National Education Policy-2020

Common Minimum Syllabus for Uttarakhand State Universities and Colleges

FYUP Programme- 7th & 8th Semester

FYUP CHEMISTRY 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
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2.	Dr. Nand Gopal Sahoo	Professor	Chemistry	Kumaun University Nainital
3.	Dr. Geeta Tewari	Professor	Chemistry	Kumaun University Nainital
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5.	Dr. Suhail Javed	Associate Professor	Chemistry	Kumaun University Nainital
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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
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National Education Policy-2020
Common Minimum Syllabus for all Uttarakhand State Universities/ Colleges
SUBJECT: CHEMISTRY

Multidisciplinary Courses of Study [Three Core Disciplines]								
Semester	Core (DSC)	Elective (DSE)	Generic Elective (GE)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Apprenticeship/ 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

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

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

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.

Programme Specific Outcomes (PSOs) (Honours Degree) After this programme the learners will be able to:	
PSO1	Understand the stereochemistry and bonding in main group compounds. Acquire knowledge about substitution reactions and reaction mechanism of octahedral complexes. Understand the electronic spectra of transition metal complexes and cluster compound.
PSO2	Students will acquire practical knowledge about inorganic, organic and physical chemistry experiments.
PSO3	Understand all the concepts of symmetry and group theory. Will also be able to master X-ray and electron diffraction.
PSO4	Understand pericyclic reactions, their classification and mechanism. Also knowledge about basics of photochemistry along with photochemistry of organic compounds would be gained.
PSO5	Learn and appreciate the concepts from basic quantum to advanced quantum chemistry and their applications
PSO6	Gain knowledge about the functions and significance of cell. Master the concepts of mathematical functions, differentiation, integrations and other fundamental mathematics that is involved in chemistry.
PSO7	Understand stereochemistry, reaction intermediate, reaction mechanism and its applications.
PSO8	Acquire knowledge and skills in inorganic, organic synthesis and experimentally verify different adsorption isotherm.
PSO9	Get knowledge of bio inorganic, bioorganic and biophysical chemistry.
PSO10	Understand metal ligand bonding, inorganic polymer chemistry and polymer characterization techniques.
PSO11	Masters the basics of solid-state chemistry. Understand the synthesis and applications of organic solids
PSO12	Acquire knowledge in basic physical and industrial chemistry.
PSO13	Understand the chemical processes taking place in environment and chemistry of toxic chemical and pollutant.

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) 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** **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

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:** **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 of the electronic spectrum of d^1-d^9 octahedral and tetrahedral complexes. Inter-electronic repulsion parameters-Racah parameters (A, B, C),	**15**

	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, Δ_o, β. 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. **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). **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. **Carbenes:** Formation and structure, reactions involving carbenes (Reimer Tiemann reaction). **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, 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 classification, Schonflies symbols, representation of group by matrices (representation for the C_n, C_{nv}, C_{nh} etc. groups to be worked out explicitly),	**6**

	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** **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.

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** (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 (ii) Determination of DO, COD and BOD of water sample. (iii) Determination of organic carbon in soil (iv) Estimation of Na/K/Ca in water/aerated drinks/soil using flame photometer (v) Estimation of alkali content in antacid tablets.	**8**
Unit III	**Organic Chemistry** i. Determination of the percentage of number of hydroxyl groups in an organic compound by acetylation method ii. Estimation of amines/ phenols using bromate-bromide solution/ or acetylation method. iii. Determination of Iodine and Saponification values of an oil sample.	**8**
Unit IV	**Physical Chemistry** (i) Determination of the velocity constant of acid catalyzed hydrolysis of an ester. (ii) Determination of activation energy of a reaction. (iii) Determination of Frequency factor of a reaction by kinetic studies. (iv) Validity of Arrhenius equation. (v) Determination of the effect of change in temperature on rate constant of a reaction. (vi) Determination of the effect of change in concentration of the reactants on rate constant of a reaction.	**8**

	(vii) Determination of the effect of change in concentration of the catalyst on rate constant of a reaction. (viii) Determination of the effect of change in temperature on rate constant of a reaction. (ix) Determination of the effect of change in concentration of the reactants on rate constant of a reaction. (x) Determination of the effect of change in concentration of the catalyst on rate constant of a reaction. (xi) Determination of the effect of change in ionic strength on the rate constant of a reaction. (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 Chemistry	4	4	-	-	Chemistry in Bachelor of Science	-
BACHELOR OF CHEMISTRY WITH HONOURS						

Programme: Bachelor of Chemistry with Honours	Year: IV	Semester: VII 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 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. **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, ambident nucleophile, regioselectivity. Neighbouring group mechanism, neighbouring group participation by π and σ 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. **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.
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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** **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	**7**

	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,	
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. **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 Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
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. **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, 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 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	10

	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	
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** 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** **Paper: DSC 8**
Subject: Chemistry		
Course: DSC 8	**Course Title: Advanced Experimental Chemistry -II**	

Course Outcomes:

The students will able to

- Synthesize various inorganic compounds
- Synthesize organic compounds via two steps. This will include photochemical and enzymatic synthesis of various organic compounds.
- 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: i. $[Ni(dmg)_2]$ ii. $[Cu(NH_3)_4]SO_4.H_2O$ iii. Cis-$K[Cr(C_2O_4)_2(H_2O)_2]$ iv. $Na[Cr(NH_3)_2(SCN)_4]$ v. $[Mn(acac)_3]$ vi. $K_3[Fe(C_2O_4)_3]$ vii. Prussian Blue, Tumbull's Blue	**08**

	viii. $Co[NH_3)_6][Co(NO_2)_6]$ ix. Cis-$[Co(trien)(NO_2)_2]Cl.H_2O$ x. Hg $[Co(SCN)_4]$ xi. $[Co(py)_2Cl_2]$ xii. $[Ni(NH_3)_6]Cl_2$ xiii. $K_3[Cr(C_2O_4)_3].3H_2O$ **(B) Quantitative estimation** of metal ions by complexometric titration, direct and / or back titration, use of masking agents.	
Unit III	**Organic Chemistry** **(I) Green Synthesis** i. Photoreduction of benzophenone to benzopinacol in 2-propanol ii. Conversion of Benzil to Benzilic acid iii. Isomerization of Dimethyl maleate to Dimethyl fumrate **(II) Conventional methods of synthesis** (i)Photochemical synthesis of Benzpinacolonefrom Benzophenone (ii) Beckmann rearrangement: Benzophenenone to Benzanilide (iii)Benzilic acid rearrangement: Benzoin to Benzilic acid (iv) Synthesis of heterocylic compounds:(a) Skraup synthesis: Preparation of quinoline from aniline (v) Fischer indole synthsis: Preparation of 2-phenyl indole from phenylhydrazine. **(III) Enzymatic synthesis** (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. (ii) Biosynthesis of ethanol from sucrose. **(IV) Microwave synthesis** (i) Synthesis using microwaves (ii)Alkylation of diethyl malonate with benzyl chloride (iii) Synthesis using phase transfer catalyst (iv) Alkylation of diethyl malonate or ethylacetoacetate with an alkyl halide. **(V)** Synthesis based on pharmaceutical intermediates /Drugs for eg. Iodex	**08**
Unit IV	**Physical Chemistry:** (i) Validity of Arrhenius equation. (ii) Flowing Clock reactions (Ref. Experiments in Physical Chemistry by Showmaker). (iii) Study of the adsorption of an acid by charcoal. (iv) Validity of Freundlich's Adsorption isotherm. (v) Determination of Partition Coefficients.	**08**

	(vi) Determination of molecular surface energy of a liquid by Stalagmometer method. (vii) Determination of association factor of the given liquid by drop-pipette method.	

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** **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** 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 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 vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzymes A, thiamine pyrophosphate, NAD^+, $NADP^+$, and vitamin B_{12}.	12
Unit IV	**Biophysical Chemistry:** Forces involved in biopolymer interactions.	

	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 and Separation Techniques	**4**	**4**	**-**	**-**	**Chemistry in Bachelor of Science**	**-**

BACHELOR OF CHEMISTRY WITH HONOURS		
Programme: Bachelor of Chemistry with Honours	**Year: IV**	**Semester: VIII** **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**: **(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. **(II)** General Introduction of Electron Diffraction: Scattering intensity vs scattering angle, Wierl equation.	**15**
Unit II	**Chromatographic methods**: I. An lntroduction to Chromatography, Principle, instrumentation and Applications of gas and liquid chromatography, Partition Chromatography, Adsorption Chromatography II. Principle and application of TLC, paper, column and HPLC, Migration Rates of Solutes, and Broadening and Column Efficiency. 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. IV. Gas-Solid Chromatography V. Ion Exchange chromatography: Cationic, anionic exchangers and their applications. VI. Gas Chromatography: Theory of gas chromatography, parts of gas chromatography, Detectors (TCD, FID, ECD).	**20**
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