

Semester-VI Paper-1
Course Title: Organic Synthesis B

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Paper-1 Theory Compulsory Subject: Chemistry		
Course Code:B020601T	Course Title: Organic Synthesis B	

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. The study of natural products and heterocyclic compounds offers an excellent strategy toward identifying novel biological probes for a number of diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a number of diseases including cancer and infection.

- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- Learn the different types of alkaloids, & terpenes etc and their chemistry and medicinal importance.
- Explain the importance of natural compounds as lead molecules for new drug discovery.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures- = 60	

Unit	Topics	No. of Lecture s
I	Reagents In Organic Synthesis A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO ₂ , mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with NaBH ₄ , LiAlH ₄ , Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H	6

II	Organometallic Compounds -Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.	4
III	Chemistry of Aldehydes and ketones: Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH_4 and NaBH_4 reductions. Halogenation of enolizable ketones An introduction to α , β unsaturated aldehydes and Ketones.	10
IV	Carboxylic acids and their Functional Derivatives Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.	8
V	Organic Synthesis via Enolates Acidity of α -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.	5
VI	Organic Compounds of Nitrogen - Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic	10

(v)

	substituton in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling	
VII	Heterocyclic Chemistry Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline	10
VIII	Natural Products Alkaloids & Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.	7

Suggested Readings:

17. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
19. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
20. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
21. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
22. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
23. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
24. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
25. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Wiley & Sons (1976).
26. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
27. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
29. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Pragati Prakashan (2010).
30. Organic Chemistry III, Krishna Prakashan Media, Meerut, Third Edition, 2019
31. Mukherji and Singh, Reaction Mechanism in Organic Chemistry, Laxmi Publications, 2016
32. Mukherji, Singh, Kapoor, Organic Chemistry, Vol 1,2, and 3, New Age International 2014
33. Arun Bahl & B S Bahl, Advanced Organic Chemistry, S. Chand Publishing
34. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC ANALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

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://nptel.ac.in/courses/104/103/104103111/>
- <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/introl.htm>
- <https://nptel.ac.in/courses/104/103/104103071/#>
- <https://swayam.gov.in/>

This course 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 semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have Passed Sem-V Theory paper-1	
Suggested equivalent online courses:	
Further Suggestions:	

Semester-VI Paper-2

Programme: Degree in Bachelor of Science		Year: Three	Semester: VI		
Paper-2 Theory		Elective Subject: Chemistry			
Course Code: B020602T	Course Title: Chemical Energetics and Radio Chemistry				
Course outcomes: Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electro chemistry ,ionic equilibrium applications of conductivity and potentiometric measurements					
Credits: 4		Elective			
Max. Marks: 25+75		Min. Passing Marks:			
Total No. of Lectures- = 60					

II	Thermodynamics II Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality , entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T. Third Law of Thermodynamics ; Nernst heat theorem , statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications .	10
III	Electrochemistry: Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law , Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations . Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only) . Transport number, definition and determination by Hittorf method and moving boundary method.	8
IV	Ionic Equilibrium: Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells-Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definition of pH and pKa , determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hassel equation, application of buffer solution. Hydrolysis of salts	10
V	Photo Chemistry: Interaction of radiation with matter, difference between thermal and photochemical processes . Laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.	04

VI	Colligative Properties -Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.	6
VII	Surface Chemistry Adsorption. Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); Colloids :Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation	07
VIII	Radiochemistry Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-99mTc radiopharmaceuticals	07

Suggested Readings:

1. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.
2. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
3. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
4. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
7. Allen Bard, J Larry . Faulkner R ,Fundamentals of Electrochemical methods –fundamentals and applications ,new York John ,Wiley & sons , 2001
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th ed., New Age International, New Delhi, 1995.
9. Bariyar, and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut , Third Edition, 2019
10. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND
11. KL KAPOOR, THERMODYNAMICS AND CHEMICAL EQUILIBRIUM VOL-2, Macmillan
12. Bahl and Bahl, Essential of physical chemstry, S CHAND

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://swayam.gov.in/>

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

<https://www.mooc-list.com/tags/physical-chemistry>

<https://www.openlearning.com/courses/introduction-to-physical-chemistry/>

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 semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12th, Physics in 12th

Suggested equivalent online courses:

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Further Suggestions:

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Semester VI, Paper-3 (Practical)
Course Title: Analytical Methods

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Practical paper-3 Subject: Chemistry		
Course Code: B020603P	Course Title: Analytical Methods	
<p>Course Outcomes: Upon successful completion of this course students should be able to quantify the product obtained through gravimetric method; determination of R_f values and identification of organic compounds through paper and thin layer chromatography laboratory techniques; perform thermo chemical reactions</p>		
Credits: 2	Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Practical 60 h		
Unit	Topics	No of Lectures
I	Gravimetric Analysis 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni (dimethylglyoxime) 3. Analysis of Ba as BaSO ₄ .	30
II	Paper Chromatography Ascending and Circular. Determination of R_f values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L – alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent	8

	- ninhydrin. Separation of monosaccharides – a mixture of D- galactose and D -fructose using n- butanol: acetone: water (4:5:1). Spray reagent – aniline hydrogen phthalate			
III	Thin Layer Chromatography Determination of R_f values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)	8		
IV	Thermochemistry 1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process 2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base 3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle	14		
Suggested Readings:				
1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010). 2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988) 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 6. 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:				
<i>Viva voce</i>	(10 marks)			
Mock test	(10 marks)			
Overall performance	(05marks)			
Course prerequisites: To study this course, a student must have had the chemistry in 12th class				
Suggested equivalent online courses:				
Further Suggestions:				