Dr. Homi Bhabha State University

The Institute of Science
Mumbai

SEM III and SEM IV
Syllabus 2021-22

MSc. Organic Chemistry

Dr.HomiBhabha State University, Mumbai

Proposed Draft Syllabus for M.Sc. Organic Chemistry

Choice Based Credit System

(To be implemented from the academic year (2020-2021)

	M.Sc. Semester III Organic Chemistry		
1	Course Code:**MSCHCC305T**	Course Title: **Synthetic Organic Chemistry I**	
	Course Credit: **4**	Total contact hours: **60 Hrs**	
Sr.No.	**Course Contents (Topics and subtopics)**		**Reqd. hours.**
	Unit 1: Name reactions with mechanism and application		**15 Hrs**
1.1	Mukaiyama esterification, Mitsunobu reaction, Baylis Hillman reaction, Suzuki coupling, Wacker process, Heck reaction, Sonogashira reaction.		**7 Hrs**
1.2	Multicomponent reactions: Strecker synthesis, Hantszch pyridine synthesis, Biginelli synthesis, Multicomponent reactions using alkyl isocyanides: Passerini and Ugi-4-component synthesis.		**6 Hrs**
1.3	Domino/cascade reactions: Introduction with one example.		**2 Hrs**
	Unit 2: Protection-deprotection, umpolung and electro-organic chemistry		**15 Hrs**
2.1	Protection and deprotection of the following functional groups: hydroxyl, carbonyl, amino and carboxyl with applications.		**5 Hrs**
2.2	Concept of umpolung, generation of acyl anion equivalent using 1,3-dithianes, methyl thiomethylsulfoxides, cyanide ions, cyanohydrin ethers, nitro compounds and vinylated ethers.		**5 Hrs**
2.3	Electro-organic chemistry: Introduction, electrode potential, cell parameters, electrolyte, working electrode, choice of solvents, supporting electrolytes. Cathodic reductions of alkyl halides, aldehydes, ketones, nitro compounds, olefins, arenes; electro-dimerizations. Anodic oxidation: Kolbe type reactions, oxidation of alkylbenzenes.		**5 Hrs**
	Unit 3: Enamines and Ylides		**15 Hrs**
3.1	Methods of preparation of enamines: condensation of secondary amine and aldehyde or ketone, reaction between alkynes and secondary amines. Comparison of reactivity of enamines and enolates. Synthetic reactions of enamines including asymmetric reactions of chiral enamines derived from chiral secondary amines.		**4 Hrs**
3.2	Phosphorus, Sulfur and Nitrogen Ylides: Preparation, structure and comparison of reactivity. Reactions of phosphorus,sulfur and nitrogen ylides with carbonyl compounds, including mechanism and stereochemistry. Wittig reaction, Wittig-Horner reaction.		**5 Hrs**
3.3	α C-H activation by nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases (LDA/n-butyl lithium) and applications in C-C bond formation. Bamford-Stevens Reaction, Julia olefination and its modification, Bestmann-Ohira Reagent, Barton-Kellogg olefination, Steven's rearrangement.		**6 Hrs**
	Unit 4: Metals / Nonmetals in organic synthesis		**15 Hrs**
4.1	Mercury in organic synthesis: oxymercuration and demercuration of alkenes, mechanism and regiochemistry, solvomercuration, mercuration of aromatics and transformation of aryl- mercurials to aryl halides.		**2 Hrs**
4.2	Organoboron compounds: applications of organo-boranes, generation of		**3 Hrs**

	diboranes, hydroboration of alkenes and alkynes: mechanism, regiochemistry, stereochemistry, asymmetric hydroboration using chiral boron reagents and functional group reduction by diborane.	
4.3	Organosilicons: Important features of silicon governing the reactivity of C-Si compounds: preparation and important bond forming reactions of alkyl silanes, alkenylsilanes, aryl silanes and allylsilanes. β-silylcations as intermediates.	**3 Hrs**
4.4	Silylenol ethers as enolate precursors, iodotrimethylsilane in organic synthesis.	**2 Hrs**
4.5	Organotin compounds: preparation of alkenyl and allyl tin compounds and their applications in C-C bond formation.	**3 Hrs**
4.6	Selenium in organic synthesis: Preparation of selenols/selenoxide, selenoxide elimination to create unsaturation, selenoxide and selenoacetals as α- C-H activating groups.	**2 Hrs**
	Suggested Readings: 1. Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag 2. Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004. 3. Organic Chemistry, ClaydenGreeves Warren and Wothers, Oxford Press (2001). 4. Moder Organic Synthesis: An Introduction, G.S. Zweifel and M.H. Nantz, W.H. Freeman and Company, (2007). 5. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Academic Press (2002). 6. Principles of Organic Synthesis, R.O.C. Norman & J. M. Coxon, 3rd Edn., Nelson Thornes 7. Organic Chemistry,7thEdn, R.T.Morrison, R. N. Boyd, & S. K. Bhattacharjee, Pearson 8. Strategic Applications of Name Reactions in Organic Synthesis,L. Kurti& B. Czako (2005), Elsevier Academic Press 9. Advanced Organic Chemistry: Reactions & Mechanisms, 2nd Edn., B. Miller & R. Prasad, Pearson 10. Organic reactions and their mechanisms, 3rd revisededition, P.S. Kalsi, New Age International Publishers 11. Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley & Sons, 2004 12. Name Reactions and Reagents in Organic Synthesis, 2nd Edn., Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience 13. Name Reactions, Jie Jack Lie, 3rd Edn., Springer 14. Organic Electrochemistry, H. Lund, and M. Baizer, 3rd Edn.,Marcel Dekker.	

Eg.MSCHCC305T; MS (Masters) CH(Chemistry) CC (Core Course)305(SEM III) T (Theory)

2	CourseCode: **MSCHCC306T**	Course Title: **Theoretical Organic Chemistry**
	Course Credit: **4**	Total contact hours: **60 Hrs**
Sr.No.	**Course Contents (Topics and subtopics)**	
	Unit 1: Physical Organic Chemistry	
1.1	Structural effects and reactivity: Linear free energy relationship (LFER) in determination of organic reaction mechanism, The Hammett equation, substituent constants, theories of substituent effects, interpretation of σ-values, reaction constants ρ, Yukawa-Tsuno equation.	
1.2	Uses of Hammett equation, deviations from Hammett equation. Dual parameter correlations, Inductive substituent constants. The Taft model, σI and σR scales, steric parameters Es and β. Solvent effects, Okamoto-Brown equation, Swain-Scott equation, Edward and Ritchie correlations, Grunwald-Winstein equation, Dimroth's ET parameter.	
	Unit 2: Organic reaction mechanisms	
2.1	Organic reactive intermediates, methods of generation, structure, stability and important reactions involving carbocations, nitrenes, carbenes, arynes and ketenes.	
2.2	Neighbouring group participation: Mechanism and effects of anchimericassistance, NGP by unshared/ lone pair electrons, π-electrons, aromatic rings, σ-bonds with special reference to bornyl and norbornyl systems (formation of non-classical carbocation) Role of FMOs in organic reactivity: Reactions involving hard and soft electrophiles and nucleophiles, ambident nucleophiles, ambident electrophiles, the α effect.	
2.3	Pericyclic reactions: Classification of pericyclic reactions; thermal and photochemical reactions. Three approaches: Conservation of orbital symmetry - Correlation diagram, Frontier molecular orbital approach [FMO] and Aromatic transition state approach [Huckel and Mobius].	
	Unit 3: Pericyclic reactions	
3.1	Cycloaddition reactions: 4nπ and (4n+2)π electron systems. Diels-Alder reactions, 1, 3-Dipolar cycloaddition and cheletropic reactions, ene reaction, retro-Diels-Alder reaction, regioselectivity, periselectivity, site selectivity and effect of substituents in Diels-Alder reactions	
3.2	Electrocyclic reactions: Conrotatory and disrotatary motions, 4nπ and (4n+2)π electron systems.	
3.3	Sigmatropic rearrangements: H-shifts and C-shifts, supra and antarafacial migrations, retention and inversion of configurations. Cope (including oxy-Cope and aza-Cope) and Claisen rearrangements. Formation of Vitamin D from 7-dehydrocholestrol, synthesis of citral using pericyclic reaction.	
	Unit 4: : Photochemistry	
4.1	Principles of photochemistry: quantum yield, electronic states and transitions, selection rules, modes of dissipation of energy (Jablonski diagram), electronic energy transfer: photosensitization and quenching process.	
4.2	Photochemistry of carbonyl compounds: $\pi^{\acute{}}\pi^*$, $n^{\acute{}}\pi^*$ transitions, Norrish-I and Norrish-II cleavages, Paterno-Buchi reaction. Photoreduction, calculation of quantum yield, photochemistry of enones, photochemical rearrangements of α, β-unsaturated ketones and cyclohexadienones. Photo Fries rearrangement, Barton reaction.	
4.3	Photochemistry of olefins: cis-trans isomerizations, dimerizations, hydrogen abstraction, addition and Di- π- methane rearrangement including aza-di- π -methane. Photochemistry of arenes: 1, 2- , 1, 3- and 1, 4- additions. Singlet oxygen and photooxygenation reactions.	
	Suggested Readings: 1. March's Advanced Organic Chemistry, Jerry March, sixth edition,2007, John Wiley and sons. 2. A guide to mechanism in Organic Chemistry, 6th edition, 2009,	

Peter Sykes, Pearson education, New Delhi.
3. Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002).
4. Mechanism and theory in Organic Chemistry, T. H. Lowry and K.C. Richardson, Harper and Row.
5. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication.
6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P. Singh, Macmillan Publishers, India.
7. Organic Chemistry, Part A and B, Fifth edition,2007, Francis A. Carey and Richard J. Sundberg, Springer.
8. Carbenes, Nitrenes and Arynes. Von T. L. Gilchrist, C. W. Rees. Th.Nelson and Sons Ltd., London 1969.
9. Organic reactive intermediates, Samuel P. MacManus, Academic Press.
10. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press (2001).
11. Organic Chemistry, Seventh Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.Advanced Organic Chemistry: Reactions & Mechanisms, second edition, B. Miller and R. Prasad, Pearson.
12. Organic reactions & their mechanisms, third revised edition, P.S. Kalsi, New Age International Publishers.
13. Organic Chemistry: Structure and Function, P. Volhardt and N. Schore, 5th Edition, 2012
14. Organic Chemistry, W. G. Solomons, C. B. Fryhle, , 9th Edition, Wiley India Pvt. Ltd.,2009.
15. Pericyclic Reactions, S. Sankararaman, Wiley VCH, 2005.
16. Advanced organic chemistry, Jagdamba Singh L. D. S. Yadav, PragatiPrakashan, 2011
17. Pericyclic reactions, Ian Fleming, Oxford university press, 1999.
18. Pericyclic reactions-A mechanistic approach, S. M. Mukherji, Macmillan Co. of India 1979.
19. Organic chemistry, 8th edition, John McMurry
20. Modern methods of Organic Synthesis, 4th Edition W. Carruthers and Iain Coldham, Cambridge University Press 2004
21. Modern physical chemistry, Eric V Anslyn, Dennis A. Dougherty, University science books,2006
22. Physical Organic Chemistry, N. S. Isaacs, ELBS/Longman
23. Stereochemistry of Carbon Compounds: Principles and Applications, D, Nasipuri, 3rd edition, New Age International Ltd.
24. Stereochemistry of Organic Compounds, Ernest L. Eliel and Samuel H. Wilen, Wiley-India edit
25. Stereochemistry, P. S. Kalsi, 4th edition, New Age International Ltd
26. Organic Stereochemistry, M. J. T. Robinson, Oxford University Press, New Delhi, India edition, 2005
27. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
28. Supramolecular Chemistry; Concepts and Perspectives, J. M. Lehn,VCH.
29. Crown ethers and analogous compounds, M. Hiraoka, Elsevier, 1992.

	30. Large ring compounds, J.A.Semlyen, Wiley-VCH, 1997. 31. Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wiley- Eastern 32. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publication. 33. Molecular Photochemistry, N. J. Turro, W. A. Benjamin. 34. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill 35. Photochemistry, R. P. Kundall and A. Gilbert, Thomson Nelson. 36. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press. 37. Molecular Orbitals and Organic Chemical Reactions by Ian Fleming (Wiley – A john Wiley and Sons, Ltd., Publication)

Eg.MSCHCC306T; MS(Masters) CH (Chemistry) CC (Core Course)306(SEM III) T (Theory)

3	Course Code: **MSCHDE305T**	Course Title: **Stereochemistry of Organic Compounds**	
	Course Credit: **4**	Total contact hours: **60 Hrs**	
Sr.No.	**Course Contents (Topics and subtopics)**		**Reqd. hours.**
	Unit 1: Stereochemistry-I		**15 Hrs**
1.1	Introduction and stereoselective and stereospecific reactions. Enantioselective synthesis (chiral approach) reactions with hydride donors, hydroboration, catalytic hydrogenation via chiral hydrazones and oxazolines. Sharplessepoxidation. Diels Alder selective synthesisStereoisomerism and determination of configuration Stability of rings and ease of rings formation)Shapes of five, six, and seven membered rings. Conformational effects in medium sized rings, Concept of I strain.Classification of point groups based on symmetry elements with examples (non- mathematical treatment)		**7Hrs**
1.2	Conformational analysis of medium rings: Eight and ten membered rings and their unusual properties, I-strain, transannular reactions		**4Hrs**
1.3	Stereochemistry of fused ring and bridged ring compounds: decalins, hydrindanes, steroids,Allenes, Spiranes and Biphenyls andBredt's rule.		**4Hrs**
	Unit 2: Dynamic stereochemistry		**15 Hrs**
2.1	Selection of substrate, Curtin-Hammett principle, Effect of conformation on reactivity of cyclohexane derivatives in the following reactions (including mechanism): electrophilic addition, nucleophilic substitution, elimination, molecular rearrangements, reduction of cyclohexanones and oxidation of cyclohexanols.		**10 Hrs**
2.2	Racemisation and resolution: Mechanism of racemisation, methods of resolution: chemical, kinetic and equilibrium asymmetric transformation and through inclusion compounds.		**5 Hrs**
	Unit 3: Stereochemistry- II		**15 Hrs**
3.1	Determination of enantiomer and diastereomer composition: Isotope dilution method, enzymatic method, chromatographic methods. Methods based on NMR spectroscopy: use of chiral derivatising agents (CDA), chiral solvating agents (CSA) and Lanthanide shift reagents (LSR).		**8 Hrs**
3.2	Correlative methods for configurational assignment: chemical, optical rotation, quasi-racemate and NMR spectroscopy.		**2 Hrs**
3.3	Molecular dissymmetry and chiroptical properties: Linearly and circularly polarized light. Circular birefringence and circular dichroism. ORD and CD curves. Cotton effect and its applications. The octant rule and the axial α–haloketone rule with applications.		**5 Hrs**
	Unit 4: Stereoselectivity		**15Hrs**
4.1	Stereochemical control in six membered rings. Reactions on small rings. Distereoselectivity: Prochirality. Additions to carbonyl groups. Stereoselective reactions of acyclic alkene. Single enantiomers from diastereoselective reactions. Use of chiral auxiliaries in diastereoselective reductions, asymmetric amplification.		**7 Hrs**
4.2	Principles of asymmetric synthesis: Introduction, the chiral pool in Nature, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions. Asymmetric synthesis:Chiral auxiliaries. Asymmetric formation of carbon-carbon bonds. Asymmetric aldol reactions. Use of chiral BINOLs, BINAPs and chiral oxazolines asymmetric transformations.		**8Hrs**
	Suggested Readings: 1.E.L. Eliel : Stereochemistry of carbon compounds 2.D. Nasipuri : Stereochemistry of organic compounds 3.P.S. Kalsi: Stereochemistry: conformation and Mechanism.		

	4.Eliel, Allinger, Angyal and Morrison : Conformational analysis 5.Hallas: Organic stereochemistry 6.Mislow and Benjamin: Introduction to stereochemistry. 7.H. Kagan : Organic stereochemistry. 8. Carl Djerassi ; Optical rotatory dispersion. 9.P. Crabbe : Optical rotatory dispersion and C.D.	

Eg.MSCHDE305T; MS (Masters) CH (Chemistry) ,DE(Discipline Specific) 305 (SEM III) T (Theory)

4	Course Code:**MSCHDE306T**	Course Title: **Heterocyclic Chemistry**	
	Course Credit: **4**	Total contact hours: **60 Hrs**	
Sr.No.	**Course Contents (Topics and subtopics)**		**Reqd. hours.**
	Unit 1: Heterocyclic compounds-I		**15 Hrs**
1.1	Heterocyclic compounds: Introduction, classification, common, systematic (Hantzsch- Widman) and replacement nomenclature of monocyclic (3-6 membered) and bicyclic (5-6 Membered) fused heterocycles (up to three hetero atoms).		**7 Hrs**
1.2	Small ring heterocycles (3-4 membered): Introduction, nucleophilic ring opening reactions of oxiranes, aziridines, oxetanes and azetidines.		**8 Hrs**
	Unit 2:Heterocyclic Compounds -II		**15 Hrs**
2.1	Reactivity and important methods of synthesis and general reactions of the following heterocycles: pyrazoles, imidazoles, oxazoles, isoxazoles, thiazoles, benzimidazoles, benzoxazoles, benzothiazoles. Synthesis of chloroquine, papavarine, amlodipine, bromouidine, ranitidine, Vit-B6, tryptophan, thiamine, histidine.		
	Unit 3: Heterocyclic compounds-III		**15 Hrs**
3.1	Reactivity, important methods of synthesis and general reactions of the following heterocycles: pyridines, pyridine-N-oxide, pyridazines, pyrimidines, pyrazines, s-triazines, quinolines, isoquinolines, indoles, purines, oxazines, coumarins.		
	Unit 4: Heterocyclics with more than two hetero atoms		**15 Hrs**
4.1	Synthesis, reactivity, aromatic character and importance of the following Heterocycles: 1,2,3-triazoies,1,2,4-triazoles, Tetrazoles, 1,2,4-oxadiazole, 1 ,3,4-oxadiazole, 1,2,5- oxadiazole, 1,2,3-thiadiazoles, 1,3,4- thiadiazoles, 1,2,5-thiadiazoles, 1,2,3-triazine, 1,2,4- triazine, 1,3,5-triazine, tetrazines. Synthesis and importance of purines and pteridines. Syntheis of Caffeine,		
	Suggested Readings: 1. Heterocyclic Chemistry, T.Gilchrist 2. An introduction to the Chemistry of heterocyclic compounds, R.M.Acheson 3. Heterocyclic Chemistry, J.A.Joule&K.Mills 4. Principles of Modern Heterocyclie Chemistry, A.Paquette 5. Heterocyclic Chemistry, J,A.Joule& Smith 6. Handbook of Heterocyclic Chemistry, A.R.Katritzky 7. The aromaticity III level, units 17-19 British open university volumes 8. Aromatic character and aromaticity by G.M.Badger 9. Non-benzenoid aromatic compounds by D.Ginsberg 10. Nonbenzenoid compounds by L. loy		

Eg. MSCHDE306T; MS (Masters) CH(Chemistry) DE (Discipline specific)306(SEM III)

	Course Code: **MSCHGE301T**	Course Title : **Research Methodology**	
	Course Credit:**2**	Total contact hours: **30 Hrs**	
Sr. No.	**Course Contents(Topics and subtopics)**		**Reqd. hours.**
	UNITI: Sources of Information		**15Hrs**
1.1	**Primary, Secondary and Tertiary sources.**		05Hrs
1.2	**Journals:** Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text- books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.		05Hrs
1.3	**Digital:** Websources,E-journals, Journal access, TO Calerts, Hotarticles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar,Chem Industry,Wiki-databases, Chem Spider, Science Direct, Sci Finder, Scopus.		05Hrs
	UNIT II: Methods Of Scientific Research and Writing Scientific Papers		**15hrs**
2.1	Information Technology and Library Resources: The Internet and World wide web, Internet resources for Chemistry, finding and citing published information. Shodhganga-a reservoir of Indian theses : Directory of open Access Journals.		**5hrs**
2.2	Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation.		**5hrs**
2.3	**Writing Scientific Papers:** Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics. **Plagiarism:** Definition of Plagiarism, Types of Plagiarism with examples, strategies to a void plagiarism, case studies (any one)		**5hrs**
	Course Outcome: 1) Students will earn to communication related to Science. 2) Awareness interminology related to Research. 3) Students will earn, to write and present Research Article.		
	REFERENCES		

1. Dean, J. R., Jones, A.M., Holmes, D., Reed,R., Weyers, J., & Jones, A.,(2011),*Practical skills in Chemistry*,2nd Ed., Prentice Hall, Harlow.
2. Hibbert, D. B. & Gooding,J. J.(2006) *Data Analysis for Chemistry*

	Oxford University Press. 3. Topping, J.,(1984) *Errors of Observation and their Treatment* 4th Ed., Chapman Hill, London. 4. Harris, D. C. (2007) *Quantative Chemical Analysis* 6thEd., Freeman Chapters 3-5 5. Levie, R. De. (2001) *Howtouse Excelin Analytical Chemistry and in general scientific data analysis* Cambridge Universty Press. 6. Research methodology techniques and methods by C	

MSCHGE302T: MS(Masters), CH(Chemistry), AE(General Elective), 302(SEM III), T(Theory)

5	Course Code: **MSCHAE301T**	Course Title: Pharmaceutical Development and Management	
	Course Credit: **2**	Total contact hours: 30Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
	UNIT I		**15 Hrs**
1.1	Understanding of Pharmaceutical Industry: What drives the pharmaceutical industry, Subsections of Pharmaceutical industry		
1.2	The Pharmaceutical Products: Drug Development and the Marketing ResearchInterface;Diversification and Specialisation; Marketing Generic Drugs; Non-prescription drugs.		
1.2	Competitive Practices: Economic and Competitive Aspects of the PharmaceuticalIndustry. Advertising; Detailing and other forms of Promotion; Retail Competition – The Community Level; International Marketing.		
1.3	Validation Process: Selectivity , Linearity, Accuracy, Precision		
	UNIT II		**15 Hrs**
2.1	Six sigma in Pharmaceutical Manufacturing Industry • How does Six Sigma work? • Six Sigma Customer Benefits • Build quality in Pharmaceutical Manufacturing Process through Six Sigma Introduction to Kaizen Concept		
2.2	Quality by Design (QbD) : Why QbD, The characteristics of a successful QbD program, The Role of Quality Risk Management in QbD .		
2.3	Review of GLP and GMP and their regulations for analytical labs		
	Suggested readings		
1	Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J. HollerHolt- Saunders 6th Edition (1992)		
2	Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann ,5th Edition (1998)		
3	Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. Settle Jr 6thEd CBS (1986)		
4	Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saonders, College publication.		
	Course Outcome :		
1	Students will get insight of the management terms used in Pharma industry.		
2	Students will get introduced to Pharmaceutical Legislation		

M. Sc. Semester III Organic Chemistry Practicals

Course Code:**MSCHLB305P**	Course Title**: Separation of a ternary mixture using micro-scale technique**
Course Credit: **2**	**Total contact hours: 60 Hrs**

Course Contents (Topics and subtopics)

Separation of a ternary mixture of organic compounds and identification including derivative preparations using micro-scale technique

1. Separation of a ternary mixture (S-S-S, S-S-L, S-L-L and L-L-L) (for solid mixture: water insoluble/ soluble including carbohydrates) based upon differences in the physical and the chemical properties of the components.
2. Purification of the three components, measurement of their mass and determination of their physical constants.
3. Calculation of percentage yield of the individual components. (Identification of the components is not expected).
4. Preparation of derivatives (any one of separated compound).

(Minimum 8 experiments)

Course Code:**MSCHLB305P**	Course Title**: Organic preparations (1.0 g scale)**
Course Credit: **2**	Total contact hours**: 60 Hrs**

Course Contents (Topics and subtopics)

Single step organic preparation (1.0 g scale) involving purification by Steam distillation / Vacuum distillation or Column chromatography.

1. Preparation of acetanilide from aniline and acetic acid using Zn dust.
2. Preparation of 1-nitronaphthalene from naphthalene.
3. Preparation of acetyl ferrocene from ferrocene. (Purification by column chromatography)
4. Preparation of 3-nitroaniline from 1,3-dinitrobenzene. (Purification by column chromatography)
5. Preparation of benzyl alcohol from benzaldehyde. (Purification by vacuum distillation).
6. Preparation of methyl salicylate from salicylic acid. (Purification by vacuum distillation).
7. Preparation of 4-methylacetophenone from toluene. (Purification by vacuum distillation).
8. Preparation of phenyl acetate from phenol. (Purification by vacuum distillation)
9. Preparation of 2-chlorotoluene from o-toluidine. (Purification by steam distillation)
10. Preparation of 4-nitrophenol from phenol. (Purification by steam distillation/ column chromatography)
11. Preparation of fluorenone from fluorene. (Purification by column chromatography)
12. Preparation of dimethylphthalate from phthalic anhydride. (Purification by vacuum distillation)

(Minimum 8 experiments)

Learning points:

1. Students are expected to know

(i) the planning of synthesis, effect of reaction parameters including stoichiometry, and safety

aspects including MSDS
(ii) the possible mechanism, expected spectral data (IR and NMR) of the starting material and final product.
2. Students are expected to purify the product by Steam distillation / Vacuum distillation or Column chromatography, measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield.

MSCHLB305P: MS(Masters), CH(Chemistry), LB(Laboratory), 305(SEM III), P(Practical)

Course Code:**MSCHLB306P**	Course Title: **Isolation / Estimation of natural products /Drugs**
Course Credit: **2**	Total contact hours: **60 Hrs**

Course Contents (Topics and subtopics)

Section A: Estimation of Natural Products(**Minimum 4 experiments)**

1. Extraction of clove oil from cloves.
2. Extraction of nicotine dipicrate from tobacco.
3. Estimation of proteins by Biuret method using spectrophotometer.
4. Estimation of glucose by Folin Wu method.
5. Estimation of citral using hydroxylamine hydrochloride.
6. Estimation of saponification value of oil.

Section B: Estimation of drugs **(Minimum 4 experiments)**

1. Estimation of penicillin by iodometric titrations.
2. Estimation of streptomycin using uv-visible spectrophotometer.
3. Estimation of paracetamol by hydrolysis
4. Estimation of aspirin in the given tablet using uv-visible spectrophotometer.
5. Estimation of diazepam by non-aqueous titrations.
6. Estimation of vitamin C by iodometric titrations.

Course Code:**MSCHLB306P**	Course Title: **Techniques of purification and green methods of synthesis**
Course Credit: **2**	Total contact hours: **60 Hrs**

Course Contents (Topics and subtopics)

Set I: Techniques of purification:

1. Steam distillation
2. Vacuum distillation
3. Column chromatography

Set II: Green methods of synthesis (microwave induced)

1. Synthesis of Schiff's base from aniline and p-anisaldehyde in the presence of lime juice
2. Synthesis of coumarin by Knoevenagel reaction using salicylaldehyde, and ethyl acetate in presence of a base.
3. Synthesis of dihydropyrimidones- Biginelli reaction: acid-catalyzedthree component reaction between vanillin, ethyl acetoacetate and thiourea.
4. Synthesis of acetanilide from aniline.

Learning points:

Set I: Techniques of purification

1. Students are expected to perform a purification technique using a known mass or volume of the given substance.
2. Check the purity of the purified compound by TLC, measure its mass and physical constant.

Set II: Green methods of synthesis (Microwave induced)

Students are expected to purify the product by recrystallization,measure its mass, determine physical constant and calculate percentage yield.

1. **The candidate is expected to submit a journal and project certified by the Head of**

the Department /institution at the time of the practical examination.

2. **A candidate will not be allowed to appear for the practical examination unless he/she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate.**
3. **Use of non-programmable calculator is allowed both at the theory and the practical examination.**

Suggested Readings:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V. K. Ahluwalia and RenuAggarwal, Universities Press India Ltd., 2000
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications
4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall
7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., 2011.

MSCHLB306P: MS(Masters), CH(Chemistry), LB(Laboratory), 306(SEM III), P(Practical)

Dr. HomiBhabha State University

The Institute of Science
Mumbai

SEM IV
Syllabus 2021-
2022

MSc. Organic Chemistry

	M.Sc. Semester IV Organic Chemistry		
1	Course Code:**MSCHCC405T**	Course Title: **Synthetic Organic Chemistry II**	
	Course Credit: **4**	Total contact hours: **60 Hrs.**	
Sr.No.	**Course Contents (Topics and subtopics)**		**Reqd. hours.**
	Unit 1: Designing organic Synthesis I		**15Hrs.**
1.1	Introduction to Retrosynthetic analysis and synthetic planning: Linear and convergent synthesis; Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions (FGI), functional group addition (FGA), functional group removal (FGR		**9Hrs**
1.2	Importance of order of events in organic synthesis, one and two group C-X disconnections (1,1; 1,2; 1,3 difunctionalized compounds), selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity		**6 Hrs**
	Unit 2: Designing organic Synthesis II		**15 Hrs**
2.1	General strategy: choosing a disconnection-simplification, symmetry, high yielding steps, and recognisable starting material. One group C-C Disconnections: Alcohols (including stereoslectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.		**11 Hrs**
2.2	Two group C-C Disconnections: 1,2- 1,3- 1,4- 1,5- and 1,6- difunctionalized compounds, Diels-Alder reactions, α, β-unsaturated compounds, control in carbonyl condensations, Michael addition and Robinson annelation.		**4 Hrs**
	Unit 3: Designing Organic Synthesis III		**15 Hrs**
3.1	Methodology in organic synthesis: convergent and divergent synthesis, functional group interconversions, general methods of synthesis of 4 -7 membered rings, disconnection approach and retrosynthetic analysis, idea of synthons and synthetic equivalents . Retrosynthesis of acyclic saturated and unsaturated systems, monocyclic, bicyclic and aromatic compounds.		**11Hrs**
3.2	Synthesis of some complex molecules: synthetic routes based on retrosynthetic analysis for following molecules: prostaglandin A2, atropine and camphor.		**4Hrs**
	Unit 4: Transition and rare earth metals in organic synthesis		**15 Hrs**
4.1	Introduction, basic concepts, 18 electron rule, bonding in transition metal complexes, oxidative addition, reductive elimination, migratory insertion. Palladium in organic synthesis: π-bonding of Pd with olefins, applications in C-C bond formation, carbonylation, alkene isomerisation, cross coupling of organometallics and halides.Catalysis of cycloaddition reactions and heteroatom coupling to produce bonds between aryl/vinyl groups and N, S or P atoms.		**7Hrs**

4.2	Olefin metathesis using Grubb's catalyst.Applications of nickel, cobalt, iron, rhodium and chromium carbonyls in organic synthesis.	**5Hrs**
4.3	Applications of Cerium (IV) in synthesis of heterocyclic quinoxalinederivatives and its role as a deprotectingagent.Sc(OTf)3 and Yb(OTf)3 as water tolerant Lewis acid catalysts in aldol condensation, Michael reaction, Diels-Alder reaction, Friedel-Crafts reaction, oxidation reactions.	**3Hrs**
	Suggested Readings: 1. Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag 2. Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004. 3. Chem.Rev. 2002, 102, 2227-2302, Rare Earth Metal Triflates in Organic Synthesis, S. Kobayashi, M. Sugiura, H. Kitagawa, and W.W.L. Lam. 4. Organic Chemistry, ClaydenGreeves Warren and Wothers, Oxford Press (2001). 5. Moder Organic Synthesis: An Introduction, G.S. Zweifel and M.H. Nantz, W.H. Freeman and Company, (2007). 6. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Academic Press (2002). 7. Principles of Organic Synthesis, R.O.C. Norman & J. M. Coxon, 3rd Edn., Nelson Thornes 8. Organic Chemistry, 7th Edn, R. T .Morrison, R. N. Boyd, & S. K. Bhattacharjee, Pearson 9. Strategic Applications of Name Reactions in Organic Synthesis, L. Kurti& B. Czako (2005), Elsevier Academic Press 10. Advanced Organic Chemistry: Reactions & Mechanisms, 2nd Edn., B. Miller & R. Prasad, Pearson 11. Organic reactions and their mechanisms, 3rd revisededition, P.S. Kalsi, New Age International Publishers 12. Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley & Sons, 2004 13. Name Reactions and Reagents in Organic Synthesis, 2nd Edn., Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience 14. Name Reactions, Jie Jack Lie, 3rd Edn., Springer 15. Organic Electrochemistry, H. Lund, and M. Baizer, 3rd Edn., Marcel Dekker.	

MSCHCC405T: MS(Masters), CH(Chemistry), CC(Core Course), 405(SEM IV),T(Theory)

2	CourseCode:**MSCHCC406T**	Course Title: **Organic Spectroscopy**
	Course Credit: **4**	Total contact hours: **60 Hrs**
Sr.No.	**Course Contents (Topics and subtopics)**	
	Unit 1: UV, IR, and Mass Spectrometry	
1.1	UV spectroscopy: Characteristic absorption of Organic chemistry	
1.2	IR spectroscopy: Introduction. Coupled Interactions. Hydrogen Bonding. Dispersion IR Spectrometer. Principle and applications of FT-IR. Application in structure elucidation.	
1.3	Mass spectrometry: Theory, instrumentation various methods of ionization (field ionization, FAB, MALDI, californium plasma), different detectors [magnetic analyzer, ion cyclotron analyzer, quadrupole mass filter, time of flight (TOF)]. Importance of HRMS, Rules of fragmentation of different functional groups, factors controlling fragmentation. Fragmentation of different types of compounds like alkanes alkenes, aromatic compounds, carbonyl compounds, nitriles.	
1.4	Problems based on combined use of UV, IR, Mass and PMR spectroscopic techniques	
	Unit 2:Advanced spectroscopic techniques-I	
2.1	NMR spectroscopy: Application in structure elucidation. Relaxation phenomenon and relaxation time. First order, second order and higher order spectra. Methods of simplification of complex spectra. Double resonance, NOE, NOE difference spectroscopy and chemical shift reagents. Spin system notations, AB, AX, AB_2-AX_2, AMX and A_2B_2-A_2X_2 spin systems with suitable examples. Coupling in aromatic and heteroaromatic systems, long range coupling. Spectra of diastereotopic systems. FT-NMR spectroscopy: Pulse sequences, pulse widths, spins and magnetization vectors.	
2.2	19F- NMR and 31P- NMR spectroscopy: Principles and applications.	
2.3	ESR and Fluorescence spectroscopy: Principles and applications.	
	Unit 3: Advanced spectroscopic techniques -II	
3.1	13C NMR Elementary ideas, instrumental difficulties. Proton Noise Decoupling technique advantages and disadvantages, off-resonance technique, Chemical shifts of solvents, factors affecting chemical shifts, analogy with 1H NMR, calculations of chemical shift of hydrocarbons, effect of substituents on chemical shifts, different types of carbons (alkene, alkyne and allene), chemical shift of aromatic carbons and effect of substituent. Chemical shifts of carbonyl, nitrile, oxime carbons.proton coupled 13C - spectra, proton decoupled 13C- spectra. DEPT technique, heteronuclear coupling of carbon to 19F and 31P	
3.2	Two-dimensional NMR spectroscopy: Introduction, COSY and HETCOR techniques,	

	(including interpretation of COSY and HETCOR spectra). NOESY and ROESY techniques.
3.3	Problems based on combined use of advanced spectroscopic techniques.
	Unit 4: Interpretation of spectral data of organic compounds (UV, IR, NMR, 13C NMR and Mass spectra).
4.1	UV, IR, NMR,13C NMR, and Mass spectra of a compound from which preliminary information should be reported and complete structure of the compound elucidated by referring to any standard reference material etc.(Minimum 10 spectral analysis)
	Suggested Readings: **1.** V.M. Parikh, Application spectroscopy of organic molecule **2.** D.W. Williams and Flemming, Spectroscopic methods of organic compound. 3. Silverstein and Basallar, Spectroscopic identification of organic compounds V.M. 4. Parikh ORPTION SPECTROSCIPY OF ORGANIC MOLECULES (J. Wiley) 5. P.S. Kalsi Spectroscope of organic compounds (New age publisher) 6. J.R. Dyer. Application of absorption spectroscopy of organic compounds. 7. Jackman and Sterneil , Application of NMR spectroscopy 8. J.D. Roberts, Nuclear magnetic resonance (J. Wiley) 9. Jafee and Orchin, Theory and application of U.V, 10. K. Benjamin. Mass spectroscopy 11. Beynon J H et.al , The mass spectra of organic molecules. 12. Wehli F.W, Marchand A. P. Interpretation of carbon 13 NMR (J. Wiley) 13. W. Kemp, Organic spectroscopy ELBS 14. Willard Merritt and Dean. Instrumental methods of analysis CBS 15. Das and Jame , Mass Spectroscopy. **NMR** **1.** High Resolution N.M.R, E.D. Becker, Academic Press (1969) **2.** Nuclear Magnetic Resonance E.R. Andrea, Cambridge University Press (1955) **3.** Pulse and Fourier transform N.M.R, T.C. Farror and E.D. Becker Academic Press N.Y (1971) **ESR** **1.** An introduction to Electron Paramagnetic Resonance, M. Bersohn&J.C.Baired,W.A.Benjamin , Inc N.Y. (1966) **2.** High resolution ESR Spectroscopy F.Gerson,(John Wiley & sons– 1970) **NQR** **1.** Nuclear Quadrupole Resonance in chemistry, G.K.Semin,T.A.Babushkina& G.G. Yakobson, John Wiley & sons,(N.Y.)-(1975)

3	Course Code:**MSCHDE405T**	Course Title: **Bioorganic Chemistry**
	Course Credit: **4**	Total contact hours: **60 Hrs**
Sr.No.	**Course Contents (Topics and subtopics)**	
	Unit 1: Biomolecules-I	
1.1	Amino acids, peptides and proteins: Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, α- helix, β-sheets, super secondary structure.Tertiary structure of protein: folding and domain structure. Quaternary structure.	
1.2	Nucleic acids: Structure and function of physiologically important nucleotides (c-AMP, ADP, ATP) and nucleic acids (DNA and RNA), replication, genetic code, protein biosynthesis, mutation.	
1.3	Chemical synthesis of oligonucleotides: Phosphodiester, Phosphotriester, Phosphoramidite and H- phosphonate methods including solid phase approach.	
	Unit 2: Biomolecules-II	
2.1	Chemistry of enzymes: Introduction, nomenclature, classes and general types of reactions catalyzed by enzymes. Properties of enzymes: i) Enzyme efficiency/catalytic power ii) Enzyme specificity; Fischer's 'lock and key' and Koshland 'induced fit' hypothesis. Concept and identification of active site.	
2.2	Factors affecting enzyme kinetics: Substrate concentration, enzyme concentration, temperature, pH, product concentration etc. Reversible and irreversible inhibition.	
2.3	Mechanism of enzyme action: transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Mechanism of chymotrypsincatalyzed hydrolysis of a peptide bond.	
	Unit 3: Biomolecules – III	
3.1	Chemistry of coenzymes. Structure, mechanism of action and bio-modeling studies of the following coenzymes: nicotinamide adenine dinucleotide, flavin adenine dinucleotide, thiamine pyrophosphate, pyridoxal phosphate, Vitamin B12, biotin, lipoic acid, Coenzyme A.	
3.2	Oxygen activation in biological systems with reference to cytochromes.	
	Unit 4: Biomolecules – IV	
4.1	Role of main enzymes involved in the synthesis and breakdown of glycogen. Enzyme catalyzed organic reactions: Hydrolysis, hydroxylation, oxidation and reduction.	
4.2	Enzymes in organic synthesis. Fermentation: Production of drugs/ drug intermediates by fermentation. Production of chiral hydroxy acids, vitamins, amino acids, β-lactam antibiotics. Synthesis of chemicals via microbial transformation, synthesis of L-ephedrine. Chemical processes with isolated enzymes in free form (hydrocyanation of m-phenoxybenzaldehyde) / immobilized form (production of 6-aminopenicillanic acid).	
	Suggested Readings: **1.** Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of Biochemistry 5th Edition, W. H. Freeman and Company, NY., USA. **2.** Stryer, Lubert; Biochemistry; W. H. Freeman publishers.	

3. Voet, D. and J. G. Voet (2004) Biochemistry, 3rd Edition, John Wiley & sons, Inc. USA.
4. Zubay, Goffrey L; Biochemistry; Wm C. Brown publishers.
5. V. Polshettiwar, R. Luque, A. Fihri, H. Zhu, M. Bouhrara and J-M Basset, Chem. Rev. 2011, 111, 3036-3075;
6. R. B. NasirBaig and R. S.Varma, Chem. Comm., 2013, 49, 752-770; 7.
7. M. B. Gawande, A. K. Rathi, P. S. Varma, Appl. Sci., 2013, 3, 656-674;
8. J. Govan and Y. K. Gun'ko, Nanomaterials, 2014, 4, 222-214.
9. K. Philippot and P. Serp, Nanomaterials in catalysis, First Edition. Edited by P. Serp and K. Philippot; 2013 Wiley –VCH Verlag GmbH & Co. K GaA
10. D. Astruc, Nanomaterials and Catalysis, Wiley-VCH Verlag GmbH & Co. KGaA, 2008, 1-48;
11. C. N. R. Roa, A. Muller and A. K. Cheetham, The chemistry of Nanomaterials, Wiley-VCH Verlag GmbH & Co. KGaA, 2005, 1-11;
12. The organic chemistry of drug design and drug action, Richard B. Silverman, 2nd edition, Academic Press
13. Medicinal chemistry, D.Sriram and P. Yogeeswari, 2nd edition, Pearson
14. An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international)
15. Burger's medicinal chemistry and drug discovery. by Manfred E. Wolf
16. Introduction to Medicinal chemistry. by Graham Patrick
17. Medicinal chemistry-William O. Foye
18. T. B. of Organic medicinal and pharmaceutical chemistry-Wilson andGisvold's (Ed. Robert F. Dorge
19. An introduction to medicinal chemistry-Graham L. Patrick, OUP Oxford, 2009.
20. Principles of medicinal chemistry (Vol. I and II)-S. S. Kadam, K. R. Mahadik and K.G. Bothara ,Niraliprakashan.
21. Medicinal chemistry (Vol. I and II)-Burger
22. Strategies for organic drug synthesis and design - D. Lednicer Wiley 23.
23. Pharmacological basis of therapeutics-Goodman and Gilman's (McGraw Hill)
24. Enzyme catalysis in organic synthesis, 3rd edition. Edited by KarlheinzDrauz, Harold Groger, and Oliver May, Wiley-VCH Verlag GmbH & Co KgaA, 2012.
25. Biochemistry, Dr U Satyanarayan and Dr U Chakrapani, Books and Allied (P) Ltd.
26. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
27. The Organic Chemistry of Enzyme-Catalysed Reactions, Academic Press, By Richard B. Silverman
28. Enzymes: Practical Introduction to structure, mechanism and data analysis, By Robert A. Copeland, Wiley-VCH, Inc.
29. The Organic Chemistry of Biological Pathways By John McMurry, Tadhg Begley by Robert and company publishers
30. Bioorganic Chemistry- A practical approach to Enzyme action, H. Dugas and C. Penny. Springer Verlag, 1931
31. Biochemistry: The chemical reactions in living cells, by E. Metzler. Academic Press.

	32. Concepts in biotechnology by D. Balasubrarnanian& others **33.** Principals of biochemistry by Horton & others. **34.** Bioorganic chemistry - A chemical approach to enzyme action by Herman Dugas and Christopher Penney. **35.** Medicinal Natural Products: A Biosynthetic Approach by Paul M. Dewick. 3rd Edition, Wiley. **36.** Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B. G. Torssell, Apotekarsocieteten – Swedish pharmaceutical press. **37.** Natural products Chemistry and applications, Sujata V Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House. **38.** Natural Products Volume- 2, By O. P. Agarwal. **39.** Chemistry of Natural Products, F. F. Bentley and F. R. Dollish, 1974. 40. Natural Product Chemistry Vol.1 and 2, K. Nakanishi J. Goto. S.ItoMajori and S. Nozoo, Academic Press, 1974. 41. Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co. 42. Green Chemistry: An Introductory Text, 2nd Edition, Published by Royal Society of Chemistry, Authored by Mike Lancater. 43. Organic synthesis in water. By Paul A. Grieco, Blackie. 44. Green chemistry, Theory and Practical, Paul T. Anastas and John C. Warner. 45. New trends in green chemistry By V. K. Ahulwalia and M. Kidwai, 2nd edition, Anamaya Publishers, New Delhi. 46. An introduction to green chemistry, V. Kumar, Vishal Publishing Co. 47. Organic synthesis: Special techniques. V.K.Ahulwalia and RenuAggarwal.

MSCHDE405T: MS(Masters), CH(Chemistry), DE(Discipline Specific), 405(SEM IV),T(Theory)

4	Course Code: **MSCHDE406T**	Course Title: **Natural products and GreenChemistry**
	Course Credit: **4**	Total contact hours: **60 Hrs**
Sr.No.	**Course Contents (Topics and subtopics)**	
	Unit 1:: Natural products-I	
1.1	Carbohydrates: Introduction to naturally occurring sugars: Deoxysugars, aminosugars, branched sugars. Structure elucidation of lactose, D-glucosamine and mesoinositol (synthesis not expected).Structural features and applications of inositol, starch, cellulose, chitin and heparin.	
1.2	Natural pigments: General structural features, occurrence, biological importance and applications of: carotenoids, anthocyanins, quinones, flavones, pterins and porphyrins (chlorophyll). Structure elucidation of β-carotene. Synthesis of ubiquinone from 3,4,5-trimethoxyacetophenone.	
1.3	Insect pheromones: General structural features and importance. Synthesis of bombykol from acetylene, disparlure from 6-methylhept-1-ene, grandisol from 2-methyl-1,3-butadiene.Alkaloids: Occurrence and physiological importance of morphine, coniine and papaverine. Structure elucidation of papaverine.	
	Unit 2: : Natural products-II	
2.1	Multi-step synthesis of natural products: Synthesis of the following natural products with special reference to reagents used, stereochemistry and functional group transformations: a) Woodward synthesis of Reserpine from benzoquinone b) Corey synthesis of Longifoline from resorcinol c) Gilbert-Stork synthesis of Griseofulvin from phloroglucinol d) E. Wenkert's synthesis of β-vetivone from acetone e) A.V.Ramarao synthesis of 4-demethoxydaunomycin from ethyl acetoacetate. f)Biosynthesis of selected natural products: L-tryptophan, cholesterol, ephedrine, citronellol.	
2.2	Prostaglandins: Classification, general structure and biological importance. Structure elucidation of PGE1 and PGF1α (synthesis not expected). Insect growth regulators: General idea, structures of JH2 and JH3. Plant growth regulators: Structural features and applications of arylacetic acids, gibberelic acids and triacontanol. Synthesis of triacontanol (synthesis of stearyl magnesium bromide and 12-bromo-1-tetrahydropyranyloxydodecane expected).	
	Unit 3: : Natural products-III	
3.1	Steroids: General structure, classification. Occurrence, biological role, important structural and stereochemical features of the following: corticosteroids, steroidal hormones, steroidal alkaloids, sterols and bile acids. Synthesis of 16-DPA from cholesterol and plant sapogenin. Synthesis of the following from 16-DPA: androsterone, testosterone, oestrone, oestriol, oestradiol and progesterone.	

3.2	Vitamins: Classification, sources and biological importance of vitamin B1, B2, B6, folic acid, B12, C, D1, E (α-tocopherol), K1, K2, H (β- biotin). Synthesis of the following: Vitamin B1 including synthesis of pyrimidine and thiazolemoieties Vitamin B2 from 3, 4-dimethylaniline and D(-)ribose Vitamin B6 from: 1) ethoxyacetylacetone and cyanoacetamide2) ethyl ester of N-formyl-DL-alanine(Harris synthesis) Vitamin E (α-tocopherol) from trimethylquinol and phytyl bromide Vitamin K1 from 2-methyl-1, 4-naphthaquinone and phytol.
3.3	Antibiotics: Classification on the basis of activity. Structure elucidation of penicillin-G and cephalosporin-C. Synthesis of penicillin-G and phenoxymethylpenicillin from D-penicillamine and t-butyl phthalimidemalonaldehyde (synthesis of D-penicillamine and t-butyl phthalimidemalonaldehyde expected).
	Unit 4: Green chemistry
4.1	Introduction, basic principles of green chemistry. Designing a green synthesis: Green starting materials, green reagents, green solvents and reaction conditions, green catalysts. Use of the following in green synthesis with suitable examples: a) Green reagents: dimethylcarbonate, polymer supported reagents. b) Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts [Aliquat 336, benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride, crown ethers], biocatalysts. c) Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide. d) Solid state reactions: solid phase synthesis, solid supported synthesis. e) Microwave assisted synthesis: reactions in water, reactions in organic solvents, solvent free reactions. f) Ultrasound assisted reactions.
4.2	Comparison of traditional processes versus green processes in the syntheses of ibuprofen, adipic acid, 4-aminodiphenylamine, p-bromotoluene and benzimidazole.
	Suggested Readings: 1. Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B.G. Torssell, Apotekarsocieteten – Swedish Pharmaceutical Press. 2. Natural products chemistry and applications, Sujata V. Bhat, B.A. 3. Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011. 4. Organic Chemistry Natural Products Volume-II, O. P. Agarwal,Krishna Prakashan, 2011. 5. Chemistry of natural products, F. F. Bentley and F. R. Dollish, 1974 6. Natural Product Chemistry Vol.1 and 2, K. Nakanishi J. Goto. S.ItoMajori and S. Nozoo, Academic Press, 1974. 7. Chemistry of natural products, V.K. Ahluwalia, Vishal PublishingCo. 2008. 8. Green Chemistry: An Introductory Text, 2nd Edition, Published byRoyal Society of Chemistry, Authored by Mike Lancater. 9. Organic synthesis in water. By Paul A. Grieco, Blackie. 10. Green chemistry, Theory and Practical, Paul T. Anastas and John C.Warner. 11. New trends in green chemistry By V. K. Ahulwalia and M. Kidwai, 2ndedition, Anamaya Publishers, New Delhi 12. An introduction to green chemistry, V. Kumar, Vishal Publishing Co. 13. Organic synthesis: Special techniques. V.K.Ahulwalia and RenuAggarwal

	Course Code: **MSCHSE401T**	Course Title: **Recent Trends in Chemistry**	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
	UNIT I Molecular Interaction		**15 Hrs**
1.1	Electric dipole moments, Polarizabilities and Polarization, Relative permittivity's		
1.2	**Interaction between molecules** Interaction between dipoles, Impact on medicine: Molecular recognition and drug design. Repulsive and total interaction. Impact on material science. Hydrogen storage in molecular clathrates.		
1.3	**Gases and Liquids** Molecular interaction in gases and liquid surface interface. Surface film. Condensation.		
	UNIT II Organic Solid-State Chemistry		**15 Hrs**
2.1	Topochemical control of solid-state organic reactions: a. Intramolecular reactions b. Intermolecular reactions c. Asymmetric synthesis d. Role of crystal defects e. Role of molecular packing arrangements Organic reactions within Inorganic host structures		
2.2	Electrically conducting organic solids: Organic metals		
2.3	Organic charge transfer complexes: New superconductors		
	UNIT III Nanoscience		**15 Hrs**
3.1	Introductions of nanomaterials. Classification of nanomaterials andproperties. Methods of synthesis of nanomaterials.		
3.2	Applications of Nanomaterials: A) Biomedical B) Fuel cell C) Next-Generation device Chips D) Catalysis. Disadvantages of nanomaterials		
3.3	Characterization of nanomaterials by XRD, EXAFS, XPS, SEM, TEM, AFM		
	UNIT IV		**15 Hrs**
4.1	Selection of Analytical Method for Analysis		
	Sampling and Sample Preparation of Environmental / Food samples		

	Stoichiometric calculations, Evaluation and Processing of Analytical data	
	Suggested readings	
1)	G. Schmid, Nanoparticle: From Theory to Applications, Wiley-VCH Verlag GmbH& Co. KGaA, 2004.	
2)	P. Dutta, S.Gupta (Ed), Understanding of Nanoscience and Technology, Global Vision Publishing House, 2006.	
3)	C.C. Koch, Nanostructured Materials: Processing, Properties andApplications, Jaico Publishing House, 2006.	
4)	Challa S.S.R. Kumar (Ed) Biological and Pharmaceutical Nanomaterials, John Wiley VerlogCmbh& Co., KgaA, 2006.	
5)	G. Schmid, Nanoparticle: From Theory to Applications, Wiley-VCH Verlag GmbH & Co. KGaA, 2004.	
6)	Green Synthesis of Nanomaterials Giovanni Benelli www.mdpi.com/journal/nanomaterials Edited by Printed Edition of the Special Issue Published in Nanomaterial	
7)	J.M.Thomas, S.E.Morsi and J.P. Desvergne, Topochemical phenomenon in organic solid stste state Chemistry, Adv Physical. Org.Chem, 15,64-151, 1977	
8)	A.R.West, Solid state Chemistry and its applications, John Wiley and Sons, 2003	
9)	l.Smart and E. Moore, Solid State Chemistry an introduction, Viva books pvt. Ltd, 2004	
10)	Atkins Physical chemistry 10 th edition	
11)	Analytical Instrumentation book by Ewing. Fourth edition	
	Course Outcome	
1)	This Paper is Interdisciplinary. Students will have knowledge of Recent development in all the branches of Chemistry	

MSCHSE402T: MS(Masters), CH(Chemistry), SE(Skill Enhancement), 402(SEM IV),T(Theory)

6	Course Code: **MSCHPR403P**	Course Title: **Research Project**	
	Course Credit: **8**	Total contact hours: **120 Hrs**	
Sr.No.	**Course Contents (Topics and subtopics)**		**Reqd. hours.**
1 **2** **3** **4** **5** **6**	**Selecting Innovative Topic for Project** **Referencing to be done for the chosen topic** **Practical work** **Writing the thesis in prescribed format** **Preparation of Power point presentation** **Presenting the research work** **Objective:** Every post graduate (M.Sc.) student is required to prepare the project subject related – based on the guidelines of his / her project guide. **The following are the guidelines to be adhered to** The project should be an individual one The language for the project is **English** The Minimum number of pages should be **60** Project observations, suggestions and conclusion shall form part of the project. The Projects will be evaluated both by the Internal as well as External Examiner each The Division of marks for the Project Report is as mentioned below: Wording of Title 10M Objectives/ Formulation including Hypothesis 20M Review of Literature 20M Relevance of Project to Social Needs 40M Methodology/ Technique/ Procedure Adopted (schemes) 70M Summary/ Findings/ Conclusion 30M Bibliography/ Annexure/ Foot notes 10M **Total 200M**		**120 Hrs**

Eg. MSCHPR405 &406 P ; MS (Masters) **CH** (Chemistry) **P R**(Project) 405 &406(SEM IV)