Paper-1 (Theory)
Course Title: Organic Synthesis A

Programme**:** Degree in Bachelor of Science	Year: Three	**SEMESTER-V**
Subject: Chemistry		
Course Code: B020501T	Course Title: **Organic Synthesis A**	

Course outcomes: Hydrocarbons are the principal constituents of petroleum and natural gas. They serve as fuels and lubricants as well as raw materials for the production of plastics, fibers, rubbers, solvents and industrial chemicals. This course will provide a broad foundation in for the synthesis of hydrocarbons. Hydroxy and carbonyl compounds are industrially important compounds The industries of plastics, fibers, petroleum and rubbers will specially recognize this course. Students will gain an understanding of which are used as solvents and raw material for synthesis of drug and other pharmaceutically important compounds.

- Synthesis and chemical properties of aliphatic and aromatic hydrocarbons
- Synthesis and chemical properties of alcohols, halides carbonyl compounds, carboxylic acids and esters
- How to design and synthesize aliphatic and aromatic hydrocarbons.
- How to convert aliphatic and aromatic hydrocarbons to other industrially important compounds
- Functional group interconversion.

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Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Chemistry of Alkanes and Cycloalkanes** **A) Alkanes** :Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity **B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.	8
II	**Chemistry of Alkenes** Methods of formation of alkenes, Addition to **C=C:** mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic	12

	addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of *E*- and *Z*- alkenes.	
III	**Chemistry of Alkynes** Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non-terminal alkynes.	06
IV	**Aromaticity and Chemistry of Arenes** Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.	10
V	**Chemistry of Alcohols** Classification and nomenclature, Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO_4] and pinacol pinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.	8
VI	**Chemistry of Phenols** : Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman syntheis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction	06
VII	**Chemistry of Ethers and Epoxides**: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.	05
VIII	**Chemistry of Organic Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN^2 and SN^1 reactions with energy profile	05

	diagrams; Polyhalogen compounds : Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.	

Suggested Readings:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley. \
9. Bariyar and Goyal , Organic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://nptel.ac.in/courses/104/106/104106096/

This course is compulsory for the students of following subjects: Chemistry in 12th Class

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, among others .

Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the . (Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper

Suggested equivalent online courses:
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Further Suggestions:
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Paper-2
Course Title: Rearrangements and Chemistry of Group Elements

Programme: Degree in Bachelor of Science	Year: Three	**SEMESTER-V**
Subject: Chemistry		
Course Code: B020502T	**Course Title: Rearrangements and Chemistry of Group Elements**	

Course outcomes: This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- This paper also provides a detailed knowledge on the elements present in our surroundings, their occurrence in nature. Their position in periodic table, their physical and chemical properties as well as their extraction. This paper also gives detailed understanding of the s, p, d and f block elements and their characteristics.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Rearrangements** A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, BenzilBensilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement	6
II	**Catalysis** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.	8
III	**Chemistry of Main Group Elements**	10

	s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements**: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gasses**: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.	
IV	**Chemistry of Transition Elements** **Chemistry of Elements of First Transition Series** -Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series-** General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.	06
V	**Chemistry of Lanthanides** Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.	4
VI	**Chemistry of Actinides** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.	4
VII	**Metal Carbonyls** Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclea carbonyls.	6
VIII	**Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with special reference to heamoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} . Nitrogen fixation.	6

Suggested Readings:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.

7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
10. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006
11. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
12. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
13. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
14. Francis**, P. G.** Mathematics for Chemists, Springer, 1984
15. Prakash Satya,Tuli G.D.,Basu S.K.Madan R.D.,Advanced inorganic Chemistry,S.Chand publishing.
16. Bariyar and Goyal , Inorganic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

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, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the . (Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper

Suggested equivalent online courses:
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Further Suggestions:
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Paper-3 (Practical)
Course Title: Qualitative Analysis

Programme: Degree in Bachelor of Science	Year: Three	**SEMESTER-V**
Subject: Chemistry		
Course Code: B020503P	**Course Title: Qualitative Analysis**	

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 mixtures and organic compounds.

- Identification of acidic and basic radicals in inorganic mixtures
- Separation of organic compounds from mixture
- Elemental analysis in organic compounds
- Identification of functional group in organic compounds
- Identification of organic compound

Credits: 2	Elective
Max. Marks: 25+75	Min. Passing Marks:

Practical **60 h**

Unit	Topics	No of lectures
I	**Inorganic Qualitative Analysis** Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3	**16**
II	**Elemental analysis and identification of functional groups** Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.	**14**
III	**Separation of Organic Mixture** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives	**18**
IV	**Identification of organic compounds** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.	**12**

Suggested Readings:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

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

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-V Theory Ppaer-1 &2

Suggested equivalent online courses:

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Further Suggestions:

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