flow and relaxation methods; ultrafast reactions.
- C) Fast reactions:** General features of fast reactions, Stopped flow method, relaxation method, Nuclear magnetic resonance method, Flash Photolysis, Numericals.

Unit-III : Theories of reaction rates**15 Hrs**

- A)** Theories of reaction rates: Collision theory, collision rates in gases, energy requirement and steric requirement. Dynamics of molecular collisions. Transition state theory : assumptions, Statistical Mechanics and Chemical equilibrium, derivations of Eyring equation, Application of transition state theory to reaction between atoms and molecules (e.g. The reaction $H + HBr \rightarrow H_2+Br$)
- B)** Theory of Unimolecular reactions : Lindemann-Christiansen hypothesis and Hinshelwood treatment, Marcus's extension of the RRK treatment

Unit-IV: Photochemistry and Nuclear Chemistry**15 Hrs**

- A) Photochemistry:**
Basics of Photochemistry and Photophysics, Jablonski diagram. Electronically excited states: electronic, vibrational and spin levels, unimolecular and bimolecular photophysical processes. Photochemical reactions and kinetics – energy transfer, electron transfer, excited state quenching – eximer and exiplex
- B) Nuclear Chemistry:**
General characteristics of radioactive decay, decay kinetics, parent daughter decay growth relationship, Geiger Nutta Law, classification of reactor, reactor power, Breeder reactor, Reprocessing of spent fuel Recovery of Uranium and Plutonium nuclear waste management.

Course Material/Learning Resources**Text books:**

1. McQuarrie, D. A.; Simon, J. D.; Physical Chemistry: A Molecular Approach, University Science Books, 2011.
2. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, 2009.
3. McQuarrie, D. A.; Statistical mechanics, University Science Publishers, 2000

Reference Books:

1. Hill, T. A.; an Introduction to Statistical Thermodynamics, Dover Publications Inc., 1987.
2. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, 2008.
3. Laidler, K. J.; Chemical Kinetics, Pearson Education, 3rd edition, 2011
4. Physical Chemistry - P.W. Atkins, ELBS fourth edition.
5. Physical Chemistry – R.A. Alberty, R.I. Bilby, John Wiley – 1995
6. Physical Chemistry – G.M. Barrow, Tata Mc – Graw Hill – 1988
7. Quantum Chemistry, - I. Levine, Fifth edition, Prentice Hall- 1999. Physical Chemistry – Thomas Engel, Philip Reid
8. Molecular quantum mechanics, Vol. I & II, P. W. Atkins, Oxford University Press, 1970.

9. Statistical thermodynamics, by T.L.Hill, Addison Wesley, 1060
Chemical thermodynamics, by F.T. Wall, W.H.Freeman & Co. 1965
10. Irreversible thermodynamics, Theory and applications, by K.S.Forland, T. Forland, S.KRatje, Jonny Witey, 1988.
11. Chemical Kinetics,by K. J. Laidler, 3rd Edition, Harper and row, 1987.
12. Chemical Kinetics-A study of reaction rate in solution, K.Conors, V.C.H.Publkatkm 1990.
13. Chemical Kinetics and Dynamics, By J.I.Streinfeld, J.S. Francisco & W.I.Hase, Pritice Hall, 1989.
Kinetics and Mechanism of Chemical transformation, J.Rajraman, J. Kucriacose, Mc-Million
Molecular reaction Dynamics and chemical reactivity, R.D.Levine and R.B. Benstin, Oxford University
ress. 1987.
14. Physical Chemistry by Alberty and Silby, Jolly Wiley

Weblink to Equivalent MOOC on SWAYAM if relevant:

Approximate Methods In Quantum Chemistry: <https://nptel.ac.in/courses/104105128>

Advanced Chemical Thermodynamics and Kinetics: <https://nptel.ac.in/courses/104106094>

Thermodynamics: Classical to statistical: <https://nptel.ac.in/courses/104103112>

Weblink to Equivalent Virtual Lab if relevant:

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester II**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY204	Analytical Chemistry-II (DSC 08)	60 hrs (4 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Select most suitable modern chromatographic technique for separation of analyte from matrix.
2. Explain various types of columns and detectors used in chromatography.
3. Determine pKa value of indicator using potentiometry
4. Summarize principles and applications of molecular absorption and molecular emission spectroscopy
5. Design experiments based on spectrophotometry and polarographic analysis.
6. Apply the principle involved in radioanalytical techniques and instrumentation therein.
7. Formulate experiments based on optical and electroanalytical techniques.

Unit-I: Modern separation techniques**15h**

A] Gas Chromatography: Principle including concept of theoretical plates and van-Deemter equation. Instrumental set up- carrier gas, sampling system, column and detector. Types of columns, their advantages and limitations. Detectors in GC analysis. Temperature programmed GC. Factors affecting retention, peak resolution and peak broadening.

B] Liquid chromatography: Principle, Instrumentation, Advantages and applications of HPLC. Types of columns and detectors. Principle and applications of size exclusion, gel permeation, ion retardation, normal phase and reverse phase chromatography.

C] Supercritical fluid chromatography: Introduction and applications.

Unit II: Optical methods of analysis-I**15h**

A] Spectrophotometry: Principle. Beer's law, its verification and deviations. Instrumentation in colorimetry and spectrophotometry (single and double beam). Sensitivity and analytical significance of molar extinction coefficient and λ_{max} . Comparison method, calibration curve method and standard addition method for quantitative estimation. Ringbom plot and Sandell's sensitivity. Photometric titrations. Determination of pK value of indicator. Simultaneous determination in binary systems (dichromate and permanganate, mixture of dyes etc). Composition of complex by Job's and mole ratio methods. Derivative spectrophotometry. Numerical problems.

B] Fluorometry and phosphorimetry: Principles of fluorescence and phosphorescence. Jablonski diagram. Concentration dependence of fluorescence intensity. Fluorescence quenching. Instrumentation. Applications.

Unit-III: Electrochemical methods of analysis-II**15h**

A] Polarography: Principle of DC polarography. Instrumentation in polarography. Advantages and limitations of DME. Types of currents- residual current, migration current, diffusion current, limiting current, adsorption current, kinetic current and catalytic current. Ilkovic equation-diffusion current constant and capillary characteristics. Derivation of equation of polarographic wave and half wave potential. Experimental determination of half wave potential. Reversible, quasi reversible and irreversible electrode reactions. Polarographic maxima and maximum suppressor. Oxygen interference and deaeration. Introduction to pulse, a.c. and oscillographic techniques and their advantages. Applications of polarography in determination of dissolved oxygen, metal ion quantification and speciation, simultaneous determination of metal ions, analysis of organic compounds. Limitations of polarography.

B] Amperometric titrations: Principle, types and applications in analytical chemistry.

Unit-IV: Radioanalytical techniques**15h**

Radioactivity, Law of radioactive decay, Radiation Units: Curie, Becquerel, Gray, Rad, Sievert, RBE, REM. Half-life and mean life. Different types of radiations and their interactions with matter. Radiation detectors: principles and working of Ionization chamber, GM counter, Proportional counter and gamma ray spectrometer. Principles, instrumentation and applications of Neutron Activation Analysis, Isotope Dilution Analysis, Radiometric titrations,

Radiochromatography, Carbon dating, Numerical problems based on above.

Course Material/Learning Resources

Text books:

1. Essentials of Nuclear Chemistry: H. J. Arnikar (Willey Eastern Ltd)

Reference Books:

1. Sub-stoichiometry in Radioanalytical Chemistry: J. Ruzicka and J Stary (Pergamon Press)
2. Introduction to Radiation Chemistry: J. W. T. Spinks and R. J. Woods
3. Radiochemistry: A. N. Nesmeyanov (Mir Publications)
4. Instrumental Methods of Analysis: Willard, Meritt and Dean (Van Nostrand)
5. Advance Analytical Chemistry: Meites and Thomas: (Mc Graw Hill)
6. An Introduction to Separation Science: L. R. Shyder and C. H. Harvath (Wiley Interscience)
7. Instrumental Methods of Chemical Analysis: G. W. Ewing

Weblink to Equivalent MOOC on SWAYAM if relevant:

Analytical Chemistry: https://onlinecourses.nptel.ac.in/noc22_cv61/preview

Advance Analytical Course: <https://nptel.ac.in/courses/104104066>

Weblink to Equivalent Virtual Lab if relevant: NA

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

1. Gas chromatography <https://www.youtube.com/watch?v=08YWhLTjlf0>

Ability Enhancement Course on DSC : 02

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY205	Acids and Bases and Virtual Lab (AEC-2)	15 hrs

Course Outcome: After completion of this course successfully, the students would be able to.....

1. correlate concept of pKa to predict the reaction mechanism
 2. apply the basic operations of spreadsheet applications
 3. operate various Chemistry software with advanced functions
 4. prepare and present report on a particular topic
- A) Concept of acids and Bases: SHAB principle, Comparing acidity of two different Hydrogens within or different molecules (ARIO Principle), Quantitative measurement: pKa (Evans Table), Predicting the position of equilibrium.
- B) Chemistry Software's (Chemdraw, Chem Sketch etc) Structure drawing, Introduction to advanced functions of MS office and its Open Office substitutes including tracking changes, inserting page numbers, Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs Incorporating tables and graphs into word processing documents, making of effective PowerPoint presentations.
- C) Seminar 15 min (10 minutes presentation and 5 minutes discussion)

Suggested Activity:

1. Assignment on prediction of acidity of different Hydrogens within or different molecules
2. Prepare and submit an assignment in MS word given by the instructor.
3. Seminar on any topic using power point presentation.

Course Material/Learning Resources

Reference Books:

1. Organic Chemistry as a Second Language: David R Klein, Jon Wiley and Sons, 2004

Weblink:

1. Draw chemical structure in MS word: <https://www.youtube.com/watch?v=4dNh1N63HkQ>

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester 2**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY206	Physical Chemistry (Lab-03)	90 hrs (9 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. Apply knowledge to determine reaction rate of chemical reactions
2. Create methods for estimation of concentration of electrolytes in mixture using potentiometry.
3. Correlate nature of graphs in conductometric titrations
4. Improve skill to perform experiment in electroanalytical methods
5. Correlate structure property relationship of conjugated systems
6. Design conjugated polymer of desired optoelectronic property.

Part A

1. Determine the specific reaction rate of the potassium persulphate-iodide reaction by the initial rate method.
2. Study the kinetics of the iodination of acetone in the presence of acid by the Initial Rate Method.
3. Study of enzyme-substrate catalysis reaction: the hydrolysis of p-nitrophenyl phosphate as catalysed by alkaline phosphatase
4. Kinetics of Iodine Clock Reaction
5. Study of an Oscillating Reaction: the oscillating reaction (Belousov-Zhabotinsky) to be studied using the Ce³⁺/Ce⁴⁺ system; dependence of the oscillation period on the metal ion concentration to be monitored.
6. *Ab-initio* calculation of rotational barrier between eclipsed and staggered conformation of ethane
7. Calculation of potential energy surface of H₂O₂ molecule using HF/6-31G(d,p)
8. Particle in 1D Box: Quantum mechanical calculation of HOMO-LUMO gap in ethene, 1,3 butadiene and 1,3,5-hexatriene.

Part B

1. Titrate conductometrically a moderately strong acid (salicylic/ mandelic acid) by the
 - a. salt-line method
 - b. double alkali method.
2. Titrate conductometrically a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide.
3. Titrate conductometrically a tribasic acid (phosphoric acid) against NaOH and Ba(OH)₂ conductometrically.
4. Titrate conductometrically magnesium sulphate against BaCl₂ and its reverse titration
5. Estimate the concentration of each component of a mixture of AgNO₃ and HNO₃ by conductometric titration against NaOH.
6. Determine the degree of hydrolysis of aniline hydrochloride conductometrically.
7. Determine the solubility and solubility product of an insoluble salt, AgX (X=Cl, Br or I) potentiometrically.
8. Determine the mean activity coefficient (γ_{\pm}) of 0.01 M hydrochloric acid solution potentiometrically.
9. Study the titration phosphoric acid potentiometrically against sodium hydroxide.
10. Find the composition of the zinc ferrocyanide complex by potentiometric titration.
11. Titrate potentiometrically solutions of mixture of KCl + KBr + KI and determine the composition of each component in the mixture.
12. Verify the Debye-Hückel theory through the solubility of ionic salts.

CY206 Physical Chemistry (Lab 03)

Time : 6-8 Hrs. (One day Examination)

Total Marks : 100

(1) Exercise-1 (Part A)	40 Marks
(2) Exercise-2 (Part B)	40 Marks
(3) Record	10 Marks
(4) Viva-Voce	10 Marks

Total -100 Marks**Course Material/Learning Resources: (to be upod****Books Suggested-****Books Suggested:**

1. J. B. Yadav, Practical Physical Chemistry
2. Das and Behra, Practical Physical Chemistry
3. Carl W. Garland, Joseph W. Nibler and David P. Shoemaker, Experiments in Physical Chemistry, Mc-Graw Hill, 8th Edition, 2009.
4. Farrington Daniels, Joseph Howard Mathews, John Warren Williams, Paul Bender, Robert A. Alberty, Experimental Physical Chemistry, Mc-Graw Hill, Fifth Edition, 1956.
5. John W. Shriver and Michael George, Experimental Physical Chemistry, Lab Manual and Data Analysis, The University of Alabama in Huntsville, Fall 2006
6. Jahgirdar D.V: Experiments In Chemistry

Weblink to Equivalent MOOC on SWAYAM if relevant:

Weblink to Equivalent Virtual Lab if relevant:

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for Two Year PG Programme**Programme: MSc (Chemistry)****Semester 1**

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
CY207	Inorganic Chemistry (Lab-04)	90 hrs (9 hrs/week)

Course Outcomes: At the end of the course students would be able to

1. apply knowledge to develop method for qualitative identification elements from the mixture having applications in industry and research
2. create methods for estimation of element/metal from the complexes.
3. improve skill for separation identification and removal of interfering radicals
4. get idea about development of spot test for the different elements.
5. Understand importance of metal complexes and green methods for the synthesis.

Part-A

Preparation of inorganic compounds. It is expected that preparation should be carried out using tenets of Green Chemistry. Any one of the prepared compound may be characterized by elemental analysis/estimation or MW determination or decomposition temperatures or molar conductance studies. **(Any Five)**

1. Preparation of $[\text{VO}(\text{acac})_2]$
2. Preparation of bis(acetylacetonato)copper(II).
3. Preparation of tris (acetylacetonato) iron (III).
4. Preparation of tris (acetylacetonato) manganese (III).
5. Preparation of Isomers of Tris (8-Hydroxyquinolinato) aluminium (III)
6. Preparation of Potassium trioxalatomanganate(III), $\text{K}_3[\text{Mn}(\text{C}_2\text{O}_4)_3]$
7. Preparation of Cis and trans isomers of $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
8. Preparation of Cis/Trans $\text{K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2] \cdot 2\text{H}_2\text{O}$ potassium bisoxalato diaquo chromate(III) dehydrate
9. Preparation of $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
10. Preparation of $[\text{Co}(\text{Py})_2\text{Cl}_2]$
11. Preparation of $[\text{Ni}(\text{DMG})_2]$
12. Preparation of $[\text{Cu}_2(\text{CH}_3\text{COO})_4(\text{H}_2\text{O})_2]$
13. Preparation of $\text{K}_3[\text{Al}(\text{C}_2\text{O}_4)_3](\text{H}_2\text{O})_3$

Part-BQuantitative Analysis **(Any two)**

Quantitative analysis of mixture of cations involving their chemical separation and separate analysis of one cation by gravimetry and another by volumetric or colorimetric. Quantitative analysis of (Brass, Bronze and Dolomite)

Part-CQualitative analysis of **Eight** mixtures

Qualitative analysis of mixtures containing at least five radicals including interfering radicals (not more than one such radical in a mixture), rare earth (not more than two rare earths in a mixture)

1. Cations of: Ag, Pb, Hg, Cu, Cd, Sn, Bi, As, Sb, Fe, Al, Cr, Co, Ni, Mn, Zn, Ca, Sr, Ba, Mg, Na and K^+ , NH_4^+
2. Cations of rare elements: W, Tl, Mo, Ce, Ti, Th, Zr, U, V, Be and Li.
3. Interfering radicals: Phosphate, Oxalate, Fluoride and Tartrate.

CY207 Inorganic Chemistry (Lab 04)

Time : 6-8 Hrs. (One day Examination)

Total Marks : 100

(1) Exercise-1 (Inorganic preparation)	40 Marks
(2) Exercise-2 (Qualitative Analysis of mixture/ Quantitative analysis of mixture)	40 Marks
(3) Record	10 Marks
(4) Viva-Voce	10 Marks

Total -100 Marks**Course Material/Learning Resources:****Books Suggested-**

1. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Experiments, J. Derck Woollins, VCH.
3. Practical Inorganic Chemistry, G. Marrant, B. W. Rockett, Van Nostrand.
4. Instrumental Methods of Analysis, Willard, Merit and Dean (CBS, Delhi)
5. Fundamental of Analytical Chemistry, Skoog D.A. & West D.M Holt Rinehart & Winston Inc.
6. Experimental Inorganic Chemistry, W.G.Palmer, Cambridge
7. Advance inorganic analysis by Agrawal Keemtilal, A Pragati Prakashan.
8. Advanced Practical Inorganic Chemistry – Gurdeep Raj
9. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.
10. G. Marr and B.W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold. 197

Weblink to Equivalent MOOC on SWAYAM if relevant:

1. Concentrations: <https://www.digimat.in/nptel/courses/video/104106121/L02.html>
2. Concentrations : <https://www.digimat.in/nptel/courses/video/104106121/L03.html>
3. Volumetric/gravimetric: <https://www.digimat.in/nptel/courses/video/104106121/L29.html>

Weblink to Equivalent Virtual Lab if relevant:

1. Brass: <https://vlab.amrita.edu/index.php?sub=2&brch=193&sim=1255&cnt=1>
2. Gravimetric estimation: <https://vlab.amrita.edu/index.php?sub=2&brch=193&sim=348&cnt=1>

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

1. <https://people.chem.umass.edu/pkhalifah/chem242/242-S2007-EP/2007-2-CoIsomer-EP.pdf>
2. <https://www.youtube.com/watch?v=s7pXbV9dumI>

Sant Gadge Baba Amravati University, Amravati

General Interest Course :01
Chemistry for All (02 Credit)

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
-----	Chemistry for All	30 hrs

Course Outcome: After completion of this course successfully, the students would be able to.....

1. grasp basic insights into concept of atoms and molecules
2. understand Periodic Table trends and functional groups;
3. correlate concept of properties of elements, chemical reactivity and stability.
4. correlate Chemistry with the process of photosynthesis and pollution.
5. apply concepts of chemistry to biomolecules and functions of drugs inside the body.

Foundation: Elements, Atoms, Subatomic particles, Discovery, Periodic Table, Radioactive Elements, Stability and reactivity, Molecules, Characterization, Properties and Chemical Reactions. Chemical compounds and functional groups (for students with non-chemistry background). Solids, liquids and gases; properties.

Environment and Impact on Daily Life: Sun (nuclear fusion), Liquid water – Importance of H-bond (potable, hard and soft), Importance of trees and plants, Photosynthesis – oxygen supply to air and water. Greenhouse effect, Atmospheric chemical pollution and its impact. Nuclear waste, Industrial chemical pollution, Pesticides – fertilizers, organic farming etc. Chemistry in the Living Beings, Healthy food pyramid, Essential chemical components (Fe, Ca, Na K, Vitamins, Proteins, Fat) – in relation to eye, blood, bones, brain, heart etc. Chemistry of food and food products.

Medicines: Common drugs and their function inside the body, Side effect of Drugs.

Course Material/Learning Resources: To be provided by the instructor

Useful Weblinks :

1. https://und.edu/academics/online/enroll-anytime/chem115.html?gclid=CjwKCAjw5NqVBhAjEiwAeCa97dl77-Xu0i2ZEIRYmMOK-0NV47kmzcVbnPE6Lcz6DnisrwLofcDfERoC_pIQAvD_BwE
2. <https://www.rsc.org/globalassets/22-new-perspectives/talent/is-chemistry-accessible-for-all/rsc-cfa-report.pdf>
3. <https://www.acs.org/content/acs/en/education/whatischemistry/everywhere.html>

History of Chemistry in ancient and Medieval India (02 credit)

Course objective: Main objective is to highlight the development of chemistry and alchemy in ancient India.

Course Outcome: After completion of this course successfully, the students would be able to

1. understand application of science & technology in ancient Indian civilization
2. get insight of Indian Contribution to World in Chemistry
3. correlate ancient health management systems through home remedies
4. apply concepts of Indology of chemistry to biomolecules and functions of drugs inside the body.

Preamble: Ancient India, an important role in the development of chemistry was made by Ayurveda which used a variety of minerals. Science and technology in ancient and medieval India covered all the major branches of human knowledge and activities. In any, early civilization, metallurgy has remained an activity central to all civilizations from the Bronze Age and the Iron Age, to all other civilizations that followed. The Indus valley civilization was the earliest society, the story of early chemistry in India begins from here. Traces of cement had been found in the era of Mohanjodaro. According to RigVeda, tanning of leather and dyeing of cotton was practiced during this period. After Vedas classical texts which give valuable information about the chemical activities of this period. The major chemical products of this period were glass, paper, soap, dyeing, cosmetics and perfumes, alcoholic lacquers, pharmaceuticals, gun powder and saltpetre. Nagarjuna (metallurgist) and Kanada were chemist of ancient period. Indian and Persian army used arrows tipped with iron. In the Gupta age metallurgical operations were found. Nataraja statue the god of dance is made of five metals Pancha Dhatu and Iron Pillar, Delhi is as a silent witness to assert the striking metallurgical skill of the Hindus. Paintings found on walls of Ajanta and Ellora also testify to the high level of chemical science achieved in ancient India

Contents:

1. Chemistry in Prehistoric India: Pre-Harappan Period and Indus Valley Civilization
2. Chemistry in Vedic and Ayurvedic Period
3. Chemistry in Translational Period
4. Chemistry in Iatrochemical Period
5. Chemistry in Practical Art

References:

1. History of chemistry in ancient and medieval India / [edited by Priyadarajan Ray] ; incorporating the 'History of Hindu chemistry' by Acharya Prafulla Chandra Rây. Praphulla Candra Ray; Priyadarajana Ray, 2004, : Chowkhamba Krishnadas Academy Varanasi.
2. Subbarayappa, B.V. 1999. Indian Alchemy: its Origin and Ramifications. In *Chemistry and Chemical Techniques in India* (Ed.) Subbarayappa, B.V., Delhi: Centre for Studies in Civilisations.
3. Deshpande, Vijaya Jayant. 1998. History of Chemistry and Alchemy in India from Pre-historic to Pre- Modern Times. In *History of Indian Science and Technology an Culture AD 1000-1800* (Ed) A. Rahman. Delhi: Oxford.
4. Habib, Irfan. 2000. Joseph Needham and The History of Indian Technology. *Indian Journal of History of Science* 35(3): 245-274.
5. Needham, Joseph. *Science and Civilisation in China*. Vols. IV (2), V(4). Cambridge: Cambridge University Press. (Especially pages 85-6,97,104-7 and 131-2).
6. Ray, P.C. 1909. *History of Hindu Chemistry*. Vols. I & II. London: Williams and Norgate
7. Useful weblinks:

Useful Weblinks:

<https://nptel.ac.in/courses/101104065>

https://www.infinityfoundation.com/mandala/t_es/t_es_agraw_chemistry_frameset.htm

<https://www.pgurus.com/chemistry-in-ancient-india/>