Programme: M. Sc. (Chemistry, Part-II)
Course Code: OCC-502
Title of the Course: Reaction Mechanisms, Stereochemistry and Asymmetric Synthesis
Number of Credits: 3 **Effective from AY:** 2019-20

Prerequisites for the course:	Should have studied the topics on Reaction Mechanisms, stereochemistry at T Y B Sc (Chemistry) and M. Sc. part-I (Chemistry) levels.	
Course Objective:	1. Introduction to important principles of stereochemistry such as Baldwin's rules. 2. Understand the importance of chirality in organic syntheses. 3. Learn about non-catalytic asymmetric synthesis methods in the classical chemistry involving alkenes and carbonyl compounds. 4. Analyse and understand mechanistic aspects for fundamental reactions studied at TYBSc/ MSc Part I levels.	
Course Outcome	1. Students should be in position to understand the importance of asymmetric synthesis in organic reactions. 2. Students should be in position to understand to apply various principles of stereochemistry and understand the mechanistic aspects of fundamental reactions.	
Content:	**I. Reaction Mechanisms-** 1. **Intramolecular Reactions** (Baldwin's Rules) **2. Molecular rearrangements and their synthetic applications** 2.1 Unifying principles and mechanisms of rearrangements taking place at an electron deficient and electron rich substrates. 2.2 Rearrangements taking place at carbon: Arndt Eistert, Wagner Meerwein, benzil-benzilic acid, Pinacol, semipinacol, Tiffeneau Demjanov, dienone phenol, Wittig, Favorskii, Stevens, Wolff, Baker-Venkatraman rearrangement, Barton decarboxylation, Pummerer rearrangement. 2.3 Rearrangements at nitrogen: Hofmann, Curtius, Lossen, Schmidt, Beckmann, Neber, Stieglitz rearrangement. 2.4 Rearrangements at oxygen: Payne (including aza and thia Payne) rearrangement, hydroperoxide rearrangement, Criegee rearrangement. 2.5 Aromatic rearrangements: Benzidine, Fries, Von Richter, Sommelet-Hauser, Smile's, Jacobsen. Rearrangement on aniline derivatives- Bamberger rearrangement, Fischer-Hepp, Orton, Hofmann-Martius,	 02 hours 07 hours

	Reilly-Hickinbottom, rearrangements of N-arylazoanilines, Phenylnitramines, Phenylsulfamines. 2.6 Rearrangements involving fragmentations: Eschenmoser fragmentation. **II Stereochemistry** **1.1 Stereoselctivity in cyclic compounds** (1) Introduction (2) Stereochemical control in six membered rings (3) Reactions on small rings (4) Regiochemical control in cyclohexene epoxides (5) Stereoselectivity in bicyclic compounds **1.2 Conformations, stability and reactivity of fused ring compounds** 1.2.1 Fused bicyclic systems with small and medium rings: (1) Bicyclo [4.4.0] decanes (cis- and trans-decalins) (2) cis- and trans- decalones and decalols (3) Octahydronaphthalins (octalins) (4) Bicyclo [4.3.0] nonane (cis- and trans-hydrindanes) **1.3 Fused polycyclic systems** (1) Perhydrophenanthrenes (2) Perhydroanthracenes (3)Perhydrocyclopentenophenanthrene system (steroids, triterpenoids and hormones). Conformations and reactivity towards esterification, hydrolysis, chromium trioxide oxidation, ionic additions (of X_2) to double bonds, formation and opening of epoxide ring, epoxidation by peroxy acids. 1.4 Spirocyclic compounds 1.5 Reactions with cyclic intermediates or cyclic transition states	 8 hours
	2. Conformation of bridged ring compounds 2.1 Bicyclo [2.2.1] heptane (norbornane) (1) Geometry and topic relationship of hydrogens. (2) Solvolysis of bicyclo[2.2.1]heptyl systems, formation, stability and reactivity of norbornylcation. (3) Relative stability and the rate of formation of *endo* and *exo* isomers in both bornane and norbornane systems. 2.2 Bicyclo [2.2.2] octane system (1) Geometry and topic relationship of hydrogens (2) Solvolysis of bicyclo[2.2.2]octyl system. 2.3 Other bridged ring systems: starting from bicyclo[1.1.1]pentane to bicyclo[3.3.3] undecane 2.4 Bicyclo system with heteroatom: the relative stabilities of	4 hours

	tropine, pseudotropine and benzoyl derivatives of norpseudotropine. **3. Dynamic Stereochemistry: Stereoselective Reactions** 3.1 Stereoselectivity: classification, terminology and principle. Selectivity in chemistry– substrate and product selectivity. 3.2 Stereoselective reaction of cyclic compounds: Introduction, reactions of four, five and six-membered rings. Conformational control in the formation of six-membered ring. 3.3 Diastereoselectivity: Introduction, making single diastereoisomers using stereospecific reactions of alkenes. 3.4 1,2-Addition to carbonyl compounds: Predicting various addition outcomes using different predictive models such as, Cram Chelate, Cornforth, Felkin-Anh. Specific reactions: allylation/crotylation by Brown, Roush, BINOL catalyzed. 3.5 Stereoselective reaction of acyclic alkenes: The Houk model **4. Asymmetric synthesis** 4.1 Chiral pool (chiron approach) 4.2 Chiral auxiliary approach Oxazolidinone & norephedrine-derived chiral auxiliary controlled Diels-Alder reaction and alkylation of chiral enolates and aldol reaction, Alkyation using SAMP and RAMP 4.3 Chiral Reagents (Use of (-)-sparteine 4.4 Asymmetric catalysis CBS catalyst, Ruthenium catalyzed chiral reductions of ketones, Catalytic asymmetric hydrogenation of alkenes, Asymmetric epoxidation (Sharpless and Jacobson), Sharpless asymmetric dihydroxylation reaction Organocatalysed aldol reaction (Use of proline) **5. Stereoisomerism due to axial chirality, planar chirality and helicity.** 5.1 Stereochemistry and configurational (R/S) nomenclature in appropriately substituted allenes, alkylidenecycloalkenes, spiranes, adamantoids, biaryls, trans-cycloalkenes, cyclophanes and ansa compounds. 5.2 Atropisomerism in biphenyls and bridged biphenyls.	 6 hours 6 hours 3 hours
Pedagogy:	Lectures/ tutorials/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/Readings	1. M. B. Smith & Jerry March, *Advanced Organic Chemistry-*	

	Reaction, Mechanism and Structure, Wiley, 2006, 6th Ed. 2. D. Nasipuri, *Stereochemistry of Organic compounds, Principles and applications*, New Age International Pvt. Ltd., 1994, 2nd Ed. 3. E.L. Eliel, *Stereochemistry of Carbon Compound*, Tata Mc-Graw Hill, 1975. 4. W. Caruthers & I. Colddham, *Modern Methods of Organic Synthesis*, Cambridge University Press, 2016, 4th Ed. 5. J. Clayden, N. Greeves and S. Warren, Oxford, 2016. 6. I. L. Finar, *Stereochemistry and the Chemistry of Natural Products*, ELBS, Vol. 2, Longman Edn, 1975. 5th Ed. 7. E.S. Gould, *Mechanism and Structure in Organic Chemistry*, Holt, Reinhart and Winston, 1965. 8. F. A. Carey & R. J. Sundberg, *Advanced Organic Chemistry*: *Part A and B*, Springer India Private Limited, 2007, 5th Ed. 9. R. O. C. Norman & J. M. Coxon, *Principles of Organic Syntheses,* CRC Press Inc, 1993, 3rd Ed. 10. V.M. Potapov & A. Beknazarov, *Stereochemistry*, Central Books Ltd., 1980. 11. D. G Morris, *Stereochemistry*, Wiley-RSC, 2002, 1st Ed. 12. Clayden, Greeves, Warren & Wothers, *Organic Chemistry*, Oxford University Press, 2002, 2nd Ed. 13. M. Nogradi, *Stereoselective Synthesis*, VCH Publishers, Inc., 1994, Revised and Enlarged Ed.	