**National Education Policy-2020**

# Common Minimum Syllabus for Uttarakhand State Universities and Colleges

## PG Two Year Programme

## Master in Science

## SYLLABUS

**w. e. f. - 2025-2026**


**DEPARTMENT OF CHEMISTRY**

**KUMAUN UNIVERSITY, NAINITAL**


29.06.2025
HEAD
DEPARTMENT OF CHEMISTRY
KUMAUN UNIVERSITY NAINITAL

29.6.2025
Dean
Faculty of Science
Kumaun University
Nainital

## SYLLABUS PREPARATION COMMITTEE

| S.N. | NAME | DESIGNATION | DEPARTMENT | AFFILIATION |
|---|---|---|---|---|
| 1. | Dr. Chitra Pande | Professor | Chemistry | Kumaun University Nainital |
| 2. | Dr. Nand Gopal Sahoo | Professor | Chemistry | Kumaun University Nainital |
| 3. | Dr. Geeta Tewari | Professor | Chemistry | Kumaun University Nainital |
| 4. | Dr. Shah Raj Ali | Professor | Chemistry | Kumaun University Nainital |
| 5. | Dr. Suhail Javed | Associate Professor | Chemistry | Kumaun University Nainital |
| 6. | Dr. Mahesh C. Arya | Assistant Professor | Chemistry | Kumaun University Nainital |
| 7. | Dr. Manoj Dhuni | Assistant Professor | Chemistry | Kumaun University Nainital |
| 8. | Dr. Penny Joshi | Assistant Professor | Chemistry | Kumaun University Nainital |
| 9. | Dr. Lalit Mohan | Assistant Professor (Contractual) | Chemistry | Kumaun University Nainital |
| 10. | Dr. Girish C. Kharkwal | Assistant Professor (Guest) | Chemistry | Kumaun University Nainital |
| 11. | Dr. Deepshikha Joshi | Assistant Professor (Guest) | Chemistry | Kumaun University Nainital |
| 12. | Miss. Anchal Aneja | Assistant Professor (Guest) | Chemistry | Kumaun University Nainital |
| 13. | Dr. Akanksha Rani | Assistant Professor (Guest) | Chemistry | Kumaun University Nainital |
| 14. | Dr. Bhawana Pant | Assistant Professor (Guest) | Chemistry | Kumaun University Nainital |

## SYLLABUS REVIEW COMMITTEE

| S.N. | NAME | DESIGNATION | DEPARTMENT | AFFILIATION |
|---|---|---|---|---|
| 1. | Dr. K. R. Prabhu | Professor | Chemistry | Indian Institute of Science, Bengaluru |
| 2. | Dr. Robina Aman | Professor | Chemistry | S. S. J. University Almora |
| 3. | Dr. Neeta Joshi | Professor | Chemistry | Sri Dev Suman Uttarakhand University, Garhwal |
| 4. | Dr. Beena Negi | Assistant Professor | Chemistry | Gargi College, University of Delhi, Delhi |

# National Education Policy-2020
## Common Minimum Syllabus for all Uttarakhand State Universities/ Colleges
## SUBJECT: CHEMISTRY

| Multidisciplinary Courses of Study [ Three core Disciplines] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sem ester | Core (DSC) | Elective (DSE) | Generic Elective (GE) | Ability Enhancement Course (AEC) | Skill Enhancement Course (SEC) | Internship/ Apprentices hip/ Project | Value Addition Course (VAC) | Total Credits |
| VII | DSC-(4) | Choose three DSE(3x4) Courses **OR** Choose two DSE(2x4) and one GE (4) Course **OR** Choose one DSE (4) and two GE(2x4) Course (Total = 12) | | | | | Dissertation on Major (4+2) OR Dissertation on Minor (4+2) OR Academic Project/ Entrepreneurship | 22 Credits |
| VIII | DSC-(4) | Choose three DSE(3x4) Courses **OR** Choose two DSE(2x4) and one GE (4) Course **OR** Choose one DSE (4) and two GE(2x4) Course (Total = 12) | | | | | Dissertation on Major (4+2) OR Dissertation on Minor (4+2) OR Academic Project/ Entrepreneurship | 22 Credits |
| Students on exit shall be awarded Bachelor of (in the field of Multidisciplinary Study) (Honours or Honours with Academic Projects/Entrepreneurship) after securing the requisite 176 credits on completion of Semester VIII **OR** If a student opts for a two-year PG Program, the have the option to obtain a PG diploma in the Core Subject upon earning 44 credits at the conclusion of the second semester of the PG program. | | | | | | | | Total= 176 |
| IX | DSC-(4) | Choose three DSE(3x4) Courses **OR** Choose two DSE(2x4) and one GE (4) Course **OR** Choose one DSE (4) and two GE(2x4) Course (Total = 12) | | | | | Dissertation on Major (4+2) OR Dissertation on Minor (4+2) OR Academic Project/ Entrepreneurship | 22 Credits |
| X | DSC-(4) | Choose three DSE(3x4) Courses **OR** Choose two DSE(2x4) and one GE (4) Course **OR** Choose one DSE (4) and two GE(2x4) Course (Total = 12) | | | | | Dissertation on Major (4+2) OR Dissertation on Minor (4+2) OR Academic Project/ Entrepreneurship | 22 Credits |
| Students on exit shall be Master's in Core Subject after securing the requisite 220 credits on completion of Semester X | | | | | | | | Total= 220 |

**Contents**

| List of Papers (DSC, DSE, GE) with Semester Wise Titles for 'Chemsirty' | | | | | |
|---|---|---|---|---|---|
| **Year** | **Semester** | **Course** | **Paper Title** | **Theory/Practical** | **Credits** |
| **Bachelor of Chemistry with Honours** | | | | | |
| **FOURTH YEAR** | VII | DSC 7 | Advanced Chemistry I | Theory | 3 |
| | | | Advanced Experiment Chemistry- I | Practical | 1 |
| | | DSE 7A | Advanced Inorganic Chemistry | Theory | 4 |
| | | DSE 7B | Advanced Organic Chemistry | Theory | 4 |
| | | DSE 7C | Advanced Physical Chemistry | Theory | 4 |
| | | GE 7A | Biology for Chemists | Theory | 4 |
| | | GE 7B | Mathematics for Chemists | Theory | 4 |
| | | IAPT 7 | Internship/ Apprenticeship/Academic Project/Applied Project/Field Work/Training | Theory/ Practical | 6 |
| | VIII | DSC 8 | Advanced Chemistry II | Theory | 3 |
| | | | Advanced Experiment Chemistry-II | Practical | 1 |
| | | DSE 8A | Pericyclic Reactions and Photochemistry | Theory | 4 |
| | | DSE 8B | Spectroscopic Techniques | Theory | 4 |
| | | DSE 8C | Chemistry of Biological Systems | Theory | 4 |
| | | GE 8A | SolidState Chemistry and Supramolecular Chemistry | Theory | 4 |
| | | GE 8B | Analytical and Separation Techniques | Theory | 4 |
| | | IAPT 8 | Internship/ Apprenticeship/Academic/Applied Project/Field Work/Trainin Dissertation for B. Sc. with Research | Theory/ Practical | 6 |
| **Master's in Chemistry** | | | | | |
| **FIFTH YEAR** | IX | DSC 9 | Advanced Spectroscopic Techniques I | Theory | 3 |
| | | | Advanced Experimental Chemistry-III | Practical | 1 |
| | | DSE 9A | Applied Photochemistry and Nuclear Chemistry | Theory | 4 |
| | | DSE 9B | Organic Synthesis | Theory | 4 |
| | | DSE 9C | Advanced Chromatography | Theory | 4 |
| | | GE 9A | Basic Physical Chemistry and Industrial Chemistry | Theory | 4 |
| | | GE 9B | Computer for Chemists | Theory | 4 |
| | | GE 9C | Essentials of Medicinal and Aromatic Plant Science | Theory | 4 |
| | | IAPT 9 | Internship/ Apprenticeship/Academic/Applied Project/Field Work/Training | Theory/ Practical | 6 |
| | X | DSC 10 | Advanced Spectroscopic Techniques II | Theory | 3 |
| | | | Advanced Experimental Chemistry-IV | Practical | 1 |
| | | DSE10A | Organometallic Chemistry | Theory | 4 |
| | | DSE 10B | Metal Ligand Bonding and Polymer Chemistry | Theory | 4 |
| | | DSE 10C | Photo Inorganic Chemistry | Theory | 4 |
| | | DSE 10D | Heterocyclic Chemistry | Theory | 4 |
| | | DSE 10E | Chemistry of Natural Products | Theory | 4 |
| | | DSE 10F | Medicinal Chemistry | Theory | 4 |
| | | DSE 10G | Advanced Chemical Dynamics and Statistical Thermodynamics | Theory | 4 |
| | | DSE 10H | Molecular Orbital Theory and Quantum Mechanics | Theory | 4 |
| | | DSE 10I | Radio and Electroanalytical Techniques | Theory | 4 |
| | | GE 10A | Corrosion, Energy and Polymers | Theory | 4 |
| | | GE 10B | Metallurgy and Inorganic Materials | Theory | 4 |

| | | | | | |
|---|---|---|---|---|---|
| | | GE 10C | Environmental Chemistry | Theory | 4 |
| | | IAPT 10 | Dissertation | Theory/ Practical | 6 |

**Abbreviations-DSC-Discipline Specific Course; DSE- Discipline Specific Electives; GE-Generic Electives**

| Programme Specific Outcomes (PSOs) -Master's in Chemistry<br><br>After this programme, the learner will be able to: | |
|---|---|
| **PSO1** | Acquire knowledge thermodynamics, polymer and surface chemistry.<br>Acquire the practical knowledge in quantitative analysis of binary mixture and learn multistep preparation in organic chemistry. |
| **PSO2** | Master advanced nuclear chemistry along with learning the applications of photochemistry. |
| **PSO3** | Understand the use of reagents in organic synthesis. Apply disconnection approach and protecting groups in organic synthesis. |
| **PSO4** | Learn the principlesinvolved in Chromatography along with their applications. |
| **PSO5** | Understand history of computers, software and their types.<br>Understand extraction techniques, cultivation, processing and therapeutic potential of medicinal plants. |
| **PSO6** | Understand the principle and application of various spectroscopies.<br>Through practical gain knowledge in inorganic, organic and physical chemistry experiment. |
| **PSO7** | Gain proficiency in advanced chemical dynamics and statistical thermodynamics. |
| **PSO8** | Acquire the knowledge of all classes of natural products.Understand the nomenclature and synthesis of heterocyclic compounds. |
| **PSO9** | Understand the organometallic compound of transition metals and mechanism of catalytic reactions. |
| **PSO10** | Gain basic knowledge in corrosion, energy and polymers.<br>Understand metallurgical processes, analyze and synthesize a variety of inorganic materials, including cement, glass, ceramics, steel, and silicones. |

## Pattern of examination

### A. Theory

Each theory paper shall be of 03 hours and will consist of two sections, A and B. Section A: (Short answers type with reasoning); 40% of the total marks (30 marks, eight questions of six marks each, any five have to be attempted). Section B: (Long answers type); 60 % of the total marks, (45 marks, three questions out of five have to be attempted. Each question carries 15 marks).

### B. Internal assessment

For each theory paper, an internal assignment (in the form of class test and or assignments including classroom attendance) of 25 marks for each paper shall be conducted during each semester. The evaluated answer sheets/assignments have to be submitted to the Head of the Department/ Principal along with one copy of award list. The marks obtained have to be uploaded onto the University examination portal and the print out of the award list from portal have to be submitted to the Controller Examination.

### C. Practical

The practical work of the students has to be evaluated periodically. The internal assessments (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 25 marks for each semester shall be conducted during the semester. In each semester, practical examination of 75 marks has to conducted by two examiners (External and internal) having duration of two days (time 6 hours each day). The external examiner will examine the students only on the second day of examination. The total number of students to be examined per batch should not be more than sixty. One copy of award list of the practical examination along with attendance has to be submitted to the Head of the Department/ Principal. The marks obtained have to be uploaded onto the University examination portal and the print out of the award list from portal have to be submitted to the Controller Examination.

# PG Two Year Programme
# Department of Chemistry

**Semester-VII**
**Bachelor of Chemistry with Honours**

**DISCIPLINE SPECIFIC COURSE (DSC 7)**
**Advanced Chemistry I (Theory)**
**Advanced Experimental Chemistry -I (Practical)**

**No. of Hours- 75**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **DSC: Advanced Chemistry I (Theory)**<br><br>**Advanced Experimental Chemistry -I (Practical)** | **4** | **3** | **-** | **1** | **Chemistry in Bachelor of Science** | **Nil** |

| | | |
|---|---|---|
| **BACHELOR OF CHEMISTRY WITH HONOURS** | | |
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VII**<br>**Paper: DSC 7** |
| **Subject: Chemistry** | | |
| **Course: DSC 7** | **Course Title: Advanced Chemistry I** | |

**Course Outcomes:**
Upon successful completion of this course, the students will be able to:

- Have a deep knowledge of the electronic spectra of transition metal complexes
- Learn electronic angular momentum in diatomic molecules
- Understand the various reaction intermediates of chemical reactions.
- Have a broad understanding about the Thermodynamics and its relative phenomena.
- Describe the elements of symmetry, point groups, orthogonality theorem and character table

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|---|---|
| **Credits: 3** | **Discipline Specific Course** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Electronic Spectra of Transition Metal Complexes:**<br><br>**a)** Introduction, types of transition, factors affecting band width and intensity, spectroscopic ground state terms (Russell Saunders coupling/ L-S coupling/Spin orbit coupling), determination of spectroscopic terms, atomic terms. Microstates- calculation and representation, Mullikan terms (molecular term), splitting of atomic terms in octahedral and tetrahedral field. Correlation diagram (general idea), Orgel diagram, ($d^1$ -$d^{10}$ octahedral and tetrahedral complexes), selection rules (spin and Laporte) and their relaxation. Discussion | **15** |

| | | |
|---|---|---|
| | of the electronic spectrum of $d^1$-$d^9$ octahedral and tetrahedral complexes. Inter-electronic repulsion parameters-Racah parameters (A, B, C), Nephelauxetic effect. Ground state terms symbol of transition metal complexes. Tanabe Sugano diagram ($d^1$ – $d^9$ octahedral complexes). Application of Tanabe-Sugano diagram- Calculation of B, $\Delta_o$, $\beta$. Spin-crossover in coordination compounds. Charge transfer spectra- Introduction, types, factors affecting. spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, magnetic properties- magnetic moment, orbital contribution to magnetic moment.<br><br>**b)** Electronic angular momentum in diatomic molecules (classification of states)- calculation of states | |
| **Unit II** | **Reaction Intermediates in Chemical reactions:** Carbocations: Classical and non-classical, neighbouring group participation, molecular rearrangements (Wagner-Meerwein rearrangement, Benzilic acid rearrangement, Schmidt reaction), stability and reactivity of bridge-head carbocations. Carbanions: Generation, structure and stability, and their general reactions (Claisen, Wittig and Mannich reaction).<br><br>**Free Radicals:** Generation, structure, stability, types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, autooxidation.<br>**Carbenes:** Formation and structure, reactions involving carbenes (Reimer Tiemann reaction).<br>**Nitrenes:** Generation, structure and reactions of nitrenes. Benzyne and cine substitution reaction | **11** |
| **Unit III** | **Advanced Thermodynamics-I:** Laws of thermodynamics: Fundamental concepts, state and path dependent functions, determination of work done, enthalpy change, and internal energy change in reversible and irreversible expansion and compression, zero, first, second law of thermodynamics and their applications, entropy and its calculations, Nernst heat theorem and third law of thermodynamics, residual entropy | **7** |
| **Unit IV** | **Advanced Thermodynamics-II:** Free energy and its calculation, properties of Helmholtz free energy and Gibb's free energy, , Clausius-Claypeyron equation, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar volume and chemical potential and their significance, Gibbs-Duhem equation, Concept of fugacity and its determination, chemical potential and fugacity, thermodynamic functions of mixing. | **6** |
| **Unit V** | **Symmetry and Group Theory:** Symmetry elements and symmetry operations, definitions of group and subgroup and their characteristics,<br>relation between orders of and subgroup and their characteristics, relation between orders of a finite group and its subgroup. Conjugacy relation and classes of symmetry operations, point symmetry (or group) and its | **6** |

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|---|---|---|
| | classification, Schonflies symbols, representation of group by matrices (representation for the $C_n$, $C_{nv}$, $C_{nh}$ etc. groups to be worked out explicitly),<br><br>products of symmetry operations. Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy. | |

**Recommended Readings:**


- F. A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advance Inorganic Chemistry, Sixth Edition, John Wiley & Sons, New York, 2003.
- J. D. Lee, Concise Inorganic Chemistry, Fifth Edition, Wiley India, 2012.
- Atkins, Overton, Rourke, Weller and Armstrong, Inorganic Chemistry, Oxford University Press.
- J. E. Huheey, E. A Keiter and R. L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, Fourth Edition, Pearson Education, 2003.
- W. W. Porterfield, Inorganic Chemistry: A Unified Approach, Elsevier.
- G. Wulfsberg, Inorganic Chemistry, Viva Books.
- G. L. Miessler and D. A. Tarr, Inorganic Chemistry, Pearson Education.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

https://nptel.ac.in/courses/104/106/104106089/
http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000658/M014009/ET/1456899566CHE_P3_M5_etext.pdf
http://ddugu.ac.in/epathshala_content1.aspx
https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf
https://nptel.ac.in/courses/104/106/104106064/
https://www.youtube.com/watch?v=bsfMa1nwNEw&list=PLmxSS9XYst21Z1kmeqDbVZM6lp-RWSWIo
https://www.youtube.com/watch?v=keoaaCXmUJo&list=PLmxSS9XYst22ylDk1NOSmCLA-l9X7xTzh
https://www.youtube.com/watch?v=JbPvMNIcdf8&list=PLmxSS9XYst22VQmOe6CFkXqAjPtCCDg6O
https://www.youtube.com/watch?v=zUwbVaBaxTY&list=PLmxSS9XYst227ymEa_ovzDf7xs8snXlRp
https://www.youtube.com/watch?v=9oQcm281TT0&list=PLmxSS9XYst22B6gnqyEAx7RlA4Lqu3nmf
https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ
https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy19/
https://onlinecourses.nptel.ac.in/noc22_cy02/preview
https://nptel.ac.in/courses/104/105/104105033/
https://egyankosh.ac.in/bitstream/123456789/15794/1/Unit-7.pd
https://www.hhrc.ac.in/ePortal/Chemistry/IImscchem-18pche3-unit1-sv.pdf
http://www.du.edu.eg/upFilesCenter/sci/1596861612.pdf

| BACHELOR OF CHEMISTRY WITH HONOURS | | |
|---|---|---|
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VII**<br>**Paper: DSC** |
| **Subject: Chemistry** | | |
| **Course: DSC (Practical)** | **Course Title: Advanced Experimental Chemistry -I** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the laboratory methods and tests related to inorganic mixture analysis including the salts of normal and rare-earth elements and insoluble salts.
- Also, they can understand the quantitative estimation of organic molecules, viscosity constant and activation energy.
- Qualitatively estimate cations and anions in samples.
- Quantitative estimation of percentage of hydroxyl groups, amines/ phenolic contents in organic compounds.
- Determine of iodine and saponification values of an oil sample.
- Determine of DO, COD and BOD of water samples.

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|---|---|
| **Credits:1** | **Discipline Specific Course** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | Laboratory hazards and safety precautions | **6** |
| **Unit II** | **Inorganic Chemistry**<br>(i) Inorganic Salt Analysis: Qualitative analysis of mixtures of salts containing six radicals including Rare-earth element salts (two rare element ions), interfering radicals, other anions, which have not been done in under graduate practical and insolubles and simple salts<br>(ii) Determination of DO, COD and BOD of water sample.<br>(iii) Determination of organic carbon in soil<br>(iv) Estimation of Na/K/Ca in water/aerated drinks/soil using flame photometer<br>(v) Estimation of alkali content in antacid tablets. | **8** |
| **Unit III** | **Organic Chemistry**<br>i. Determination of the percentage of number of hydroxyl groups in an organic compound by acetylation method<br>ii. Estimation of amines/ phenols using bromate-bromide solution/ or acetylation method.<br>iii. Determination of Iodine and Saponification values of an oil sample. | **8** |
| **Unit IV** | **Physical Chemistry**<br>(i) Determination of the velocity constant of acid catalyzed hydrolysis of an ester.<br>(ii) Determination of activation energy of a reaction.<br>(iii) Determination of Frequency factor of a reaction by kinetic studies.<br>(iv) Validity of Arrhenius equation.<br>(v) Determination of the effect of change in temperature on rate constant of | **8** |

| | | |
|---|---|---|
| | a reaction.<br>(vi) Determination of the effect of change in concentration of the reactants on rate constant of a reaction.<br>(vii) Determination of the effect of change in concentration of the catalyst on rate constant of a reaction.<br>(viii) Determination of the effect of change in temperature on rate constant of a reaction.<br>(ix) Determination of the effect of change in concentration of the reactants on rate constant of a reaction.<br>(x) Determination of the effect of change in concentration of the catalyst on rate constant of a reaction.<br>(xi) Determination of the effect of change in ionic strength on the rate constant of a reaction.<br>(xii) Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide. | |

**Note:** Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 20; Organic exercise 20; Physical exercise 20; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10).

**Recommended Readings:**


- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis,
- Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

**Suggested equivalent online content:**

https://www.labster.com/chemistry-virtual-labs/

https://www.vlab.co.in/broad-area-chemical-scienceshttp://chemcollective.org/vlabs

**Semester-VII**

**Bachelor of Chemistry with Honours**

## DISCIPLINE SPECIFIC ELECTIVE (DSE 7 A)
## ADVANCED INORGANIC CHEMISTRY

**No. of Hours- 60**

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Advanced Inorganic | 4 | 4 | - | - | Chemistry in | - |

| Chemistry | | | | | Bachelor of Science | |
|---|---|---|---|---|---|---|

**BACHELOR OF CHEMISTRY WITH HONOURS**

| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VII**<br>**Paper: DSE 7 A** |
|---|---|---|
| **Subject: Chemistry** | | |
| **Course: DSE 7A** | **Course Title: Advanced inorganic chemistry** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the stereochemistry and bonding in main group compounds and simple reactions of covalently bonded molecules
- Learn about the substitution reactions in square planar complexes.
- Understanding reaction mechanism of octahedral complexes
- To determine the electronic angular momentum in diatomic molecules- calculation of States.

| **Credits:4** | **Discipline Specific Elective 7A** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Stereochemistry and Bonding in Main Group Compounds:** Hybridization, Isovalent hybridization, Drago Rule, Bent rule, its applications and energetics of hybridization, some simple reactions of covalently bonded molecules (Atomic inversion, Berry pseudorotation, nucleophilic substitution reactions, free radical mechanism). | **15** |
| **Unit II** | **Reaction Mechanism of Octahedral Complexes I:** Energy profile of a reaction, reactivity of metal complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, anation reactions, reactions without metal ligand bond cleavage. | **10** |
| **Unit II** | **Reaction Mechanism of Octahedral Complexes II:** Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer-sphere type reactions. Complimentary and non-complimentary electron transfer reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions. | **10** |
| **Unit IV** | **Substitution Reactions of Square Planar Complexes:** Substitution reactions in square planar complexes: Types, mechanism, potential energy diagrams, transition states and intermediates. Factors affecting the substitution reaction. *Trans* effect and its applications in synthesis of complexes, theories of *trans* effect. | **10** |
| **Unit V** | **PROBLEM SOLVING BASED ON THE ABOVE THEORY** | **15** |

**Recommended Readings:**


- F.A. Cotton, Chemical Application of Group Theory, Wiley.

- D. C. Harris, Bertolucci, Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy, Dover Publications, New York.
- P. K. Bhattacharya, Group Theory and its Chemical Applications, Himalaya Publishing House,

Mumbai.
- Gurdeep Raj, Ajay Bhagi and Vinod Jain, Group Theory and Symmetry in Chemistry, Krishna Prakashan Media (P) Ltd., Meerut.


**Suggested Continuous Evaluation Methods:** Since the class is conceived as learner-centric and built around tasks that require learners to actively use various language skills, formative assessment can and should be used extensively. Oral presentations, peer interviews, and group tasks can be used for this purpose. The end-semester written examination will test all the areas targeted in the course.

**Suggested equivalent online courses:**

https://nptel.ac.in/courses/113/106/113106069/
https://onlinecourses.nptel.ac.in/noc20_mm22/preview
https://nptel.ac.in/courses/112/106/112106223/
https://nptel.ac.in/courses/104/104/104104080/
https://nptel.ac.in/courses/104/101/104101094/
https://onlinecourses.nptel.ac.in/noc22_cy28/preview

**Semester-VII**

**Bachelor of Chemistry with Honours**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 7B)**
**ADVANCED ORGANIC CHEMISTRY**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Advanced Organic chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| BACHELOR OF CHEMISTRY WITH HONOURS | | |
|---|---|---|
| Programme: Bachelor of Chemistry with Honours | Year: IV | Semester: VII<br>Paper: DSE 7B |
| Subject: Chemistry | | |
| Course: DSE 7B | Course Title: Advanced Organic chemistry | |

**Course outcome:**

- This course will provide a deep knowledge of reaction mechanism. After completion of this course, the students will be able to understand the mechanism and stereochemistry of electrophilic, & nucleophilic

substitution reactions and elimination reaction.

- Study of the name reactions and the mechanism and stereochemistry of all the mentioned name reactions will enhance student's skill to understand the various important methods of synthesizing compound which are industrially important.
- This will not only help them to clear the competitive exams but also increase the job opportunities related to these industries.

| **Credits:4** | **Compulsory** | |
|---|---|---|
| **Unit** | **Contents** | **Number of Hours** |
| **Unit I** | **Reaction mechanism-I: Aliphatic Electrophilic Substitution:** Biomolecular mechanisms- $S_E2$ and $S_E1$. The $S_E1$ mechanism, electrophilic substitution accompanied by double bonds shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.<br>**Aliphatic Nucleophilic Substitution**: The $S_N^2$, $S_N^1$, mixed $S_N^1$ and $S_N^2$, $S_N^i$ and SET mechanisms. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound,<br>ambident nucleophile, regioselectivity. Neighbouring group mechanism, neighbouring group participation by $\pi$ and $\sigma$ bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system. Neighbouring group assistance in substitution reactions. Substitution reactions involving non-classical carbocations. | **9** |
| **Unit II** | **Reaction mechanism-II: Elimination reactions:** The E2, E1 and E1cB mechanisms and their spectrum. Orientation of the double bond. Reactivity-effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination | **06** |
| **Unit III** | **Reaction mechanism-II:** Aromatic Nucleophilic Substitution: The $S_N$ Ar, $S_N^1$, benzyne and $S_N^1$ mechanism. Reactivity-effect of substrate structure leaving group and attacking nucleophile. The Von-Richter, Sommelet-Hauser and Smiles rearrangements.<br>**Aromatic Electrophilic Substitution**: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ispo attack, orientation in other ring systems. Diazonium coupling. | **15** |
| **Unit IV** | **Name Reactions and their applications:** Vilsmeier reaction, Gattermann-Koch reaction, Sandmeyer reaction, Hunsdiecker reaction, Michael reaction. Sharpless asymmetric epoxidation, Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions, Wittig reaction, Heck reaction, Still reaction, Sonogarishira, Negishi coupling, Grubbs Catalyst. | **15** |
| **Unit V** | **SYNTHESIS AND IDENTIFICATION OF RELATED PROBLEMS** | **15** |

**Recommended Readings:**


i. Jerry March, Advanced Organic Chemistry Reactions, Mechanism and Structure, John Wiley.

ii. RT Morrison and RN Boyd Organic Chemistry, , Prentice Hall.

iii. CK Ingold, Structure and Mechanism in Organic Chemistry, Cornell University Press.

iv. SM Mukherji and SP Singh, Reaction Mechanism in Organic Chemistry, Macmillan.
v. D Nassipuri, Stereochemistry of Organic Compounds, New Age International
vi. PS Kalsi, Stereochemistry of Organic Compounds, New Age International.
vii.
viii. FA Carey and RJ Sundberg, Advanced Organic Chemistry, Plenum.
ix. Modern Organic Reactions, HO House, Benjamin.
x. Jonathan Clayden, Nick Greeves,and Stuart Warren, Organic Chemistry, Oxford Chemistry press.

**Suggested online links:**
**https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ**
https://nptel.ac.in/content/storage2/courses/104103022/download/module5.pdf
https://nptel.ac.in/content/storage2/courses/104103022/download/module9.pdf
https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%208.pdf
https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%207.pdf

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Semester-VII**

**Bachelor of Chemistry with Honours**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 7C)**
**ADVANCED PHYSICAL CHEMISTRY**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Advanced Physical Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| BACHELOR OF CHEMISTRY WITH HONOURS | | |
|---|---|---|
| Programme: Bachelor of Chemistry with Honours | Year: IV | Semester: VII<br>Paper: DSE 7C |
| Subject: Chemistry | | |
| Course: DSE 7C | Course Title: Advanced Physical Chemistry | |

**Course Outcomes:**

- This paper provides detailed knowledge of surface, polymer, electro and quantum chemistry.
- Upon successful completion of this course, the students should be able to describe Gibb's adsorption isotherm, Freundlich and Langmuir adsorption isotherm, BET method, applications of polymers, Debye-Huckel theory, Debye-Huckel-Onsagar theory and concept of quantum chemistry.

| Credits:4 | Compulsory | |
|---|---|---|
| **Unit** | **Contents** | **No. of Hours** |
| **Unit I** | **Surface Chemistry:** Gibb's adsorption isotherm, Freundlich and Langmuir adsorption isotherms, determination of free energy of adsorption, BET theory for multilayer adsorption with derivation, determination of surface area using BET method, catalytic activity on solid surfaces, macromolecules, | **7** |
| **Unit II** | **Polymer Chemistry:** Polymers and their general applications, classification of polymers, chain configuration of polymers, liquid crystals and their applications. Molecular mass, number and mass average molecular mass, molecular mass determination using osmometry, viscometry, diffusion and light scattering methods. | **8** |
| **Unit III** | **Advanced Electrochemistry:** Determination of activity coefficient, Debye-Huckel theory of strong electrolytes with derivation, ionic atmosphere and thickness of ionic atmosphere, Debye-Huckel-Onsagar theory, theory of conduction, Onsagar equation including mathematical deduction. | **10** |
| **Unit IV** | **Advanced Quantum Chemistry:** de-Broglie concept and de-Broglie equation, physical interpretation and properties of wave functions, Linear, Laplacian, Linear-momentum and Hamiltonian operators, postulates of quantum mechanics, eigen values, eigen functions, derivation of the Schrodinger's wave equation, concept of cartesian and spherical coordinates. Schrodinger's wave equation general and detailed discussion on the applications of Schrodinger's wave equation to some model systems *viz.* particles in a 1D-, 3D- box, harmonic oscillator, rigid rotator and hydrogen atom. | **20** |
| **Unit V** | **PROBLEM SOLVING BASED ON ABOVE UNITS** | **15** |

**Recommended Readings:**

- R. Puri, L. R. Sharma and M. S. Pathnia, Physical Chemistry, Milestone Publisher & Distributors, New Delhi.
- K. L. Kapoor, Physical Chemistry. Macmillan *Publishers* India Limited.
- K. J. Laidler, Kinetics, Pearson Education India.

**Suggested online links:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ

https://books.google.co.in/books/about/Basics_of_Polymer_Chemistry.html?id=ciRHDwAAQBAJ&redir_esc=y
https://www.google.co.in/books/edition/Applied_Colloid_and_Surface_Chemistry/FGyIJ1Z5Tr4C?hl=en&gbpv=1&dq=SURFACE+CHEMISTRY&printsec=frontcover

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

| Evaluation method | Marks |
|---|---|

| | |
|---|---|
| Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations | 15 marks |
| Overall performance throughout the semester, Discipline, participation in different activities) & Attendance | 10 marks |

**Course prerequisites:** To study this course, a student must have had passed theory papers of VII semester.

**Suggested equivalent online courses:**
**https://onlinecourses.nptel.ac.in/noc21_cy45/preview**
**https://onlinecourses.nptel.ac.in/noc21_ch48/preview**
https://onlinecourses.nptel.ac.in/noc20_cy27/preview
https://onlinecourses.nptel.ac.in/noc21_cy20/preview
https://www.classcentral.com/course/swayam-chemistry-i-introduction-to-quantum-chemistry-and-molecular-spectroscopy-3981
https://www.classcentral.com/course/swayam-quantum-chemistry-of-atoms-and-molecules-19982
https://nptel.ac.in/courses/104/108/104108057/
https://nptel.ac.in/courses/115/101/115101107/
https://nptel.ac.in/courses/104/101/104101124/
https://nptel.ac.in/courses/104/105/104105128/

**Semester-VII**
**Bachelor of Chemistry with Honours**

## GENERIC ELECTIVE (GE 7A)- Biology for Chemists

**No. of Hours- 60**

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| GE: Biology for Chemists | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| | | |
|---|---|---|
| **BACHELOR OF CHEMISTRY WITH HONOURS** | | |
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VII Paper: GE 7A** |
| **Subject: Chemistry** | | |
| **Course: GE 7A** | **Course Title: Biology for Chemists** | |

**Course Outcomes:**
Upon successful completion of this course, the students will be able to:

- Understand the functions and significance of cell organelles. This course will make them appreciate the structural and functional aspects of cell and organelles.
- Have the basic understanding of the metabolic processes in biological system which will help them to have better grip on biochemistry.

| | |
|---|---|
| **Credits:4** | **Generic Electives 2** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|

| | | |
|---|---|---|
| **Unit I** | **Cell as Unit of Life:** The cell theory; prokaryotic and eukaryotic and eukaryotic cells; cell size and shape; Eukaryotic cell components.<br>**Cell Membrane and Cell Wall:** The functions of membranes; Models of membrane structure; faces of the membrane, selective permeability of permeability of the membranes; cell wall | **15** |
| **Unit II** | **Cell Organelles-I:** Mitochondria: Structure, marker enzymes, composition; function. Chloroplast: Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body and Lysosomes: Structures and roles of ER, golgibody and lysosomes. | **15** |
| **Unit III** | **Cell Organelles-II:** Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief). Nacleoside and Nacloeotides and DNA structure. | **15** |
| **Unit IV** | **Metabolism:** Introduction, basal metabolic rate (BMR), Carbohydrate protein and lipid metabolism, cell respiration, amaerabic respiration, aerobic respiration, formation of acetal COA, citric acid cycle, electron transport system, adenosinetnphosphate, mechanism. ATP generation. | **15** |

**Recommended Readings:**

P. H. Raven, Biology, Tata MacGraw Hill.
P. Sheeler, Cell and Molecular Biology, John Wiley.
N. A. Campbell, Biology Pearson.
L.Styer, Biochemistry, Freeman & Co.
Outlines of biochemistry. Fourth edition (Conn, Eric E.; Stumpf, P. K.). Wiley India Pvt. Limited

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online courses:**
https://nptel.ac.in/courses/102/103/102103012/
https://nptel.ac.in/content/storage2/courses/102106025/Mod%201/Lec-1.pdf
https://books.google.co.in/books/about/Biology_for_Chemists.html?id=N4nToAEACAAJ&redir_esc=y

**Semester-VII**
**Bachelor of Chemistry with Honours**

**GENERIC ELECTIVE (GE 7B)**
**Mathematics for Chemists**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course | Credits | Credit distribution of the Course | Eligibility | Pre-requisite of the |
|---|---|---|---|---|

| Title | | Lecture | Tutorial | Practical/Practice | criteria | course (if any) |
|---|---|---|---|---|---|---|
| GE 7B: Mathematics for Chemists | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

**BACHELOR OF CHEMISTRY WITH HONOURS**

| | | |
|---|---|---|
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VIII Paper: GE 7B** |
| **Subject: Chemistry** | | |
| **Course: GE 7B** | **Course Title: Mathematics for Chemists** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the concept of mathematical functions, graphs, differentiations, integration and mathematical relations. It will help them to have better grip on mathematics involved in chemistry.

| | |
|---|---|
| **Credits:4** | **Generic Electives 2** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Mathematical Functions:** Polynomial expression, exponential function, trigonometrically function. inverse trigonometrically function. Logarithms and antilogarithms | **10** |
| **Unit II** | **Curve Sketching/Graph:** Inclination of a line and the slope of a line, General equation of straight line, slope-intercept form, slope point form Two-point form, Intercept form, Parallel and perpendicular lines | **10** |
| **Unit III** | **Differentiation:** Differentiation formulas, Concept of maximum and minimum, Rules of finding maxima and minima, Partial differentiation, Euler reciprocal relation, exact and in exact differentials, Chain rule for partial differential.<br>**Integration:** Methods of integrations, substitution, partial function, by parts, successive, reduction, integration formulas including concept of limit | **20** |
| **Unit IV** | **Fundamentals of Mathematical Relations**: Permutations and Combination, Probability, vectors mathematical relations,<br>Vectors, Matrices, Determinants, Complex number, Series, Stirling approximation, Roots of quadratic equation. Methods of solving equation. Coordinate systems in three dimensions (Cartesian, spherical and polar). | **20** |

**Recommended Readings:**

D.A. McQuarrie, Mathematics for physical Chemistry University Science Books.

R. Mortimer, Mathematics for Physical Chemistry, 3rd Ed. Elsevier.

E. Steiner, The Chemical Maths Books, Oxford University Press.

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a

mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online courses:**

https://www.jcu.edu.au/__data/assets/pdf_file/0004/115897/Maths-for-Chemistry.pdf
https://www.birmingham.ac.uk/Documents/college-eps/college/stem/Student-Summer-Education-Internships/Maths-for-Chemists-Booklet.pdf

**Semester-VIII**

**Bachelor of Chemistry with Honours**

**DISCIPLINE SPECIFIC COURSE (DSC 8)**
**Advanced Chemistry II (Theory)**
**Advanced Experimental Chemistry -II (Practical)**

**No. of Hours- 75**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSC 8: Advanced Chemistry II Advanced Experimental Chemistry -II (Practical) | 4 | 3 | - | 1 | Chemistry in Bachelor of Science | - |

**BACHELOR OF CHEMISTRY WITH HONOURS**

| Programme: Bachelor of Chemistry with Honours | Year: IV | Semester: VIII<br>Paper: DSC 8 |
|---|---|---|
| **Subject: Chemistry** | | |
| **Course: DSC 8** | **Course Title: Advanced Chemistry II** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand stereoselectivity, stereospecificity, regioselectivity, chemo selectivity, enantiomeric and diastereomeric excess.
- understand about the metal ligand bonding and cluster compounds
- a brief introduction about the stereochemistry of organic molecules
- to know about the higher order reactions, collision theory and arrhenius equation
- understand the thermodynamics of non ideal solutions

| Credits:3 | Discipline Specific Course 8 |
|---|---|
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules |

| Unit | Topic | No. of Hours |
|---|---|---|

| | | |
|---|---|---|
| **Unit I** | **Metal-Ligand Bonding:** Sigma bonding in octahedral complexes: Classification of metal valence orbitals into sigma symmetry, formation of ligand group orbitals (LGOs) of sigma symmetry, Formation of molecular orbitals of sigma symmetry, construction of molecular orbital energy level<br><br>diagram involving only sigma bond contribution from ligands, pi bonding in octahedral complexes: Classification of metal valence orbital into pi symmetry, Formation of LGOs of pi symmetry. Formation of pi MOs and construction of molecular orbital energy level diagram involving sigma and pi contribution from pi donor ligands, Sigma and pi bonding in tetrahedral complexes and square planar complexes | **10** |
| **Unit II** | **Cluster Compounds:** Introduction, classification, higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and metal halide clusters. Clusters with metal-metal multiple bonds. Electron counting in clusters (Wade's rule), Isolobal analogy. | **5** |
| **Unit III** | **Stereochemistry**<br>Axial and planar chirality and helicity (P & M); stereochemistry and configurations of allenes, spiranes, alkylidene, cycloalkanes, adamantanes, catenanes, biphenyls (atropisomerism), bridged biphenyls, ansa compounds and cyclophanes. Topicity and prostereoisomerism: Topicity of ligands and faces and their nomenclature, stereogenicity, cyclostereoisomerism; configurations, conformations and stability of cyclohexanes, (mono and di Substituted), cyclohexenes, cyclohexanones, halocyclohexanones, decalines, decalols, decalones. Asymetric induction; Cram's, Prelog's and Horeaus rules. Dynamic stereochemistry (cyclic and acyclic). Stereochemistry of compounds containing N, S and P. stereospecificity, regioselectivity and chemoselectivity. Enantiomeric and diasteriomeric excess. | **15** |
| **Unit IV** | **Chemical Dynamics:** Third and general order reactions, Experimental methods for kinetic studies, *viz*; conductometric, potentiometric and spectrophotometeric methods, effect of temperature on rate of reaction, Arrhenius equation. Chemical molecular dynamics: Collision theory of reaction rates, steric factor, activated complex theory, comparison of collision and activated complex theories, ionic reactions, kinetic salt effects, steady state concept, kinetic and thermodynamic control of reactions. Kinetics of gaseous reactions on solid surface, unimolecular and bimolecular surface reactions, kinetics of condensation and addition polymerization reactions, mechanism of $H_2$-$Br_2$, $H_2$-$Cl_2$ reactions, decomposition of the following compounds: acetaldehyde, ozone and $H_2O_2$. | **10** |
| **Unit V** | **Thermodynamics of Non-ideal Solutions:** Non-ideal systems; Excess functions for non-ideal solutions, activity, activity coefficient, Debye-Hückel theory for activity coefficient of electrolytic solutions, determination of activity coefficients, ionic strength. | **5** |

**Recommended Readings:**

- Jerry March, Advanced Organic Chemistry Reactions, Mechanism and Structure, John Wiley

- R. T. Morrison and R. N. Boyd, Organic Chemistry, Prentice Hall.
- K. Ingold, Structure and Mechanism in Organic Chemistry, Cornell University Press.
- S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan.
- Nasipuri, Stereochemistry of Organic Compounds, New Age International
- P. S. Kalsi, Stereochemistry of Organic Compounds, New Age International.

- S. M. Mukherjee, Pericyclic Reactions, Macmillan, India.
- F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Plenum
- Benjamin, Modern Organic Reactions, HO House
- Ernest L. Eliel and Samuel H. Wilen, Stereochemistry of Organic Compounds, Wiley Indi
- Ernest L. Eliel, Stereochemistry of Carbon Compounds. Tata McGraw Hill.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

https://nptel.ac.in/courses/104/106/104106127/
https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy25/
https://onlinecourses.swayam2.ac.in/ugc19_ch01/preview
https://nptel.ac.in/courses/104/101/104101005/
https://nptel.ac.in/courses/104/106/104106077/
https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ
https://nptel.ac.in/content/storage2/courses/104103022/download/module5.pdf
https://nptel.ac.in/content/storage2/courses/104103022/download/module9.pdf
https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%208.pdf

| **BACHELOR OF CHEMISTRY WITH HONOURS** | | |
|---|---|---|
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VIII**<br>**Paper: DSC 8** |
| **Subject: Chemistry** | | |
| **Course: DSC 8** | **Course Title: Advanced Experimental Chemistry -II** | |
| **Course Outcomes:**<br>The students will able to<br>• Synthesize various inorganic compounds<br>• Synthesize organic compounds via two steps. This will include photochemical and enzymatic synthesis of various organic compounds.<br>• Experiments to physically verify different adsorption isotherms. | | |
| **Credits:1** | **Discipline Specific Elective** | |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** | |

| **Unit** | **Topic** | **No. of Hours** |
|---|---|---|
| **Unit I** | Laboratory hazards and safety precautions | **06** |
| **Unit II** | **(A) Inorganic Compound Synthesis:** Preparation of selected inorganic compounds such as:<br>i. $[Ni(dmg)_2]$<br>ii. $[Cu(NH_3)_4]SO_4.H_2O$<br>iii. Cis-$K[Cr(C_2O_4)_2(H_2O)_2]$ | |

| | | |
|---|---|---|
| | iv. $Na[Cr(NH_3)_2(SCN)_4]$<br>v. $[Mn(acac)_3]$<br>vi. $K_3[Fe(C_2O_4)_3]$<br>vii. Prussian Blue, Tumbull's Blue<br>viii. $Co[NH_3)_6][Co(NO_2)_6]$<br>ix. Cis-$[Co(trien)(NO_2)_2]Cl.H_2O$<br>x. Hg $[Co(SCN)_4]$<br>xi. $[Co(py)_2Cl_2]$<br>xii. $[Ni(NH_3)_6]Cl_2$<br>xiii. $K_3[Cr(C_2O_4)_3].3H_2O$<br>**(B) Quantitative estimation** of metal ions by complexometric titration, direct and / or back titration, use of masking agents. | **08** |
| **Unit III** | **Organic Chemistry**<br>**(I) Green Synthesis**<br>i. Photoreduction of benzophenone to benzopinacol in 2-propanol<br>ii. Conversion of Benzil to Benzilic acid<br>iii. Isomerization of Dimethyl maleate to Dimethyl fumrate<br>**(II) Conventional methods of synthesis**<br>(i)Photochemical synthesis of Benzpinacolonefrom Benzophenone<br>(ii) Beckmann rearrangement: Benzophenenone to Benzanilide<br>(iii)Benzilic acid rearrangement: Benzoin to Benzilic acid<br>(iv) Synthesis of heterocylic compounds:(a) Skraup synthesis: Preparation of quinoline from aniline<br>(v) Fischer indole synthsis: Preparation of 2-phenyl indole from phenylhydrazine.<br>**(III) Enzymatic synthesis**<br>(i) Enzymatic reduction: Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomeric excess of S (+) ethyl-3-hydroxybetanoate and determine its optical purity.<br>(ii) Biosynthesis of ethanol from sucrose.<br>**(IV) Microwave synthesis**<br>(i) Synthesis using microwaves<br>(ii)Alkylation of diethyl malonate with benzyl chloride<br>(iii) Synthesis using phase transfer catalyst<br>(iv) Alkylation of diethyl malonate or ethylacetoacetate with an alkyl halide.<br>**(V)** Synthesis based on pharmaceutical intermediates /Drugs for eg. Iodex | **08** |
| **Unit IV** | **Physical Chemistry:**<br>(i) Validity of Arrhenius equation. | |

| | | |
|---|---|---|
| | (ii) Flowing Clock reactions (Ref. Experiments in Physical Chemistry by Showmaker).<br>(iii) Study of the adsorption of an acid by charcoal.<br>(iv) Validity of Freundlich's Adsorption isotherm.<br>(v) Determination of Partition Coefficients.<br><br>(vi) Determination of molecular surface energy of a liquid by Stalagmometer method.<br>(vii) Determination of association factor of the given liquid by drop-pipette method. | **08** |

**Note:** Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 20; Organic exercise 20; Physical exercise 20; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10). Students have to perform one practical from each section.

**Recommended Readings**


- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

**Suggested equivalent online content:**

https://www.labster.com/chemistry-virtual-labs/
https://www.vlab.co.in/broad-area-chemical-sciences
http://chemcollective.org/vlabs

**Semester-VIII**
**Bachelor of Chemistry with Honours**

## DISCIPLINE SPECIFIC ELECTIVE (DSE 8A)
## Pericyclic Reactions and Photochemistry

**No. of Hours- 60**

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **DSE: Pericyclic Reactions and Photochemistry** | **4** | **4** | **-** | **-** | **Chemistry in Bachelor of Science** | **-** |

| BACHELOR OF CHEMISTRY WITH HONOURS | | |
|---|---|---|
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VIII**<br>**Paper: DSE 8A** |
| **Subject: Chemistry** | | |
| **Course: DSE 8A** | **Course Title: Pericyclic Reactions and Photochemistry** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire the knowledge of pericyclic and photochemical reactions.
- Apply laws of photochemistry to different types of photochemical reactions,
- Able to draw the Jablonskii diagram.

| | |
|---|---|
| **Credits:4** | **Discipline Specific Elective** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Pericyclic Reactions I:** Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions- conrotatory and disrotatory motions, 4n, 4n+2 and allyl system. Cycloadditions- antarafacial and suprafacial additions, 4n and 4n+2 systems. | **10** |
| **Unit II** | **Pericyclic Reactions II:** 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements- suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3- and 5,5 sigmatropic rearrangements. Claisen, Cope and Aza-Cope rearrangements. Fluxional tautomerism, Ene reaction. | **10** |
| **Unit III** | **Basics of Photochemistry:** Laws of photochemistry, electronically excited states-life times, Energy dissipation by radiative and non-radiative processes, Franck-Condon principle, Photochemical stages-primary and secondary processes. photo-physical reactions, Jablonskii diagram, photosensitization, quantum yield and its determination, fluorescence, phosphorescence and chemi luminiscence with suitable examples. | **10** |
| **Unit IV** | **Photochemistry of Organic Compounds:** Photochemistry of alkenes; cis-trans isomerization, ; photochemical additions; reactions of 1,3- and 1,4-dienes; dimerization, Norrish type I & II reactions (cyclic and acyclic); α,β-unsaturated ketones; β,γ-unsaturated ketones; cyclohexenones (conjugated, cyclohexadienones (cross conjugated & conjugated); paterno- Buchi reaction, photoreductions; photochemistry of aromatic compounds, isomerisations reactions , Dewar and prismanes in isomaerisations, singlet oxygen reactions, photo Fries rearrangement of ester & anilidets, Barton reaction, Hoffmann- Loefller-Freytag reaction. | **15** |
| **Unit V** | **PROBLEM BASED ON ABOVE SYLLABUS** | **15** |

**Recommended Readings**


- F.A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Parts A & B, Plenum: U.S.
- W. M. Horspool, Aspects of Organic Photochemistry, Academic Press.
- T. H. Lowry and K. S. Richardson, Mechanism and Theory in Organic Chemistry Addison-Wesley Educational Publishers, Inc.
- J. March, Advanced Organic Chemistry, John Wiley & Sons.
- L. Stryer, Biochemistry, W. H. Freeman & Co. vi. P. A. Sykes, Guidebook to Mechanism in Organic Chemistry, Prentice-Hall
- Jerry March, Advanced Organic Chemistry Reactions, Mechanism and Structure, John Wiley.
- K. Ingold, Structure and Mechanism in Organic Chemistry, Cornell University Press.
- S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan. Page 8 of 42
- Nasipuri, Stereochemistry of Organic Compounds, New Age International
- P. S. Kalsi, Stereochemistry of Organic Compounds, New Age International.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online contents:**

https://nptel.ac.in/courses/104106077
https://www.youtube.com/watch?v=Md1GS3vdYdA
https://www.youtube.com/watch?v=Ih7tQ7rY2Wc

**Semester-VIII**

**Bachelor of Chemistry with Honours**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 8B)**
**Spectroscopic Techniques**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Spectroscopic Techniques | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |
| BACHELOR OF CHEMISTRY WITH HONOURS | | | | | | |
| Programme: Bachelor of Chemistry with Honours | | | | Year: IV | | Semester: VIII Paper: DSE 8B |
| Subject: Chemistry | | | | | | |

| Course: DSE 8B | Course Title: Spectroscopic Techniques |
|---|---|

**Course outcomes:**

- This course will add on the theoretical aspects of electron spin, nuclear magnetic resonance, infrared and UV spectroscopy along with mass spectrometry which will further help in structure elucidation of various compounds through numerical problems.

- This is essential for structure elucidation of known as well as novel compounds.

| Credits:4 | Discipline Specific Elective |
|---|---|
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules |

| Unit | Contents | No. of Hours |
|---|---|---|
| Unit I | **Nuclear Magnetic Resonance Spectroscopy:** Nuclear Spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing the chemical shift. Deshielding, spin-spin interaction, factors influencing coupling constant (J). Classification (ABX, AMX, ABC, $A_2B_2$ etc.), spin decoupling, basic idea about instruments, NMR studies of nuclei other than proton; Advantages of FT NMR. Use of NMR in medical diagnostics. NOE, simplification of complex spectra. | 15 |
| Unit II | **Mass Spectrometry:** Introduction, ion production-EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Detectors-ECD, TCD and FID, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule, examples of Mass fragmentation of class of organic compounds. | 10 |
| Unit III | **Infrared Spectroscopy:** Instrumentation and simple handling. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the bond positions and intensities, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines and carbonyl compounds (ketones, aldehydes, esters, amides, acids anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding, solvent effect on IR of gaseous, solids and polymeric materials. Simple applications, vibrational spectra of metal carbonyls. | 15 |
| Unit IV | **Ultraviolet and Visible Spectroscopy**: Various electronic transitions (185 to 800 nm), Lambert-Beer's Law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, diens, conjugated polyenes. Fieser-Woodward rules for conjugated diens and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. | 5 |
| Unit V | **Interpretation of Organic Compounds**<br>Problems based on spectroscopic data viz. NMR, IR, UV Spectroscopy and Mass spectrometry. | 15 |

**Books Recommended:**

- Pavia, Lampman, Kriz, Spectroscopy, Books/Cole; Vyvyan
- PS Kalsi Spectroscopy of Organic Compounds, New Age International Publishers;
- Silverstein, Robert M.; Webster, Francis X.; Kiemle, Spectrometric Identification of Organic Compounds, John Wiley;
- ML Martin, JJ Delpeach and GJ Martin, Heyden, Practical NMR Spectroscopy,
- Colin N. Banwell and Elaine M. Mc Cash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.
- RJ Abraham, J Fischer and P Loftus, Introduction to NMR Spectroscopy, Wiley.
- DH Williams, I Fleming, Spectroscopic Method in Organic Chemistry: Tata MacGraw Hill.
- Willard Merritt, Dean, Settle, Instrumental Method of Analysis: Seventh Edition, CBS, Publication.


**Suggested online links**:

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in- class or on-line tests, home assignments, group discussions or oral presentations.

| **Evaluation method** | **Marks** |
|---|---|
| Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations | 15 |
| Overall performance throughout the semester, Discipline, participation in different activities) & Attendance | 10 |

**Course prerequisites:** To study this course, a student must have had passed theory papers of VII semester.

**Suggested equivalent online courses:**

**Further Suggestions:** ……

**Semester-VIII**

**Bachelor of Chemistry with Honours**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 8C)**
**Chemistry of Biological Systems**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| **Course Title** | **Credits** | **Credit distribution of the Course** | | | **Eligibility criteria** | **Pre-requisite of the course (if any** |
|---|---|---|---|---|---|---|
| | | **Lecture** | **Tutorial** | **Practical/Practice** | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **DSE 8C: Chemistry of Biological Systems** | **4** | **3** | **-** | **1** | **Chemistry in Bachelor of Science** | **-** |

| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VIII**<br>**Paper: DSE 8C** |
|---|---|---|

**BACHELOR OF CHEMISTRY WITH HONOURS**

| **Course: DSE 8 C** | **Course Title: Chemistry of Biological systems** |
|---|---|

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Detailed knowledge of bioinorganic, bioorganic and biophysical chemistry.
- Get information about the synthesis, classification, extraction, purification, uses of enzymes and coenzymes, essential and trace metals and role of metal ions in biological processes.
- Understand the forces and mechanisms which are essential to sustain all the life on earth.

| **Credits: 4** | **Discipline Specific Elective DSE 8C** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| **Unit** | **Topic** | **No. of Hours** |
|---|---|---|
| **Unit I** | **Bioinorganic Chemistry**: Essential and non-essential elements, toxic elements (Al, Hg, Cd, Pb). Role of metal ions in biological processes: $K^+$, $Na^+$, $Ca^{2+}$, $Mg^{2+}$, $Mn^{2+}$, $Fe^{3+}$, $Co^{2+}$, $Ni^{2+}$, $Cu^{2+}$, $Zn^{2+}$. Ion transport through cell membrane: active transport (ionophores and ion channels) and passive transport (ion pumps: $Na^+/K^+$ pump). Nitrogen fixation: definition, types, mechanism, structure of nitrogenase, factors affecting nitrogen fixation. Metal complexes in transmission of energy: chlorophyll a, chlorophyll b, light dependent reaction, Haeme proteins: definition, porphin, porphyrin, haeme groups, structure and biological functions of cytochrome P450, peroxidase, catalase, myoglobin, haemoglobin, and oxygen uptake. Metalloproteins: function of metalloproteins, electron transfer (cytochrome, rubredoxin, plastocynin), light harvesting (chlorophyll), catalyst (superoxide dismutase, carbonic anhydrase), oxygen storage and transport | **12** |
| **Unit II** | **Bioorganic Chemistry I:** Introduction, Nomenclature and classification, extraction, purification and uses of enzymes in food drink industry and clinical therapy. Chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Proximity effects and molecular adaption. Enzyme kinetics, Michaelis-Mentien and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition state theory, Fisher's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by site- directed, mutagenesis. | **12** |
| **Unit III** | **Bioorganic Chemistry II:** Acid-base catalysis, covalent catalysis, strain or distortion. Example of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme, carboxypeptidase A. Cofactors as derived from | **12** |

| | | |
|---|---|---|
| | vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzymes A, thiamine pyrophosphate, $NAD^+$, $NADP^+$, and vitamin $B_{12}$. | |
| **Unit IV** | **Biophysical Chemistry:** Forces involved in biopolymer interactions.<br><br>Electrostatic charge and molecular expansion, hydrophobic forces, osmotic pressure, membrane equilibrium. Bioenergetics: Standard free energy change in biological reactions. Hydrolysis of ATP, synthesis of ATP from ADP. Coupling of ATP cleavage to endergonic processes Size, shape and molecular mass of biopolymer. | **9** |
| **Unit V** | **PROBLEM REALTED TO ABOVE UNITS** | **15** |

**Recommended Readings:**


- P.S. Kalsi, Bioorganic, Bioinorganic and Supramolecular Chemistry, New Age International.
- L. Stryer, Biochemistry 4th Ed., W. H. Freeman & Co.
- S. Zubay, Biochemistry Addison-Wesley.
- S. J. Lippard and J. M. Berg, Principles of Bioorganic Chemistry, University Science Books.
- Berteni, H.B. Gray, S.J. Lippard and J.S. Valentine, FBioinorganic Chemistry, , University Science Books.
- Hermann Dugs and C. Penny, Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Springer-Verlag.
- Trevor Palmer, Understanding Enzymes, Prentice Hall.
- Collins J Sucking, Enzyme Chemistry: Impact and Application, Ed. Chapman and Hall.
- M.I. page and A. Williams, Enzyme Mechanisms Ed., Royal Society of Chemistry.
- N.C. Price and L. Stevens, Fundamental of Enzymology, Oxford University Press.
- Michael D. Trevan, Immobilized Enzymes: An Introduction and Application in Biotechnology, John Wiley.
- Alan Fersht. Enzyme Reaction and Mechanism, W H Freeman & Co (Sd).
- A.L. Lehninger, Principles of Biochemistry, Worth Publishers.
- J. M. Berg, J. L. Tymoczko and L. Stryer, Biochemistry, W.H. Freeman.
- Donald *Voet*, Charlotte W. Pratt, Judith G. *Voet,* Biochemistry, John Wiley.
- E.E. Conn and P.K. Stumpf, Outlines of Biochemistry, John Wiley.
- L. S. W. H. Freeman, Macromolecules: Structure and Function, Prenctice Hall.
- Pramod Pandey, Organic Chemistry, John Wiley


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ

https://onlinecourses.nptel.ac.in/noc22_cy06/preview

https://onlinecourses.nptel.ac.in/noc22_cy12/preview

https://nptel.ac.in/content/storage2/courses/104103018/pdf/mod1.pdf

**Semester-VIII**
**Bachelor of Chemistry with Honours**

**GENERAL ELECTIVE (GE 8A)**
**Solid State Chemistry and Supramolecular Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credit | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Solids State Chemistry and supramolecular Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| BACHELOR OF CHEMISTRY WITH HONOURS | | |
|---|---|---|
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VIII Paper: GE 8A** |
| **Subject: Chemistry** | | |
| **Course: GE 8A** | **Course Title: Solid State Chemistry and Supramolecular Chemistry** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand basics of solid-state reaction, crystal defects, and their effects on properties of materials.
- Learn the synthesis, preparations and applications of organic solids, fullerenes and molecular devices.
- Understanding the role of supramolecules in catalysis.
- Supramolecular chemistry will help them in understanding the role of supramolecules in catalysis. It will assist them to get a suitable job in the relevant industrial and scientific field.

| | |
|---|---|
| **Credits:4** | **Discipline Specific Elective** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| Unit I | **Solid State Reactions, Crystal Defects and Non-stoichiometry**: General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid-state reactions, Perfect and imperfect crystals, intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky defects and Frenket defects | 15 |

| | | |
|---|---|---|
| **Unit II** | **Electronic Properties and Band Theory**: Metals, insulators and semiconductors, electronic structure of solids-band theory. Band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. | **15** |
| **Unit III** | **Organic Solids, Fullerenes, Molecular Devices:** Electrically conducting solids, organic charge transfer complexes, organic metals, new super conductors, magnetism in organic materials, fullerenes- doped, fullerenes as superconductors. Molecular rectifiers and transistors, artificial photosynthetic devices. | **15** |
| **Unit IV** | **Supramolecular Chemistry I:** Molecular recognition: molecular receptors for different types of molecules including arisonic substrates, design and synthesis of co-receptor molecules and multiple recognition. Strong, weak and very weak H-bonds, utilization of H-bonds to create supramolecular structures. Chelate and macrocyclic effects. Cation binding hosts, binding of anions, binding of neutral molecules, binding of organic molecules. Supramolecular reactivity and catalysis. Supramolecular devices, supramolecular photochemistry, supramolecular switching devices. Some examples of self-assembly in supramolecular chemistry. | **15** |

**Recommended Readings:**

- G.W. Castellan, Physical Chemistry, 4 th Ed. Narosa.
- R.G. Mortimer, Physical Chemistry, 3 rd Ed. Elsevier: NOIDA, UP.

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in- class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online courses:**
https://www.ias.ac.in/article/fulltext/reso/023/03/0277-0290

**Semester-VIII**

**Bachelor of Chemistry with Honours**

**GENERIC ELECTIVES (GE 8 B)**
**Analytical and Separation Techniques**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| GE: Analytical | 4 | 4 | | | Chemistry | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **and Separation Techniques** | | | | | **in Bachelor of Science** | |

| **BACHELOR OF CHEMISTRY WITH HONOURS** | | |
|---|---|---|
| **Programme: Bachelor of Chemistry with Honours** | **Year: IV** | **Semester: VIII**<br>**Paper: GE 8B** |
| **Subject: Chemistry** | | |
| **Course: GE 8B** | **Course Title: Analytical and Separation Techniques** | |

**Course outcomes:**

- This paper provides detailed knowledge of X-ray diffraction and electron diffraction techniques as well as students will learn chromatographic methods, radio analytical methods and extraction methods used in analysis of compounds.
- On completion of this course students will have detailed knowledge on TLC, HPLC, GLC, GSC, Ion exchange and gas chromatography.

| Unit | Content | No. of Hours |
|---|---|---|
| **Unit I** | **X-ray Diffraction Methods**:<br>**(I)** Bragg condition, Miller indices, Laue's method, Bragg's method, Debye-Scherrer method of Xray structural analysis of crystals. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules. Ramchandran diagram.<br>**(II)** General Introduction of Electron Diffraction: Scattering intensity vs scattering angle, Wierl equation. | **15** |
| **Unit II** | **Chromatographic methods**:<br>I. An lntroduction to Chromatography, Principle, instrumentation and Applications of gas and liquid chromatography, Partition Chromatography, Adsorption Chromatography<br>II. Principle and application of TLC, paper, column and HPLC, Migration Rates of Solutes, and Broadening and Column Efficiency.<br>III. Principles of GLC, Instruments for GLC, Gas Chromatographic Columns and Stationary Phases, Applications of GC and advances in GC, Column Efficiency in LC, Van-Demeter equation (no derivation), concept about HETP- Applications.<br>IV. Gas-Solid Chromatography<br>V. Ion Exchange chromatography: Cationic, anionic exchangers and their applications.<br>VI. Gas Chromatography: Theory of gas chromatography, parts of gas | **20** |

| | | |
|---|---|---|
| | chromatography, Detectors (TCD, FID, ECD). | |
| **Unit III** | **Radio Analytical Methods**: Basic principles and types of measuring instrument, isotope dilution techniques- principle ofoperations and uses. Applications. Neutron Activation Methods, Isotope Dilution Methods | **15** |
| **Unit IV** | **Types of Extraction**: Introduction, principle, techniques, factors affecting solvent extraction | **10** |

**Books Recommended**


- Skoog et al principles of Instrumental Analysis 2017 Brooks/ Cole Publisher
- Vogels Analytical Chemistry. Sultan Chand & Sons publishers 2005.
- B.K. Sharma, Instrumental methods of chemical analysis; Krishna Prakashan India 1972
- R. Puri, L. R. Sharma and M. S. Pathnia, Advanced Physical Chemistry, Milestone Publisher & Distributors, New Delhi


**Suggestive digital platforms web links**
https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000944…
https://egyankosh.ac.in/handle/123456789/43341

**Semester-IX**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC COURSEE (DSC 9)**
**Advanced Spectroscopic Techniques I**
**Advanced Experimental Chemistry-III**

**No. of Hours- 75**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **DSE: Advanced Spectroscopic Techniques-I Advanced Experimental Chemistry-IV** | **4** | **3** | **-** | **1** | **Chemistry in Bachelor of Science** | **-** |
| **MASTER'S IN CHEMISTRY** | | | | | | |
| **Programme: Master's in Chemistry** | | | **Year: V** | | | **Semester: IX Paper: DSC 9** |
| **Subject: Chemistry** | | | | | | |

| Course: DSC 9 | Course Title: Advanced Spectroscopic Techniques I |
|---|---|

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Develop a comprehensive understanding of Nuclear Magnetic Resonance (NMR) spectroscopy, including nuclear spin, chemical shift, spin-spin interaction, instrumentation with applications to nuclei such as $^{13}C$, $^{19}F$ and $^{31}P$.
- Master the principles and techniques of Mass Spectrometry, including ion production methods, fragmentation patterns and interpretation of mass spectra for organic compounds.
- Gain proficiency in Microwave and Raman Spectroscopy, diatomic vibrating rotator, anharmonicity, selection rules, CARS and their applications.
- Understand structure elucidation of various compounds through numerical problems.
- To know about the electromagnetic spectrum, born oppeheimer approximation, and fourier transform spectroscopy

| Credits: 3 | Discipline Specific Course |
|---|---|
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules |

| Unit | Topic | No. of Hours |
|---|---|---|
| Unit I | **Nuclear Magnetic Resonance Spectroscopy:** Instrumentation and principle of NMR, Nuclear Overhauser effect, Factors affecting Signal to noise ratio, Simplification of complex spectra by the use of Shift reagent and field strength.$^{13}C$ NMR spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne and aromatic hetero aromatic and carbonyl carbon), shelding and desheilding. Coupling constants, First order and second order spectra, Long range coupling. Effect of solvents on chemical shift. $^{13}C$, $^{31}P$, $^{19}F$ NMR**.** | **12** |
| Unit II | **Two-dimensional NMR spectroscopy: Pulse sequence, Pulse width-** Principle, COSY, HETCOR, HMQC, NOESY, COSY, DEPT, INEPT, APT and INADEQUATE techniques. Problem solving using spectral graphs and data. | **9** |
| Unit III | **Electromagnetic spectrum**: Characterization of Electromagnetic radiation, Quantization of energy, Born Oppenheimer approximation, Lambert beer's law, Zeeman and Stark effect, Representation of spectra, Signal to Noise resolution, Factors affecting line width and intensity of spectral transitions, Fourier transform spectroscopy. | **8** |
| Unit IV | **Microwave Spectroscopy**: Diatomic vibrating rotator, Zero point energy, Force constant and bond strength, anharmonicity, Morse potential energy diagram, P, Q, R branches, Breakdown of Born Oppenheimer approximation, Interaction of rotations and vibrations, Vibrations of polyatomic molecule. Simple applications. Problem solving. | **8** |
| Unit V | **Raman Spectroscopy:** Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual principles. Resonance Raman spectroscopy, CARS. Structure | **8** |

| | | |
|---|---|---|
| | determination of AB2, AB3 molecule by IR and Raman spectroscopy. | |

**Recommended Readings**

- Pavia, Lampman, Kriz, Spectroscopy, Books/Cole; Vyvyan
- P.S. Kalsi, Spectroscopy of Organic Compounds, New Age International Publishers;
- Silverstein, Robert M.; Webster, Francis X.; Kiemle, Spectrometric Identification of Organic Compounds.

- M. L. Martin, J.J. Delpeach and G.J. Martin, Heyden, Practical NMR Spectroscopy,
- Colin N. Banwell and Elaine M. Mc Cash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.
- R.J. Abraham, J. Fischer and P. Loftus, Introduction to NMR Spectroscopy, Wiley

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ

| **MASTER'S IN CHEMISTRY** | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: IX**<br>**Paper: DSC** |
| **Subject: Chemistry** | | |
| **Course: DSC** | **Course Title: Advanced Experimental Chemistry – III (Practical)** | |

**Course Outcomes:**

Upon completion of this course, the students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic, organic and physical experiments. The students will able to

- Determine the concentrations of inorganic compounds through complexometric titration and gravimetric estimation.
- Synthesize organic compounds via two steps. This will include photochemical and enzymatic synthesis of various organic compounds.
- Learn the experiments of chemical kinetics for the determination of the velocity constant, activation energy, effect of temperature and concentration on the rate constant, partition coefficients etc.
- Experiments to physically verify different adsorption isotherms.

| | |
|---|---|
| **Credits:1** | **Discipline Specific Course** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| **Unit** | **Topic** | **No. of Hours** |
|---|---|---|
| **Unit I** | Laboratory hazards and safety precautions | **4** |
| **Unit II** | (A). Synthesis and interpretation of organic / inorganic compounds using various spectroscopic techniques<br>i). U.V<br>ii). I.R<br>iii). NMR<br>iv). Raman<br>(B). Estimation of amino acid(s) using U.V. Spectroscopy. | **26** |

| | | |
|---|---|---|
| | (C). Analysis of compounds using Raman/I.R. spectroscopy | |

**Note:** Allocation of marks - External assessment: Total marks 75 (Each practical carries 30 marks; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10). Students have to perform two practicals.

**Recommended Readings**


- J. Mendham, Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- D. C. Harris, Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- S.M. Khopkar, Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, Cengage Learning India Edition


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**
https://www.labster.com/chemistry-virtual-labs/
https://www.vlab.co.in/broad-area-chemical-sciences
http://chemcollective.org/vlabs

**Semester-IX**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 9A)**
**Applied Photochemistry and Nuclear Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Applied Photochemistry and Nuclear Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |
| MASTER'S IN CHEMISTRY | | | | | | |
| Programme: Master's in Chemistry | | | Year: V | | | Semester: IX |

| | | |
|---|---|---|
| | | **Paper: DSE 9A** |
| **Subject: Chemistry** | | |
| **Course: DSE 9A** | **Course Title: Applied Photochemistry and Nuclear Chemistry** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the interaction of electromagnetic radiation with matter, quantum yield and photochemical reaction mechanisms.
- Learn about singlet molecular oxygen reactions, smog formation, photodegradation of polymers and energy state transitions.
- Gain proficiency in determining rate constants, effects of light intensity and molecular photochemistry including fluorescence and phosphorescence.
- Master advanced nuclear chemistry concepts including radioactive decay, nuclear reactions, fission processes and energy production in stars.

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|---|---|
| **Credits:4** | **Discipline Specific Course** |
| **Max. Marks: As per Univ. rules** | **Min. Passing Marks: As per Univ. rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Photochemical Reactions**: Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry. Singlet molecular oxygen reactions, photochemical formation of smog and photodegradation of polymers. | **10** |
| **Unit II** | **Determination of Reaction Mechanism**: Classification, rate constants and life times of reactive energy states, determination of rate constants, effect of light intensity on the rate of photochemical reactions.<br>**Molecular Photochemistry**: Transitions between states (Chemical, classical and quantum dynamics, vibronic states). Potential energy surfaces; transitions between potential energy surfaces, radiative transitions. A classical model of radiative transitions. The absorption and emission of light-state mixing, spinorbit coupling and spin forbidden radiative transitions, absorption complexes, fluorescence, phosphorescence and chemiluminiscence. | **20** |
| **Unit III** | **Nuclear Models**<br>Atomic structure, Nuclides, Nuclear stability, mechanical effects due to orbiting and spinning nucleons, quarks and gluons**.** Franck -Condon principle**.**<br>**Radiation Chemistry**<br>Interaction of neutrons, gamma radiation with matter. Units, Radiolysis.Radiochemical, and radiometric analysis in chemistry**.** | **5** |
| **Unit IV** | **Advanced Nuclear Chemistry**: Radioactive equilibrium, nuclear reaction, Q value cross section, types of reaction. Theory of Nuclear forces. Radioactive decay, alpha, beta, gamma, nuclear reactions; characteristics and similarities with chemical reactions, threshold and cross section, nuclear reaction due to neutron, proton, deutron and gamma irradiation, Nuclear fission, fission cross section, chain fission and resonance capture. Fission products and fission yields, mass and charge distribution in fission and spallation reaction, nuclear reactor. Nuclear fission and stellar energy. | **10** |
| **Unit V** | **PROBLEM BASED ON ABOVE THEORY** | **15** |

**Recommended Readings**


- N.J. Turro Modem Molecular Photochemistry, University Science Books
- A Gilbert, J Baggot, Essentials of Molecular Photochemistry, Blackwell Scientific
- K.K. Rohtagi-Mukharji, Fundamentals of Photochemistry, Wiley- Eastern.
- A Cox and T. Champ, Introductory Photochemistry, McGraw-Hill.
- R.P. Kundall and A. Gilbert, Thomson Nelson, Photochemistry
- J. Coxon and B. Halton, Organic Photochemistry, Cambridge University Press.
- N.J. Turro, Modern molecular photochemistry, University Science Books.
- D. N. Bajpai, Advanced Physical Chemistry, S. Chand and Co.
- Kundu and Jain, Modern Physical Chemistry, S. Chand and Co.


**Suggested Continuous Evaluation Methods:** Since the class is conceived as learner-centric and built around tasks that require learners to actively use various language skills, formative assessment can and should be used extensively. Oral presentations, peer interviews, and group tasks can be used for this purpose. The end-semester written examination will test all the areas targeted in the course.

**Semester-IX**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 9B)-**
**Organic Synthesis**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE: Organic Synthesis | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |
| MASTER'S IN CHEMISTRY | | | | | | |
| Programme: Master's in Chemistry | | | | Year: V | | Semester: IX Paper: DSE 9B |
| Subject: Chemistry | | | | | | |
| Course: DSE 9B | | Course Title: Organic Synthesis | | | | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand use of the reagents in organic synthesis, oxidation, reduction of different organic compounds.
- Learn and appreciate the concepts of disconnection approach and protection of groups.

- Understand the applications of these concepts in drug designing. Develop expertise in oxidation and reduction techniques for transforming hydrocarbons, alcohols, carbonyls and amines.
- Apply the disconnection approach and synthons in planning organic synthesis, ensuring correct order of functional group transformations.
- Understand and utilize protecting groups to safeguard functional groups such as alcohols, amines, carbonyls and carboxylic during synthesis.
- Gain knowledge of organometallic reagents, including preparation and application of compounds from Group I and II metals, transition metals and elements like sulfur, silicon and boron.

| **Credits:4** | **Discipline Specific Course** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| **Unit** | **Topic** | **No. of Hours** |
|---|---|---|
| **Unit I** | **Oxidation:** Introduction. Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated & nonactivated). Alcohols, diols, aldehydes, ketones and carboxylic acids. Amines. Oxidation with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate**.** **Reduction:** Introduction, Different reductive process. Hydrocarbons-alkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids. Epoxides, Nitro and azo, Hydrogenolysis. | **20** |
| **Unit II** | **Disconnection Approach:** An introduction to synthons and synthetic equivalents, disconnection approach, functional group interconversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, One group and two group C-C disconnections. Aliphatic nitro compounds in organic synthesis. Application in chemical synthesis and name reactions, Diels alder reaction, Michaeal addition, Robinson annelation | **10** |
| **Unit III** | **Protecting Group:** Principle of protection of alcohol, amine, carbonyl and carboxyl groups. **Ring Synthesis:** Saturated heterocycles, synthesis of 3,4,5 and 6 membered rings. | **5** |
| **Unit IV** | **Organometallic Reagents**: Principle, preparations, properties and applications of the following in organic synthesis: Group I and II metal organic compounds Li, Hg and Zn compounds. Transition metals: Pd, Ni, Fe and Cu compounds; Other elements; Si and B compounds. | **10** |
| **Unit V** | **Problems based on above theory** | **15** |

**Recommended Readings**


- H.O. House, W.A. Benjamin, Modern Synthetic Reaction,
- W. Carruthers, Some Modern Methods of Organic Synthesis. Cambridges Univ. Press.
- J. March Advanced Organic Chemistry, Reactions Mechanisms and Structure.
- F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry Part B, Plenum Press.

- Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
- S. Warren, Designing Organic Synthesis, Wiley.
- J. Fuhrhop and G. Penzillin, Organic Synthesis- Concept, Methods and Starting Materials Verlage VCH.
- W. A. Benjamin, Modern Synthetic Reactions, H.O. House


**Suggested Continuous Evaluation Methods:** Since the class is conceived as learner-centric and built around tasks that require learners to actively use various language skills, formative assessment can and should be used extensively. Oral presentations, peer interviews, and group tasks can be used for this purpose. The end-semester written examination will test all the areas targeted in the course.

**Suggested equivalent online courses:**

https://onlinecourses.nptel.ac.in/noc22_cy30/preview
https://nptel.ac.in/courses/104/105/104105087/
https://nptel.ac.in/courses/104/103/104103111/
https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ
https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%2013.pdf
https://nptel.ac.in/content/storage2/courses/104103023/download/module2.pdf
https://nptel.ac.in/courses/104/103/104103111/

**Semester-IX**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 9C)**
**Advanced Chromatography**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 9C: Advanced Chromatography | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| Programme: Master's in Chemistry | Year: V | Semester: IX<br>Paper: DSE 9C |

**Subject: Chemistry**

| **Course: DSE** | **Course Title: Advanced Chromatography** |
|---|---|

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the chromatographic methods and their industrial applications.
- Gain a comprehensive understanding of various chromatographic techniques, including adsorption, paper, thin layer, and column chromatography and their principles and applications.
- Master the theory and practice of gas chromatography, including knowledge of detectors and chromatographic efficiency concepts like the Van-Deemter equation and plate theory.
- Understand the features and instrumentation of high-performance liquid chromatography (HPLC) and its applications in complex sample analysis.
- Learn the principles of ion exchange chromatography, including ion exchange resins, equilibria with their applications in separating ionic species.

| **Credits:4** | **Discipline Specific Course** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Chromatography**<br>Introduction, Definition, Classification of Chromatographic Techniques. | **5** |
| **Unit II** | **Adsorption Chromatography**<br>**Paper Chromatography:** Principle, Types and theory of paper chromatography, $R_f$, $R_X$ and $R_G$ values, Techniques of paper chromatography, Two-dimensional paper chromatography, Applications.<br>**Thin Layer Chromatography**: Theory of TLC, Quantitative evolution of separated solutes, Various types of TLC, High performance thin layer chromatography, Applications Column Chromatography: Principle of adsorption chromatography, Separation of the compounds, Chiral chromatography, Applications | **15** |
| **Unit III** | **Gas Chromatography**: Theory of gas chromatography, parts of gas chromatograph, detectors (TCD, FID, ECD), Van-Deemter equation (no derivation), concept about HEPT- plate theory and rate theory. Applications.<br>**High Performance Liquid Chromatography**<br>Characteristics feature of HPLC, Instrumentation for HPLC, Applications. | **10** |
| **Unit IV** | **Ion Exchange Chromatography**<br>Ion Exchangers, Cation Exchange resins, Ions Exchange equilibria, Anion Exchange resins, Factor affecting ion exchange equilibria, Application of IEC. | **15** |
| **Unit V** | **Problems Related to Chromatographic Techniques** | **15** |

**Recommended Readings**


- Vogel's Quantitative Chemical Analysisby J. Mendham.
- Instrumental Methods of Analysis by H. H. Willard.
- Analytical Chemistry by G. D. Christian.
- Exploring Chemical Analysis by D. C. Harris.

- Basic Concepts of Analytical Chemistry by S. M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman.
- Laboratory Handbook of Chromatographic & Allied Methods by O. Mikes and R. A. Chalmes.
- Analytical Chemistry: Methods of separation by R. V. Ditts.
- Skoog et al principles of Instrumental Analysis 2017 Brooks/ Cole Publisher
- Vogels Analytical Chemistry. Sultan Chand & Sons publishers 2005.
- B.K. Sharma, Instrumental methods of chemical analysis; Krishna Prakashan India 1972
- B. R. Puri, L. R. Sharma and M. S. Pathnia, Advanced Physical Chemistry, Milestone Publisher & Distributors, New Delhi


**Suggested Continuous Evaluation Methods:** Since the class is conceived as learner-centric and built around tasks that require learners to actively use various language skills, formative assessment can and should be used extensively. Oral presentations, peer interviews, and group tasks can be used for this purpose. The end-semester written examination will test all the areas targeted in the course.

**Semester-IX**

**Masters of Chemistry**

**GENERIC ELECTIVES (GE 9A)**
**Basic Physical Chemistry and Industrial Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| GE: Basic Physical Chemistry and Industrial Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

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|---|---|---|
| **MASTER'S IN CHEMISTRY** | | |
| **Programme: Master's in Chemistry** | **Year: IV** | **Semester: IX**<br>**Paper: GE 9A** |
| **Subject: Chemistry** | | |
| **Course: GE 9A** | **Course Title: Basic Physical Chemistry and Industrial Chemistry** | |
| **Course Outcomes:**<br>Upon successful completion of this course, the students will be able to:<br>• Understand about Gas laws, ideal and real gas.<br>• Acquire knowledge about rate laws and order of reaction.<br>• Know about polymer industrial chemistry. | | |
| **Credits:4** | **Generic Elective 1** | |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** | |

| Unit | Topic | No. of Hours |
|---|---|---|

| | | |
|---|---|---|
| **Unit I** | **Basic physical chemistry I**<br>Gaseous state: Gas laws, kinetic theory of gas, collision and gas pressure, derivation of gas laws from kinetic theory, average kinetic energy of translation, Boltzmann constant and absolute scale of temperature, Maxwell's distribution law of molecular speeds (without derivation), most probable, average and root mean square speed of gas molecules, principle of<br><br>equipartition of energy (without derivation). Mean free path and collision frequencies. Heat capacity of gases (molecular basis); viscosity of gases. Real gases, compressibility factor, deviation from ideality, van der Waals equation of state, critical phenomena, continuity of states, critical constants. Liquid state: physical properties of liquids and their measurements: surface tension and viscosity. | **15** |
| **Unit II** | **Basic Physical Chemistry II**<br>Chemical kinetics and catalysis: order and molecularity of reactions, rate laws and rate equations for first order and second order reactions (differential and integrated forms); zero order reactions. Determination of order of reactions. Temperature dependence of reaction rate, energy of activation. Catalytic reactions: homogeneous and heterogeneous catalytic reactions, autocatalytic reactions, catalyst poisons, catalyst promoters (typical examples). | **15** |
| **Unit III** | **Industrial chemistry I**<br>Fuels: Classification of fuel, heating values. Origin of coal, carbonization of coal, coal gas, producer gas, water gas, coal-based chemicals. Origin and composition of petroleum, petroleum refining, cracking, knocking, octane number, anti-knock compounds, Kerosene, liquefied petroleum gas (LPG), liquefied natural gas (LNG), petrochemicals (C1 to C3 compounds and their uses).<br>Fertilizers: Manufacture of ammonia and ammonium salts, urea, superphosphate, biofertilizers.<br>Glass and Ceramics: Definition and manufacture of glasses, optical glass and coloured glass. Clay and feldspar, glazing and vitrification, glazed porcelein, enamel. Portland cement: composition and setting of cement, white cement. | **15** |
| **Unit IV** | **Industrial Chemistry II Polymers:**<br>Basic concept, structure and types of plastics, polythene, polystyrene, phenol-formaldehydes, PVC; manufacture, physical properties and uses of natural rubber, synthetic rubber, silicone rubber; synthetic fibres: Nylon-6,6, polyester, terylene, rayon; foaming agents, plasticizers and stabilizers.<br>Paints, Varnishes and Synthetic Dyes: Primary constituents of a paint, binders and solvents for paints. Oil based paints, latex paints, baked-on paints (alkyd resins). Constituents of varnishes. Formulation of paints and varnishes. Synthesis of Methyl orange, Congo red, Malachite green, Crystal violet.<br>Drugs and pharmaceuticals: Concept and necessity of drugs and | **15** |

| | | |
|---|---|---|
| | pharmaceuticals. Preparation, and uses of Aspirin, Paracetamol, Sulphadiazine, Quinine, Chloroquine, Phenobarbital, Metronidazole. Fermentation Chemicals: Production, and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin. | |

**Recommended Readings:**

- N. Levine: Physical Chemistry
- G. W. Castellan: Physical Chemistry
- P. W. Atkins: Physical Chemistry
- R. S. Berry, S. A. Rice and J. Ross: Physical Chemistry
- T. Engel and P. Reid: Physical Chemistry
- W. J. Moore: Physical Chemistry
- F. Maqdoom: A Textbook for Industrial Chemistry
- Kent J. A.: Riegels Handbook of Industrial Chemistry

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:** https://caluniv.ac.in/syllabus/chemistry.pdf

**Semester-IX**

**Master's in Chemistry**

**GENERIC ELECTIVES (GE 9 B)- Computer For Chemists**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **GE 9B: Computer for Chemists** | **4** | **4** | **-** | **-** | **Passed Class XII** | **-** |

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| **MASTER'S IN CHEMISTRY** | | |
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: IX Paper: GE 9 B** |
| **Subject: Chemistry** | | |
| **Course: GE9B** | **Course Title: Computer for Chemists** | |
| **Course Outcomes:** Upon successful completion of this course, the students will be able to: | | |

- Understand about history and development of different types of Computers.
- Acquire knowledge about Software's and languages

| **Credits:4** | **Generic Elective 2** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | History of Development of Computer, Classification of Computer, Generation of Computers, General Awareness of Computer Hardware- CPU and other Peripheral devices, Input, Output and Auxiliary Storage Devices | **15** |
| **Unit II** | Software and their types (System Software and Application Software) Computer Language and their types (Low Level and HighLevel Languages), Operating System, Requirement of OS, Types of OS: Single User and Multi-user OS with examples. | **15** |
| **Unit III** | MS Word, Facilities in MS Word, MS Excel, Facilities in MS Excel, MS PowerPoint, Facilities in MS PowerPoint, Oral Presentations using visual aids such as PowerPoint etc. | **15** |
| **Unit IV** | Computer Applications in Chemistry: Introduction to Computers, General Information, Some related terminology, Flow Charting- Concept, Some flow charts- examples, Concept of Programming- BASIC language, Some Programmes in BASIC. | **15** |

**Recommended Readings:**

- Computer Fundamentals by P K Sinha.
- Computer Fundamentals by Goel.
- Computer Fundamentals and Programming in C by Reema Thareja.

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Semester- IX**

**MASTER'S IN CHEMISTRY**

**GENERIC ELECTIVE (GE 9C)**
**Essentials of Medicinal and Aromatic Plant Science**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **GE 9C: Essential of Medicinal and Plant Science** | **4** | **4** | **-** | **-** | **Chemistry in Bachelor of Science** | **-** |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: IX**<br>**Paper: GE 9C** |
| **Subject: Chemistry** | | |
| **Course: GE 9C** | **Course Title: Essentials of Medicinal and Aromatic Plant Science** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Proficiency in identifying and utilizing medicinal plant parts for therapeutic purposes in diverse forms.
- Mastery of extraction techniques including hydrodistillation and solvent extraction.
- Comprehensive understanding of cultivation practices, post-harvest handling, and industrial applications of medicinal plants.

| | |
|---|---|
| **Credits:4** | **Generic Electives 2** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Introduction to Medicinal and Aromatic Plants:** General aspects, occurrence, history, present and future needs, introduction of rich sources, quality control, contributions of research labs. | **15** |
| **Unit II** | **Utilization of Medicinal Plant Parts**: Plant parts used as powder, juice/decoction, lotion and ointments, oil, surgical fibers, sutures and dressings, poultice. | **15** |
| **Unit III** | **Extraction Techniques and Phytochemical Isolation** Extraction methods for terpenoids, hydrodistillation, steamdistillation, solvent extraction, isolation methods, factors affecting yield and quality. | **20** |
| **Unit IV** | **Cultivation, Processing, and Industrial Applications:** Cultivation, aromatic plant standards and grades, post-harvest handling, value addition, industrial applications, pharmaceutical and biological activities, health benefits. | **10** |

**Recommended Readings:**


- Shiva, M.P., Aromatic and Medicinal Plants: Yielding Essential oil for Pharmaceutical Perfumery and Cosmetic Industry and Trade.
- Verma and Joshi, Post Harvest Technology of Fruits and Vegetables, Handling, Processing, Fermentation and Waste Management.
- C. Shukla, Plant Constituents and their Mechanism of Action as Pesticide, Lambert Academic Publishing, Germany
- Egbuna, J. Chinenye Ifemeje, S. C. Udedi, S. Kumar, Phytochemistry: Vol. 1, Fundamentals, Modern Techniques, and Applications,
- Atta-ur-Rahman, Studies in Natural Products Chemistry, Elsevier.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a

mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Semester-X**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC COURSEE (DSC 10)**
**Advanced Spectroscopic Techniques II**
**Advanced Experimental Chemistry-IV**

**No. of Hours- 75**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSC: AdvancedSpectroscopic Techniques II AdvancedExperimental Chemistry-IV | 4 | 3 | - | 1 | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSC 10** |
| **Subject: Chemistry** | | |
| **Course: DSC 10** | **Course Title: AdvancedSpectroscopic Techniques II** | |

**Course Outcomes:**
Upon successful completion of this course, the students will be able to:

- Understand structure elucidation of various compounds through numerical problems.
- Master the principles and techniques of Mass Spectrometry, including ion production methods, fragmentation patterns and interpretation of mass spectra for organic compounds.
- Understand the principle and applications of Electron Spin Resonance (ESR) and Mossbauer Spectroscopy, including zero field splitting, hyperfine coupling, spectral parameters and structure elucidation through spectral analysis.
- Gain proficiency in Mossbauer spectroscopy and and X-ray differection methods and their applications.

| | |
|---|---|
| **Credits:3** | **Discipline Specific Course** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| Unit I | **Molecular dissymmetry and chiroptical properties:** Linear and circularly polarised lights, circular birefringence and circular dichroism, ORD and CD curves, Cotton effect. The axial haloketone rule, octant diagrams, helicity. Application of ORD and CD to structural and stereochemical problems. | 10 |
| Unit II | **Mass Spectrometry:** Introduction, ion production-EI, CI, FD and FAB, | |

| | | |
|---|---|---|
| | factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule, isotopic mass peaks, relative intensity, FTMS, etc.; General fragmentation rules: α-, β-, allylic and benzylic cleavage; ESI, APCI and MALDI, etc. Fragmentation of various classes of organic molecules, including compounds containing oxygen, sulphur, nitrogen and halogens. | **10** |
| **Unit III** | **Electron Spin Resonance Spectroscopy:** Basic Principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Hyperfine coupling isotopic and anisotropic hyperfine coupling constants spin Hamiltinian, spin-orbit coupling and significance of g-tensors. | **10** |
| **Unit IV** | **Mossbauer Spectroscopy:** Basic principles, spectral parameters and spectrum display**.** Application of the technique to the studies of bonding and structure of $Fe^{++}$ and $Fe^{+++}$ compounds, nature of M-L bond, coordination number, structure anddetection of oxidation state and inequivalent MB atoms. Structure elucidation through problems. | **10** |
| **Unit V** | **X-ray Diffraction Methods and Electron Microscopy**: Bragg condition, Miller indices, Laue's method, Bragg's method, Debye- Scherrer method of Xray structural analysis of crystals. Ramchandran diagram.<br>General Introduction of Electron Diffraction: Scattering intensity vs scattering angle.<br>**Electron Microscopy**: TEM, SEM | **05** |

**Recommended Readings**


- Pavia, Lampman, Kriz, Spectroscopy, Books/Cole; Vyvyan
- P.S. Kalsi, Spectroscopy of Organic Compounds, New Age International Publishers;
- Silverstein, Robert M.; Webster, Francis X.; Kiemle, Spectrometric Identification of Organic Compounds.
- M. L. Martin, J.J. Delpeach and G.J. Martin, Heyden, Practical NMR Spectroscopy,
- Colin N. Banwell and Elaine M. Mc Cash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.
- R.J. Abraham, J. Fischer and P. Loftus, Introduction to NMR Spectroscopy, Wiley


**Suggested Continuous Evaluation Methods:**

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSC** |
| **Subject: Chemistry** | | |
| **Course: DSC** | **Course Title: AdvancedExperimental Chemistry – IV (Practical)** | |

**Course Outcomes:**

- Upon completion of this course, the students will perform the inorganic exercise related to semimicro analysis and preparation of various coordination compounds.
- They will also learn to determine stability constant of metal complexes by Job's method. They can separate metal ions using paper chromatography.
- They will have the knowledge and skills to separate and identify three components in the given organic mixture.
- They will be able to learn the extraction of organic compounds from natural sources. Spectroscopic exercise will train them to interpret the spectral data organic compounds and will make them job ready for suitable industries.
- The students of physical chemistry group will learn the experimental setting up and determination of stability constant, transport number, liquid junction potential by different methods.
- They will learn the conductometric determination of equivalent conductivity, determination of degree of dissociation, pH determination.
- They will be able to check the validity of Ostwald dilution law, Langmuir adsorption isotherm.

| **Credits:4** | **Discipline Specific Course** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | Laboratory hazards and safety precautions | **5** |
| **Unit II** | **Inorganic Chemistry**<br>**A.** To determine the composition of Cu-EDTA complex by Job's method<br>**B.** Inorganic synthesis<br>Synthesis of selected inorganic compounds/ complexes and their characterization by IR, electronic spectra (UV & Visible), NMR, Mossbauer, ESR nd magnetic susceptibility etc. measurements. Selection can be made from the following or any other from the existed literature.<br>(i) cis-and trans- isomers of *trans*-dichlorobis (ethylenediamine)cobalt(III) chloride: $[Co(en)_2Cl_2]$ Cl.<br>(ii) Metal acetylacetonates: $[Cr(acac)_3]$; Vanadyl acetylacetonate, $[Cu(acac)_2.H_2O$ etc.<br>(iii) Ferrocene | **25** |

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|---|---|---|
| | (iv) Cr(II) complexes: $[Cr(H_2O)_6](NO_3)_3.3H_2O$; $[Cr(H_2O)_4Cl_2]Cl.2H_2O$; $[Cr(en)_3]Cl_3$<br>(v) Tin (IV) iodine, Tin(IV) choride, Tin(II) iodine.<br>(vi) Mixed valence dinuclear complexes of manganese (III, IV).<br>(viii) Tris(thiourea) copper (I) sulphate: $[Cu[(NH_2)_2CS]_3]_2.SO_4.2H_2O$<br>(ix) *Cis*-bis(glycinato) copper (II) monohydrate: *Cis*-$[Cu(glyo)_2(H_2O)]$<br>(x) *Trans-p*otassium-dioxalato diaqua chromate(III) dihydrate: $K[Cr(C_2O_4)_2(H_2O)_2].2H_2O$<br>(xi) Synthesis of iron oxide nano particles and its possible characterization<br>**(C) Chromatography:** separation of cations and anions by paper/TLC/Ion Exchange chromatography<br>**(D) Quantitative analysis** of metal ions involving volumetric (by complexometric titration) and gravimetric analysis (Copper, Nickel, Zinc, Silver, Magnesium). | |
| **Unit III** | **Organic chemistry**<br>**A. Qualitative analysis**<br>Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid), using TLC for checking the purity of the separated compounds, chemical analysis, IR, PMR and Mass Spectral data (sets of spectra may be provided to Students for characterization of components).<br>**(B) Extraction of Organic Compounds from Natural Sources**<br>I) Isolation of caffeine from tea leaves.<br>II) Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).<br>III) Isolation of lactose from milk (purity of sugar should be checked by TLC, PC and Rf value reported).<br>IV) Isolation of nicotine dipicrate from tobacco.<br>V) Isolation of cinconine from cinchona bark.<br>VI) Isolation of piperine from black pepper.<br>VII) Isolation of lycopene from tomatoes.<br>VIII) Isolation of β-carotene from carrots.<br>IX) Isolation of oleic acid from olive oil (involving the preparation complex with urea and separation of linoleic acid).<br>X) Isolation of eugenol from cloves.<br>XI) Isolation of limonene from citrus fruits<br>(C) Extraction, TLC, GC/ HPLC of essential oils from natural products | **25** |

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|---|---|---|
| | I). Extractionfrom Coriander Seeds<br>II). Extraction from Ajwain Seeds<br>III. Spectroscopy Identification of organic compounds by the analysis of the spectral data (UV, IR, PMR, CMR & MS) | |
| **Unit-IV** | **Physical Chemistry**<br>1. Study of complex formation by the following methods and determination of stability constant wherever practicable:<br>2. Cryoscopy<br>3. Electrical Methods<br>4. E.M.F.<br>5. Determination of transport number.<br>6. Determination of liquid junction potential.<br>7. Determination of the charge on colloidal particle.<br>8. Determination of λ (max) of compounds and verification of Beer's law.<br>9. Validity of Langmuir's adsorption isotherm.<br>10. Determination of partial molar volume of solute.<br>11. Determination of the following thermodynamic parameters of a reaction<br>12. Enthalpy of activation.<br>13. Entropy of activation.<br>14. Free energy change.<br>15. Equilibrium constant.<br>16. Frequency factor<br>17. Conductometric determination of the equivalent conductivity at infinite dilution of a strong electrolyte.<br>18. Determination of the dissociation constant of a weak acid by conductivity method.<br>19. Conductometric determination of the equivalent conductivity at infinite dilution of a weak electrolyte.<br>20. Validity of Ostwald's dilution law.<br>21. Determination of the degree of dissociation/ association conductometrically.<br>22. Determination of the formula of silver ammonia complex & copper | **25** |

ammonia complex.

23. Kinetic Study of the primary salt effect
24. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
25. Determination of pH by EMF.
26. Hydrolysis of the salts by cryoscopic method.
27. Determination of strengths of halides in a mixture potentiometrically.
28. Determination of the valency of mercurous ions potentiometrically.
29. Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
30. Verification of the law of photo-chemical equivalence.
31. Determination of the velocity constant of acid catalyzed hydrolysis of an ester.
32. Determination of activation energy of a reaction.
33. Determination of Frequency factor of a reaction by kinetic studies.
34. Validity of Arrhenius equation.
35. Determination of the effect of change in temperature on rate constant of a reaction.
36. Determination of the effect of change in concentration of the reactants on rate constant of a reaction.
37. Determination of the effect of change in concentration of the catalyst on rate constant of a reaction.
38. Determination of the effect of change in ionic strength on the rate constant of a reaction.
39. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide.
40. Flowing Clock reactions (Ref. Experiments in Physical Chemistry by Showmaker).
41. Study of the adsorption of an acid by charcoal.
42. Validity of Freundlich's Adsorption isotherm.
43. Determination of Partition Coefficients.
44. Determination of molecular surface energy of a liquid by Stalagmometer method.

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|---|---|---|
| | 45. Determination of association factor of the given liquid by drop-pipette method. | |

**Note:** Choice of practical as per specialization each 30 Hrs. Allocation of marks - External assessment: Total marks 75 (Each exercise carries 20 marks; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10). It is compulsory to perform three experiments from any one of thespecial papers.

**Recommended Readings**


- J. Mendham, Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- D. C. Harris, Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- S.M. Khopkar, Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, Cengage Learning India Edition


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

https://www.labster.com/chemistry-virtual-labs/
https://www.vlab.co.in/broad-area-chemical-sciences
http://chemcollective.org/vlabs

**Semester-X**

**Master's in chemistry**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10 A)**
**Organometallic Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10 E: General and Organometallic Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

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|---|---|---|
| **MASTER'S IN CHEMISTRY** | | |
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSE 10 A** |
| **Subject: Chemistry** | | |
| **Course: DSE 10 A** | **Course Title: Organometallic Chemistry** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the organometallic compounds of transition metals with sigma and pi bonding ligands

- They will also get acquainted with the chemistry of fluxional molecules.
- The students will learn about chemistry and mechanism of homogeneous catalytic reactions. It will assist them to get a suitable job in the relevant industrial and scientific field.

| **Credits:4** | **Discipline Specific Elective** | |
|---|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** | |
| **Unit** | **Topic** | **No. of Hours** |
| **Unit I** | **Organic Derivatives of Transition Metals:** Alkyls, aryls and acyls of transition metals, nature of metal carbon bond, routes of synthesis, stability, decomposition pathways, stabilization, Alkyls, aryls and acyls of s-block and p-block elements, synthesis, stability, reactivity. Comparison between transition and non-transition element derivates. | **10** |
| **Unit II** | **Compounds of Metal-Carbon Multiple Bonds and Fluxional Organometallic Compounds:** Synthesis, properties, nature of bonding and structural features of π-bonded organo-metallic compounds (π-complexes) with unsaturated organic molecules: alkenes, alkynes, chelating olefinic ligands, allyl, dienes-butadiene, cyclobutadiene, cyclopentadiene, dienyl-cyclpentadienyl, cyclohexadienyl and arene complexes. Important reactions relating to nucleophilic and electrophilic attack on ligands, role in organic synthesis. Fluxionality and dynamic equilibria in compounds such as $\acute{\eta}^3$- allyl and dienyl complexes, their characterization. | **15** |
| **Unit III** | **Mechanism of Some Catalytic Reactions**: Stoichiometric reactions for catalysis, oxidative-addition, migratory insertion, reductive elimination, homogeneous catalytic Hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydroformylation of olefins (oxo-reaction), Wacker's process. | **10** |
| **Unit IV** | **Silicates and Aluminosilicates**: Silicates: Classification, properties, structure and applications of naturally occurring silicates. Aluminosilicates: chemistry of feldspars, ultramarine, zeolites, classification, structure and applications of zeolites. Clays: montmorilonite clay, synthesis of pillared clays, characterization and applications of clays and pillared clays as catalysts. | **10** |
| **Unit V** | Problem based on the above syllabus | **15** |

**Recommended Readings**


- J. P. Collman, L. S. Hegsdus, J. P. Norton and R. G. Finke, Principle and Application of Organotransition Metal Chemistry, University Science Books.
- R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley
- J. Person, Metallo-organic Chemistry, Wiley.
- R. C. Mehrotra and A. singh, Organometallic Chemistry, New Age International.
- J. E. Huheey, E.A. Keiter, R.L. Keiter,Inorganic Chemistry: Principle of structure and Reactivity, Pearson Education.
- N. L. H. Green, Organometallic Compounds, Chapman & Hall, U.K.

- G. E. Coates, M. L. H. Green., P. Pwell,Principles of Organometallic Chemistry, Chapman & Hall, U.K.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online courses:**

**https://tech.chemistrydocs.com/Books/Organic/A-Guidebook-of-Organic-Reaction-Mechanism-by-Peter-Sykes.pdf**
https://nptel.ac.in/courses/104/101/104101079/
https://onlinecourses.nptel.ac.in/noc21_cy12/preview
https://nptel.ac.in/courses/104/108/104108062/
https://onlinecourses.nptel.ac.in/noc21_cy36/preview
https://onlinecourses.nptel.ac.in/noc22_cy05/preview
https://onlinecourses.nptel.ac.in/noc22_cy05/preview
https://nptel.ac.in/courses/104/101/104101100/

**Semester-X**

**Master's in chemistry**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10B)**
**Metal Ligand Bonding and Polymer Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10B: Metal Ligand Bonding and Polymer Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSE 10B** |
| **Subject: Chemistry** | | |
| **Course: DSE 10B** | **Course Title: Metal Ligand Bonding and Polymer Chemistry** | |

**Course Outcomes:**

- Upon successful completion of this course, the students will be able to:
- Explain the molecular orbital theory of transition metal complexes.
- Gain an understanding of Sigma and pi bonding in transition metal complexes through molecular orbital energy diagrams.
- Acquire knowledge about the chemical analysis of polymers.

| Credits:4 | Discipline Specific Elective | |
|---|---|---|
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules | |
| **Unit** | **Topic** | **No. of Hours** |
| **Unit I** | **Metal-Ligand Bonding:** Sigma bonding in octahedral complexes: Classification of metal valence orbitals into sigma symmetry, formation of ligand group orbitals (LGOs) of sigma symmetry, Formation of molecular orbitals of sigma symmetry, construction of molecular orbital energy level diagram involving only sigma bond contribution from ligands, pi bonding in octahedral complexes: Classification of metal valence orbital into pi symmetry, Formation of LGOs of pi symmetry. Formation of pi MOs and construction of molecular orbital energy level diagram involving sigma and pi contribution from pi donor ligands, Sigma and pi bonding intetrahedral complexes and square planar complexes. | **10** |
| **Unit II** | **Basics of Inorganic Polymers:** Importance of polymers, basic concepts: monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers, polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization. Polymerization conditions and polymer reactions Kinetics of polymerization. Stereochemistry and mechanism of polymerization. Polymerization in homogeneous and heterogeneous systems. | **10** |
| **Unit III** | **Structure and Properties**: Morphology and order in crystalline polymers-configurations of polymer chains: Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point (TM); melting points of homogeneous series, effect of chain, flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature (Tg), relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. | **10** |
| **Unit IV** | **Polymer Characterization:** Polydispersion, average molecular weight concept: number average, weight average and viscosity average molecular weights. Polydispersity and molecular weight distribution. Measurement of molecular weight: end-group, viscosity, light scattering, osmotic and ultacentrifugation methods. Analysis and testing of polymers, chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue impact. Tear resistance. Hardness and abrasion resistance. | **15** |
| **Unit V** | PROBLEM BASED ON THE THE ABOVE | **15** |

**Recommended Readings:**

- F. A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, Advance Inorganic Chemistry, Sixth Edition, John Wiley & Sons, New York, 2003.
- J. D. Lee, Concise Inorganic Chemistry, Fifth Edition, Wiley India, 2012.
- Atkins, Overton, Rourke, Weller and Armstrong, Inorganic Chemistry, Oxford University Press.
- J. E. Huheey, E. A Keiter and R. L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, Fourth Edition, Pearson Education, 2003.
- W. W. Porterfield, Inorganic Chemistry: A Unified Approach, Elsevier.
- G. Wulfsberg, Inorganic Chemistry, Viva Books.
- G. L. Miessler and D. A. Tarr, Inorganic Chemistry, Pearson Education.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online contents:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ
https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy19/
https://onlinecourses.nptel.ac.in/noc22_cy02/preview
https://nptel.ac.in/courses/104/105/104105033/
https://nptel.ac.in/courses/104/106/104106089/
http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000658/M014009/ET/1456899566CHE_P3_M5_etext.pdf
http://ddugu.ac.in/epathshala_content1.aspx
https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf

**Semester-X**
**Master's in chemistry**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10 C)**
**Photo Inorganic Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10 C: Photo Inorganic Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| Programme: Master's in Chemistry | Year: V | Semester: X<br>Paper: DSE 10C |
| Subject: Chemistry | | |
| Course: DSE 10C | Course Title: Photo Inorganic Chemistry | |
| Course Outcomes: | | |

Upon successful completion of this course, the students will be able to:

- Explain the basica of photochemistry.
- Gain an understanding of photochemical reactions.
- Acquire knowledge about the chemical analysis of polymers

| **Credits: 4** | **Discipline Specific Elective** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Basics of Photochemistry:** Absorption, excitation, photochemical laws, electronically excited states-life times, measurements of the times. Flash photolysis, stopped flow techniques. Energy dissipation by radiative and non-radiative processes, absorption spectra, Franck-Condon principle, photochemical stages- primary and secondaryprocesses. **Photochemical Reactions:** Interaction of electro magnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry. Singlet molecular oxygen reactions. Photochemical formation of smog. Photo- degradation of polymers. Photochemistry of vision. | **10** |
| **Unit II** | **Properties of Excited States and Excited States of Metal Complexes:** Structure, dipole moment, acid-base strengths, reactivity. Photochemical kinetics-calculation of rates of radiative processes. Biomolecular deactivation-quenching. Excited states of metal complexes: comparison with organic compounds, electronically excited states of metal complexes. Charge-transfer spectra, charge transfer excitations, methods forobtainingcharge-transferspectra. | **10** |
| **Unit III** | **Ligand Field Photochemistry:** Photosubstitution, photo-oxidation andphoto-reduction, lability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero-zero spectroscopic energy, development of the equations for redox potentials of the excited states. | **10** |
| **Unit IV** | **Redox Reactions by Excited Metal Complexes:** Energy transfer underconditions ofweak interactionandstronginteraction-exciplex formation, conditions of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2'-bipyridine and 1,10-phenenthroline complexes), illustration of reducing and oxidizing character of $Ru^{2+}$ bipyridyl complex (comparison with [Fe(bipy)3]); roleofspin-orbitcoupling- life time of these complexes. Application of redox processes of electronically excited states for catalytic purpose, transformation of low energy reactants into high energy products, chemical energy | **15** |
| **Unit V** | **PROBLEM BASED ON THE THE ABOVE** | **15** |

**Recommended Readings:**


- A.W.AdamsonandP.D. Fleischauer, Conceptof Inorganic Photochemistry, Wiley.
- Inorganic Photochemistry, J. Chem. Educ., vol. 60, no.10,1983.

- J. Lippard, Progressin Inorganic Chemistry, Vol.30, ed. Wiley.
- CoordinationChem. Revs., 1981, Vol. 39, 121,131; 1975, 15,321; 1990, 97, 313.
- V. Balzariand Carassiti, Photochemistry of Coordination Compounds, Academic Press.
- G.J. Ferraudi, Elements of Inorganic Photochemistry, Wiley-Eastern.
- K.K. Rohtagi-Mukherji, Fundamentals of Photochemistry, Wiley-Eastern.
- A. Gilbert andJ. Baggott, Essentials of Molecular Photochemistry, Blackwell Scientific Publication.
- N.J. Turro, W.A. Benjamin, Molecular Photochemistry,
- A. Cox and T. Camp, Introductory Photochemistry, McGraw-Hill.
- R.P. Kundall and A. Gilbert, Photochemistry, Thomson Nelson.
- J. Coxon and B. Halton, Organic Photochemistry, Cambridge UniversityPress.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Semester-X**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10 D)**
**Heterocyclic Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10 D: Heterocyclic Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| Programme: Master's in Chemistry | Year: V | Semester: X<br>Paper: DSE 10D |
| Subject: Chemistry | | |
| Course: DSE 10 D | Course Title: Heterocyclic Chemistry | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the advanced aspects of heterocyclic chemistry.
- This will provide broader areas of opportunities in these related industries.

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|---|---|
| Credits:4 | Discipline Specific Elective |
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules |

| Unit | Topic | No. of Hours |
|---|---|---|

| | | |
|---|---|---|
| **Unit I** | **Aromatic and Non aromatic heterocycles-** Systematic nomenclature (Hantzsch-Widman vystem) for monocyclic, fused and bridged heterocycles. General chemical behaviour of aromatic heterocycles, classification, Strain - hood angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocyeles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion, Stereo-electronic effects, aromatic and related effects. Attractive interactions hydrogen bonding and intermolecular nucleophilic, electrophilic interaction | **15** |
| **Unit II** | **Small ring and benzo-fused five membered heterocycles-**Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxetanes and thietanes. Synthesis and reactionds including medicinal applications of benjoapyrroles, benzofurans and benzothiophenes | **10** |
| **Unit III** | **Six membered heterocycles**<br>Sythesis and reactions of pyrylinum salts and pyrones, coumarins and chromomes. Synthesis and reactions of diazines. | **10** |
| **Unit IV** | **Seven or large membered heterocycles**<br>Synthesis and reactions of azepines, oxepines, thiepines, diazepines thiaropines, arocines, diazocines, dictopines and dithiocines | **10** |
| **Unit V** | **PROBLEMS REATED TO THE ABOVE SYLLABUS** | **15** |

**Recommended Reading**


- R.R. Gupta, M. Kumar and V. Gupta,Heterocyclic Chemistry Vol. 1-3, Springer Verlag.
- G.R. Newkome and W.W. Paudler, Contemporary Heterocyclic Chemistry, Wiley-Inter Science.
- R.M. Acheson, An Introduction to the Heterocyclic Compounds, John Wiley.
- A.R. Katritzky and C.W. Rees, Comprehensive Heterocyclic Chemistry, eds. Pergamon press.
- Heterocyclic Chamuty Vol. 1 & R.K. Gupta, M. Kumar and V. Taupta, Sponger Verlag
- The Chemistry of Heterocycles. 7. Elcher and S. Hauptmann. Thieme.
- Heterocyelle Chemistry, L.A. Jouke, K. Mills and GF. Smith, Chapman and Hall. Heterocyclic Chemistry, TL Gilchrist, Longman Scietific Technical
- Contemporary Huterocyclic Chennistry, UK. Newkome and W.W. Pauller, Wiley-Inter Science
- An introduction to the Heterocyelic Compounds, R.M. Acheson, John Wiley Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergame
- Natural Products: Chemistry and Biological Significance, J.Mann, R.S. Davidson, 1
- Hebba, DV. Banthrope and J.R. Harborne, Longman. Essex
- Organic Chemistry, Vol 2, 1.1. Finar, ELBS.
- Stereselective Synthesis A Practical Approach, M. Nagradi, VCI


**Suggested equivalent online courses:**

https://swayam.gov.in/

https://www.coursera.org/learn/physical-chemistry

**Semester-X**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10 E)**
**Chemistry of Natural Products**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10 E: Chemistry of Natural Products | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| Programme: Master's in Chemistry | Year: V | Semester: X<br>Paper: DSE 10 E |
| Subject: Chemistry | | |
| Course: DSE 10 E | Course Title: Chemistry of Natural Products | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire knowledge of all the natural products and heterocyclic compounds such as terpenoids, alkaloids, carotenoids, steroids and plant pigments which form the back bone of natural systems of medicines such as Ayurveda, Homeopathy andYunani system of medicine.

| Credits:4 | Discipline Specific Elective |
|---|---|
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules |

| Unit | Topic | No. of Hours |
|---|---|---|
| Unit I | **Vitamins:** Classification, occurrence, chemistry of Vitamins A, C and E, structure elucidation and synthesis, deficiency syndromes. | 10 |
| Unit II | **Terpenoids and Carotenoids:** Classification, occurrence, isolation, general methods of structure determination, Synthesis of citral, menthol and β-carotene.<br>**Plant Pigments:** Occurrence, nomenclature, synthesis of Quercetin and cyanidine. Biosynthesis of flavonoids. | 10 |
| Unit III | **Steroids:** Occurrence, physiological action, basic skeleton, diel's hydrocarbons, stereochemistry, structure determination of cholesterol, | 10 |
| | | |

| | | |
|---|---|---|
| | synthesis of cholesterol and testosterone, estrone. | |
| **Unit IV** | **Alkaloids:** Occurrence, isolation, general method structure elucidtion, classification based on nitrogen heterocyclic ring structure, stereochemistry, synthesis of morphine, reserpine, Applications. | **10** |
| **Unit V** | **Enzymes:** Techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry-brewing and cheese-making, syrups from corn starch, enzymes as targets for drug design. Clinical uses of enzymes, | **5** |
| **Unit VI** | **PROBLEMS RELATED TO THE ABOVE SYLLABUS** | **15** |

**Recommended Reading**

- Chemsitry of Natural products,B.A.Naga Sampagi (Author), S. Minakshi (Author), S. V. Bhat (Author)
- L. Finar, Vol. I & II, ELBS.

**Semester-X**

**Master's in chemistry**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10 F)**
**Medicinal Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **DSE 10 F: Medicinal Chemistry** | **4** | **4** | **-** | **-** | **Chemistry in Bachelor of Science** | **-** |

| | | |
|---|---|---|
| **MASTER'S IN CHEMISTRY** | | |
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSE 10 F** |
| **Subject: Chemistry** | | |
| **Course: DSE 10 F** | **Course Title: Medicinal Chemistry** | |

**Course Outcomes:**
Upon successful completion of this course, the students will be able to:

- After completion of this course, the students will be able to understand the process of drug designing

- and to have some information about antineoplastic Agents, cardiovascular drugs, local anti-infective drugs and antibiotics and psychoactive drugs.

| **Credits:4** | **Discipline Specific Elective** | |
|---|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** | |
| **Unit** | **Topic** | **No. of Hours** |
| **Unit I** | **Drug Design :** Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drug, structure-activity relationship (SAR), factors affecting bioactivity. Theories of drug activity: general discussion. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptor interactions. Physico-chemical parameters: Lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. Free-Wilson analysis, Hansch analysis, relationships between Free-Wilson and Hansch analysis. LD-50, ED-50 (Mathematical derivations of equations excluded). | **15** |
| **Unit II** | **Pharmacokinetics & Pharmacodynamics:** Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process. Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry. | **10** |
| **Unit III** | **Antineoplastic Agents:** Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotic and mitotic inhibitors.<br>Synthesis of mechlorethamine, cyclophosphamide, melaphalan, uracil, mustards and 6- mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products. | **10** |
| **Unit IV** | **Psychoactive Drugs-The Chemotherapy of Mind :**Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, buspirone, neurochemistry of mental diseases. Antipsychotic drugs –the neuroleptics, antidepressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs.<br>Synthesis of diazepam, oxazepam, clonazepam, alprazolam, phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, glutethimide. | **10** |
| **Unit V** | **PROBLEMS RELATED TO THE ABOVE** | **15** |

**Recommended Readings**


- Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH
- Wilson and Gisvold's Text –Book of Organic Medicinal and Pharmaceutical
- Chemistry, Ed. Robert F. Dorge.
- An introduction to Drug Design, S.S. Pandeya and U.R. Diiock, New Age International.
- Burger's Medicinal Chemistry and Drug Discovery, Vol.- 1 (Chapter 9 and Ch-14), Ed. M.E. Wolf, John Wiley.
- Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
- The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
- Strategies for Organic Synthesis and Design, D. Lednicer, John Wiley.
- Pharmaceutical drug analysis, Ashutosh Kar


**Suggested online links:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ
https://nptel.ac.in/courses/104/106/104106106/
https://onlinecourses.nptel.ac.in/noc20_cy16/preview
https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cy16/
https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-cy05/

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in- class or on-line tests, home assignments, group discussions or oral presentations.

**Semester-X**

**MASTER'S IN CHEMISTRY**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10 G)**
**Advanced Chemical Dynamics and Statistical Thermodynamics**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10 G: Advanced Chemical Dynamics and Statistical Thermodynamics | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| Programme: Master's in Chemistry | Year: V | Semester: X<br>Paper: DSE10 G |
| Subject: Chemistry | | |

| Course: DSE 10 G | Course Title: Advanced Chemical Dynamics and Statistical Thermodynamics |
|---|---|

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire knowledge on chemical dynamics, kinetics in solution, fast chemical reactions, statistical thermodynamics and thermodynamic equilibrium. Develop expertise in advanced chemical dynamics, encompassing reaction rate theories, unimolecular reactions, chain reactions and kinetic isotope effects.
- Master statistical thermodynamics principles, including thermodynamic probability, partition functions and statistical distributions for diatomic molecules.
- Understand kinetics in solution, fast chemical reactions and enzyme catalysis, employing experimental techniques like stopped flow and flash photolysis.
- Gain proficiency in thermodynamic equilibrium concepts, including free energy, entropy, chemical potential, fugacity, ideal solutions and applications of the Duhem-Margules and Gibbs-Helmholtz equations.

| Credits:4 | Discipline Specific Elective 10 A |
|---|---|
| Max. Marks: As per University rules | Min. Passing Marks: As per University rules |

| Unit | Topic | No. of Hours |
|---|---|---|
| Unit I | **Advanced Chemical Dynamics:** Theories of reaction rates: Partition functions (translational, vibrational and rotational) for diatomic molecules and application to rate processes, statistical mechanics of chemical equilibrium, theory of absolute reaction rates, thermodynamical formulation of reactions rates, theories of unimolecular reactions: Lindemann's theory, Hinshelwood's treatment, RRK treatment, Slater's theory (no derivation), Rice-Ramsperger-Kassel-Marcus (RRKM) theory (no derivation), general treatment of chain reactions, branching chains, explosive reactions between hydrogen and oxygen, oxidation of hydrocarbons, polymerization reactions (molecular and free radical), oscillatory reactions, kinetic isotope effect. | 12 |
| Unit II | **Statistical Thermodynamics:** Introduction to Statistical Thermodynamics, Thermodynamic probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Partition function: Translational, rotational, vibrational and electronic partition functions for diatomic molecules, relation between partition function and various thermodynamic quantities. | 6 |
| Unit III | **Kinetics in Solution and Fast Chemical Reactions:**<br>**Kinetics in Solution:** Influence of solvent reactions between ions, reactions between ions and molecules, reactions involving dipoles, influence of ionic strength, primary and secondary salt effects,<br><br>homogeneous and heterogeneous catalysis, absolute rate theory of heterogeneous reactions. Enzyme Catalysis: Michaelis-Menton mechanism, single and double intermediates, general methods for working out the kinetics of complex enzymatic reactions | 15 |

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|---|---|---|
| | **Fast Chemical Reactions:** Study of kinetics by stopped flow techniques, relaxation methods, flash photolysis and magnetic resonance methods and temperature jump method. | |
| **Unit IV** | **Thermodynamic Equilibrium:** Free energy and entropy of mixing, chemical potential and its use in heterogeneous equilibrium, fugacity, its significance and determination, Ideal solutions and their properties, Duhem-Margules equation and its applicability, Gibb's-Helmholtz equation and its uses, Nernst heat theorem, third law of thermodynamics, entropy determination from the third law of thermodynamics. | **12** |
| **Unit V** | **PROBLEM RELATED TO THE ABOVE** | **15** |

**Recommended Readings**


- B. R. Puri, L. R. Sharma and M. S. Pathnia, Physical Chemistry, Milestone Publisher & Distributors, New Delhi
- K. L. Kapoor, Physical Chemistry. Macmillan *Publishers* India Limited.
- K. J. Laidler, Kinetics, Pearson Education India.
-


**Suggested Continuous Evaluation Methods:** Since the class is conceived as learner-centric and built around tasks that require learners to actively use various language skills, formative assessment can and should be used extensively. Oral presentations, peer interviews, and group tasks can be used for this purpose. The end-semester written examination will test all the areas targeted in the course.

**Suggested equivalent online courses:**

https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ

https://www.classcentral.com/course/swayam-concepts-of-thermodynamics-13015

https://onlinecourses.nptel.ac.in/noc20_me20/preview

https://www.coursera.org/learn/thermodynamics-intro

https://onlinecourses.nptel.ac.in/noc22_cy14/preview

https://onlinecourses.nptel.ac.in/noc20_cy22/preview

**Semester-X**

**Master's in chemistry**

**DISCIPLINE SPECIFIC ELECTIVE (DSE 10H)**
**Molecular Orbital Theory and Quantum Mechanics**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10H: Molecular Orbital Theory and Quantum Mechanics | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

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|---|---|---|
| **MASTER'S IN CHEMISTRY** | | |
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSE 10H** |
| **Subject: Chemistry** | | |
| **Course: DSE 10H** | **Course TitleMolecular Orbital Theory and Quantum Mechanics** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand of advanced quantum mechanics will help them to explain the related terms. Acquire the knowledge about concept of molecular orbital and valence bond theories will help them to understand the bonding concept.
- a detailed idea about the de Broglie is concept different types of operators Schrodinger wave equation, and application of Schrodinger's Wave Equation to some models, that is particle in 1D 3D box and hydrogen atom

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| **Credits:4** | **General Elective** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Quantum Chemistry-I:** de-Broglie concept and de-Broglie equation, physical interpretation and properties of wave functions, Linear, Laplacian, Linear-momentum and Hamiltonian operators, postulates of quantum mechanics, eigen values, eigen functions, normalization and orthogonalizaion, derivation of the Schrodinger's wave equation, concept of cartesian and spherical coordinates. | **10** |
| **Unit II** | **Quantum Chemistry-II:** Schrodinger's wave equation general and detailed discussion on the applications of Schrodinger's wave equation to some model systems *viz.* particles in a 1D-, 3D- box, harmonic oscillator, rigid rotator and hydrogen atom. | **10** |
| **Unit III** | **Advanced Quantum Mechanics:** Applications of basic concepts of quantum chemistry, Angular momentum including spin coupling of angular momentum and spin-orbit coupling. Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigen values of angular momentum, operator using ladder operators. | **10** |

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| **Unit IV** | **Concepts in Molecular Orbital (MO) Theory and Concepts in Valence Bond (VB) Theory:** MO theory of $H_2$ molecule, Introduction to Hückle Molecular Orbital (MO) method as means to explain modern theoretical methods, advanced techniques in PMO and FMO theory, Ab initio method, semi empirical methods.<br>Quantitative MO theory – Hückel Molecular Orbital (HMO) methods, MO energy levels, orbital symmetry,<br>orbital interaction diagrams, MO of simple organic systems. Valence Bond (VB) configuration mixing diagrams, reaction profiles, potential energy diagrams. | **15** |
| **Unit V** | **PROBLEMS RELATED TO THE ABOVE SYLLABUS** | **15** |

**Recommended Readings**


- G.W. Castellan, Physical Chemistry, 4th Ed. Narosa.
- R.G. Mortimer, Physical Chemistry, 3rd Ed. Elsevier: NOIDA, UP.
- F.A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Parts A & B, Plenum: U.S.
- W. M. Horspool, Aspects of Organic Photochemistry, Academic Press.
- T. H. Lowry and K. S. Richardson, Mechanism and Theory in Organic Chemistry Addison-Wesley Educational Publishers, Inc.
- J. March, Advanced Organic Chemistry, John Wiley & Sons.
- L. Stryer, Biochemistry, W. H. Freeman & Co.
- P. A. Sykes, Guidebook to Mechanism in Organic Chemistry, Prentice-Hall.
- James H. Clark and Duncan J. Macquarrie, Handbook of Green Chemistry and Technology, Wiley-Blackwell.
- Paul T. Anastas and Tracy C. WilliamsonGreen Chemistry: Frontiers in Benign Chemical syntheses and Processes, Oxford University Press.
- Geoffrey Alan Ozin, A. C. Arsenault and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry.


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online courses:**

- https://www.ias.ac.in/article/fulltext/reso/023/03/0277-0290
- https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ
- https://www.ias.ac.in/article/fulltext/reso/023/03/0277-0290

**Semester-X**

**Master's in chemistry**

**DISCIPLINE-SPECIFIC ELECTIVE (DSE 10 I)**
**Radio and Electroanalytical Techniques**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| DSE 10 I: Radio and Electroanalytical Techniques | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: DSE 10 I** |
| **Subject: Chemistry** | | |
| **Course: DSE 10 I** | **Course Title: Radio and Electroanalytical Techniques** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the theory of voltammetry, amperometry and radioanalytical techniques.
- Explain the principle of polarography, CV nd radioanalytical techniques.
- Apply the concepts of polarography voltammetry, amperometry and radioanalytical techniques.
- Appreciate the importace and applications of of polarography, voltammetry, amperometry and radioanalytical techniques.
- Solve the problems based on the concepts of polarography, voltammetry, amperometry and radioanalytical techniques..

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| **Credits:4** | **Discipline Specific Elective** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Advanced Electroanalytical Techniques: Voltammetry**<br>Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry. Stripping Voltammetry- anodic, cathodic, and adsorption Chemically and electrolytically modified electrodes and ultra- microelectrodes in voltammetry | **15** |
| **Unit II** | **Advanced Electroanalytical Techniques: Amperometry, potentiometry and Polarography**<br>Potential Step method- Chronoamperomertry | |

| | | |
|---|---|---|
| | Controlled potential technique- Chronopotentiometry<br>Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography | **10** |
| **Unit III** | **RADIOANALYTICAL Techniques:**<br>Radiotracer Techniques Choice of Radiotracers Factors Affecting Choice of Radiotracers<br>Isotope Dilution Analysis (IDA) Principle and Equation Instrumentation Applications Advantages and Limitations Substoichiometic Isotope Dilution Analysis (SIDA)<br>Activation Analysis (AA) Principle of NAA Neutron Sources Interferences Sensitivity and Detection Limits Classification Instrumentation Applications Advantages and Limitations | **10** |
| **Unit IV** | **Radiometric Titrations (RT):** Procedure Advantages and Limitations 13.7 Radiochromatography 13.8 Radioimmunoassay Principle Methodology Procedure Applications | **10** |
| **Unit V** | **PROBLEMS RELATED TO THE ABOVE** | **15** |

**Recommended Readings**


- Introduction to Instrumental Analysis, R. D. Braun, Mc Graw Hill (1987)
- Electrochemical Methods, A. J. Bard and L.R. Faulkner, John Wiley, New York, (1980)
- Electroanalytical Chemistry, J.J . Lingane, 2 nd Ed Interscience, New York (1958)
- Modern Polarographic Methods in Analytical Chemistry, A. M. Bond, Marcel Dekker, New York, 1980. 10. Electroanalytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes) 11. Techniques and mechanism of electrochemistry, P. A. Christian and A. Hamnett, Blachie Academic and Professional (1994)
- Radiochemistry and Nuclear Methods of Analysis by W. D. Ehmann and D. E. Vance, John Wiley & Sons, New Delhi (1994).
- Principles of Activation Analysis by P. Kruger, Wiley-Interscience, New York (1971). 3. Neutron Activation Analysis by D. De Soete, R. Gijbels and J. Hoste, Wiley Interscience, New York (1972).
- 7.Radioanalytical Chemistry by J. Tolgyessy and M. Kyrs, Vol 1 and 2, Ellis Horwood Ltd, Chichester (1989).
- Modern Methods for Trace Element Determination by C. Vandecasteele and C. B. Block, John Wiley & Sons, Chichester (1993).
- Activation Analysis, Ed. Z. B. Alfassi, Vol 1 and 2, CRC Press, Boca Raton, USA (1991).
- Instrumental Methods of Analysis, 7th Edn by H. H. Willard, L. L. Merritt, J. A. Dean and F. Settle, CBS Publishers and Distributors, New Delhi (2000).
- Instrumental Analysis, Editors, Eds. H. H. Bauer, G. D. Christian and J. E. O'Reilly, 2nd Edn, Allyn and Bacon, Inc., Boston (1991).
- Principles of Instrumental Analysis, 5th Edn, by D. A. Skoog, F. J. Holler and T. A. Nieman. Thomson, Brooks/Cole (2003).


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a

mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online courses:**

https://gtu.ge/AgroLib/Vogels_textbook_of_quantitative_chemical_analysis_5th_ed__-_G_H_Jeffery.MsuCity.pdf
https://media.iupac.org/publications/analytical_compendium/Cha16all.pdf
https://egyankosh.ac.in/bitstream/123456789/43341/1/Unit-13.pdf
https://pubs.acs.org/doi/10.1021/acs.jchemed.7b00361
https://ebooks.inflibnet.ac.in/esp02/chapter/cyclic-voltammetry/

**Semester – X**
**MASTER'S IN CHEMISTRY**

**GENERIC ELECTIVE (GE 10 A)**
**Corrosion, Energy and Polymers**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | redits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| GE: 10A Corrosion, Energy and Polymers | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X Paper: GE 10A** |
| **Subject: Chemistry** | | |
| **Course: GE 10A** | **Course Title: Corrosion, Energy, and Polymers** | |

**Course Outcomes:**
Upon completion of this course, students will:

- Understand corrosion causes, types, and prevention.
- Analyze battery components, operation, and advantages.
- Gain insight into fuel properties and polymer characteristics.

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| **Credits:4** | **Generic Electives 1** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| Unit I | **Corrosion:** Introduction, cause of corrosion, types and mechanism of corrosion, passivity, factors influencing corrosion, protective measure against corrosion. | 15 |
| Unit II | **Batteries:** Primary and secondary batteries, battery component and their role, Characteristics of the battery, Working of the following batteries: | 15 |

| | | |
|---|---|---|
| | Pb storage battery, Li battery, Fuel cell, advantage of fuel cell, Dry cell, Mercury Cell, Solar cell and polymer cell. | |
| **Unit III** | **Fuels:** Introduction, definition and classification of fuels, Characteristics of a good fuel, calorific value, determination of calorific value, Use of coal and its composition, Coal gas, producer gas,and water gas-composition and uses. | **15** |
| **Unit IV** | **Polymers**<br>**Fibers:** Polyamides, Polethylrne terephthalate (PET), Cellulose acetate, Polyvinyls, Acronitriles<br>**Rubbers/ Elastomers:** Natural rubbers, styrene rubber, nitrile rubber<br>**Plastics:** Polyethylene, polyvinyl Chloride, Polyvinyl acetate, Teflon | **15** |

**Recommended Readings:**


- Alexander V. Dimitrov, Introduction to Energy Technologies for Efficient Power Generation, CRC Press
- Charles E. Carraher Jr., Introduction to Polymer Chemistry, CRC Press
- H.A. Kiehne and F. Lampert, Battery Technology Hand book, CRC Press
- Isidor Buchmann, Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers, Cadex Electronics Inc.
- Malcolm P. Stevens, Polymer Chemistry: An Introduction - Oxford University Press
- Manas Chanda and Salil K. Roy, Introduction to Polymer Science and Chemistry: A Problem-Solving Approach - CRC Press
- Pierre Roberge, Corrosion Engineering: Principles and Practice - McGraw Hill Education
- R. Winston Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering – Wiley
- Robert J. Young and Peter A. Lovell, Introduction to Polymers, CRC Press
- Sivakumar Pasupathi, Fuel Cells: Principles, Design, and Analysis, Elsevier


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Semester – X**

**MASTER'S IN CHEMISTRY**

**GENERIC ELECTIVE (GE 10 B)**
**Metallurgy and Inorganic Materials**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| **GE: 10 B Metallurgy and Inorganic Materials** | **4** | **4** | **-** | **-** | **Chemistry in Bachelor of Science** | **-** |

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|---|---|---|
| **MASTER'S IN CHEMISTRY** | | |
| **Programme: Master's in Chemistry** | **Year: V** | **Semester: X**<br>**Paper: GE 10B** |
| **Subject: Chemistry** | | |
| **Course: GE 10 B** | **Course Title: Metallurgy and Inorganic Materials** | |

**Course Outcomes:**
By the end of this course, students will:

- Understand metallurgical processes, from ore extraction to metal refining.
- Analyze and synthesize a variety of inorganic materials, including cement, glass, ceramics, steel, and silicones.

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| **Credits:4** | **Generic Electives** |
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Metallurgy:** Minerals & ore, Crushing of the ore, Concentration of the ore: Gravity separation, Froth Floatation, Leaching, Extraction of Crude metal: Calcinations, Roasting, flux, Smelting. | **20** |
| **Unit II** | **Cement, Glass and Ceramics:**<br>**Cement (Portland Cement):** Composition of cement, manufacture, Setting of cement<br>**Glass:** different type, manufactures, raw material, manufacture of ordinary glass.<br>**Ceramics:** Types, Manufacturing Techniques, and Applications | **15** |
| **Unit III** | **Steel and Paint**<br>**Steel:** Classification of steel, Manufacture of steel, heat treatment of steel<br>**Paints:** Requisities of a good paint, constituents of pigments, white pigments, blue pigment, red pigment, green pigment, black pigment, yellow pigment. | **15** |
| **Unit IV** | **Silicones**: Preparation, calssifiaction of silicones, properties and uses of different type of silicones | **10** |

**Recommended Readings:**


- R. K. Rajput, Material Science and Metallurgy, S. Chand Publishing
- B. V. Raghavaiah, Engineering Materials and Metallurgy, Pearson India Education Services
- V. D. Kodgire, Material Science and Metallurgy, Everest Publishing House
- O. P. Khanna, Material Science and Metallurgy, Dhanpat Rai Publications
- S. L. Kakani, Material Science and Metallurgy, Khanna Publishers
- R. K. Singal, Engineering Materials: Material Science and Metallurgy, Khanna Publishers
- R. Balasubramaniam, Material Science and Metallurgy, Oxford University Press India
- R. Santha Kumar, Materials Science and Metallurgy, Pearson Education India
- N. R. Aravindan, Metallurgical Engineering Materials Science and Metallurgy, McGraw Hill Education India
- V. D. Kodgire, Material Science and Metallurgy, Nirali Prakashan


**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Semester-X**

**MASTER'S IN CHEMISTRY**

**GENERIC ELECTIVES (GE 10C)**
**Environmental Chemistry**

**No. of Hours- 60**

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title | Credits | Credit distribution of the Course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/Practice | | |
| GE: 10C Environmenal Chemistry | 4 | 4 | - | - | Chemistry in Bachelor of Science | - |

| MASTER'S IN CHEMISTRY | | |
|---|---|---|
| **Programme: Master's In Chemistry** | **Year: V** | **Semester: X Paper: GE** |
| **Subject: Chemistry** | | |
| **Course: GE 10C** | **Course Title: Environmental Chemistry** | |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand information regarding the chemical processes taking place in atmosphere, lithosphere, hydrosphere along with the chemistry of to toxic chemical and pollutants.
- State Atmosphere, Lithosphere, Hydrosphere, Biosphere, Acid Rain and ozone layer
- Define Composition of soil, types of soil, Soil Classification Based on Particle Size.
- Understand Control of Soil Erosion and Conservation. Concept of pH and pH measurement.

- Explain Structure and Physiochemical Properties of Water, sources of water.

Explain different types of water purification methods and determination of pH of water.

| **Credits:4** | **Generic Elective 3** |
|---|---|
| **Max. Marks: As per University rules** | **Min. Passing Marks: As per University rules** |

| Unit | Topic | No. of Hours |
|---|---|---|
| **Unit I** | **Introduction to Environmental Chemistry:** Concept and scope of environmental chemistry. Environmental terminology and nomenclatures. Environmental segments. The natural cycles of environment (Hydrological, Oxygen, Nitrogen). | **12** |
| **Unit II** | **Atmosphere and Air Pollution:** Regions of the atmosphere, reactions in atmospheric chemistry, Earth's radiation balance, particles, ion and radicals in the atmosphere. Chemistry of ozone layer. Particulates, aerosols, SOx, NOx, COx and hydrocarbon. Photochemical smog, air-quality standards. | **12** |
| **Unit III** | **Hydrosphere and Water Pollution:** Complexation in natural water and waste-water. Micro-organism in aquatic chemical reactions. Eutrophication. Microbiology mediated redox reactions Water-quality parameters and standards: physical and chemical parameters (colour, odour, taste and turbidity). Dissolved oxygen: BOD, COD. Total organic carbon, nitrogen, sulfur, phosphorus and chlorine. Chemical speciation (Pb, As, Hg).<br>**Lithosphere:** Inorganic and organic components in soil, acid-base and ion-exchange reactions in soil, micro and macro nutrients, nitrogen pathways and NPK in soil. | **25** |
| **Unit IV** | **Chemical Toxicology :** Toxic chemicals in the environments. Impact of toxic chemicals on enzymes. Biochemical effects of arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides and sulphur oxides. | **11** |

**Recommended Readings:**

- Environmental Chemistry A global perspective; Fourth Edition, Gary W. vanLoon and Stephen J. Duffy
- Environmental Chemistry A.K. Day, New Age.

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

**Suggested equivalent online content:**

- https://nptel.ac.in/courses/122/106/122106030/
- https://nptel.ac.in/courses/104/103/104103020/
- https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ce57/
- https://onlinecourses.nptel.ac.in/noc21_ce63/preview
- https://www.vssut.ac.in/lecture_notes/lecture1530778260.pdf
- https://drive.google.com/drive/folders/1FVY2nWBmNohhazw338xUgtEyQVRd1gUJ