FACULTY OF HUMANITIES, SCIENCES & MANAGEMENT
DEPARTMENT OF CHEMISTRY

Periyar Nagar, Vallam, Thanjavur-613403, Tamilnadu
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FACULTY OF HUMANITIES, SCIENCES & MANAGEMENT

DEPARTMENT OF CHEMISTRY

CURRICULUM AND SYLLABUS (I - IV SEMESTER)

M.Sc. CHEMISTRY
(FULL TIME – 2 Years)

REGULATION 2018

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

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CURRICULUM & SYLLABUS (I to IV Semester)
FOR
M.Sc. CHEMISTRY

(FULL TIME – 2 Years)

REGULATION 2018

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

CURRICULUM AND SYLLABUS FOR

MASTER OF SCIENCE

M.Sc. (Chemistry) - (TWO YEARS - FULL TIME)

REGULATION - 2018

(Applicable to the students admitted from the academic year 2018-2019 onwards)

CURRICULUM -M.Sc. (Chemistry) - (TWO YEARS - FULL TIME)

REGULATION - 2018

	SEMESTER I							
Type	**Course Code**	**Course Title**	**L**	**T**	**SS**	**P**	**H**	**C**
CCI	YCY101	Organic Chemistry I	4	1	0	0	5	5
CCII	YCY102	Inorganic Chemistry I	4	1	0	0	5	5
CCIII	YCY103	Physical Chemistry I	4	1	0	0	5	5
CPI	YCY104	Inorganic Practical I	0	0	0	6	6	3
CPII	YCY105	Physical Chemistry Practical I	0	0	0	6	6	3
		Total	**12**	**3**	**0**	**12**	**27**	**21**

	SEMESTER II							
Type	**Course Code**	**Course Title**	**L**	**T**	**SS**	**P**	**H**	**C**
CCIV	YCY201	Inorganic Chemistry II	4	1	0	0	5	5
CCV	YCY202	Physical Chemistry II	4	1	0	0	5	5
CPIII	YCY203	Inorganic Practical II	0	0	0	6	6	3
CPIV	YCY204	Physical Chemistry Practical II	0	0	0	6	6	3
ECIA ECIB	YCYE01/ YCYE02	(A) Solid State Chemistry/ (B) Supramolecular Chemistry	4	1	0	0	5	5
		Total	**12**	**3**	**0**	**12**	**27**	**21**

	SEMESTER III							
Type	**Course Code**	**Course Title**	**L**	**T**	**SS**	**P**	**H**	**C**
CCVI	YCY301	Organic Chemistry II	4	1	0	0	5	5
CCVII	YCY302	Physical Methods in Chemistry-I	4	1	0	0	5	5
CPV	YCY303	Organic Chemistry Practical -I	0	0	0	6	6	3
ECIIA ECIIB	YCYE03/ YCYE04	(A) Pharmaceutical Chemistry/ (B) Electro-Organic Chemistry	4	1	0	0	5	5
ECIC	YEC305	Analytical Chemistry	4	1	0	0	5	5
		Total	**16**	**4**	**0**	**6**	**26**	**23**

	SEMESTER IV							
Type	**Course Code**	**Course Title**	**L**	**T**	**SS**	**P**	**H**	**C**
CCVIII	YCY401	Physical Methods in Chemistry-II	4	1	0	0	5	5
CCVI	YCY402	Organic Chemistry Practical -II	0	0	0	6	6	3
ECIIIA ECIIIB	YCYE05/ YCYE06	(A) Green Chemistry/ (B) Industrial Chemistry	4	1	0	0	5	5
ECIVA ECIVB	YCYE07/ YCYE08	(A) Selected topics in Chemistry/ (B) Chemistry of nanoscience and nanotech.	4	1	0	0	5	5
Project	YCY405	Dissertation –Project work	0	0	0	12	12	6
		Total	**12**	**3**	**0**	**18**	**33**	**24**

COURSE CODE	COURSE NAME	L	T	P	C
YCY101	ORGANIC CHEMISTRY- I	4	1	0	5
C:P:A	4.0: 0.5 : 0.5				
		L	T	P	H
		4	1	0	5

COURSE OUTCOMES- On the successful completion of the course, students will be able to		DOMAIN	LEVEL
CO1	***Recognize*** the various basic concepts of aromaticity.	Cognitive	Remember
CO2	***Identify*** the oxidation and reducing reagents for organic synthesis.	Cognitive	Understand
CO3	***Describe*** and ***give*** examples of stereochemistry of organic compounds.	Cognitive Psychomotor	Remember Understand Mechanism
CO4	***Recognize*** the effect of light in organic reactions and ***understand*** the mechanism of photochemistry.	Cognitive and Affective	Understand and Receiving
CO5	***Recall*** and ***explain*** the mechanism of pericyclic reactions.	Cognitive	Remember Understand

UNIT - I Aromaticity **15**

Aromatic character: Five, six, seven, and eight membered rings – other systems with aromatic sextets – Huckel's theory of aromaticity, concept of homoaromaticity and anti-aromaticity.

Electron occupancy in MO's and aromaticity – NMR concept of aromaticity and antiaromaticity, systems with 2,4,8 and 10 electrons, systems of more than 10 electrons (annulenes), Mobius aromaticity. Bonding properties of systems with $(4n+2)\pi$-electrons and $4n\pi$-electrons, alternant and non-alternant hydrocarbons (azulene type) – aromaticity in heteroaromatic molecules.

UNIT – II Reagents in Organic Synthesis **15**

Oxidation: Baeyer-Villiger, Jacobsen epoxidation, Jones reagent, NOCl, $Cu(OAC)_2$, Swern oxidation, Sommelet reaction, Oxidative coupling of phenols, Prevost reaction and Woodward modification. Reduction: palladium / platinum / rhodium / nickel based heterogeneous catalysts for hydrogenation, Wilkinson's catalyst, Noyori asymmetric hydrogenation – reductions using Li/Na in liquid ammonia. Hydride transfer reagents from group III in reductions.

(i) triacetoxyborohydride, Luche reduction, $NaBH_4$.

(ii) stereo/enantioselectivity reductions

UNIT – III Stereochemistry and Conformational Analysis **15**

Stereoisomerism – symmetry – enantiomers and diastereomers – R and S nomenclature – optical activity and chirality – types of molecules exhibiting optical activity – absolute configuration – chirality in molecules with non- carbon stereocenters (N, S and P) – molecules with more than one chiral centre – atropisomerism. Molecular chirality – allenes, spiranes, biphenyls – methods of determining configuration – E and Z nomenclature – determination of configuration of geometrical isomers – stereochemistry of addition and elimination reactions – stereospecific and stereoselective synthesis [elementary examples]. Basic concepts of conformational analysis – conformations of cyclopentane, cyclohexane, cyclohexene and bridged (norbornane type) ring systems –

	anomeric effect in cyclic compounds.	
	UNIT –IV Organic Photochemistry	**15**
	Organic photochemistry – fundamental concepts – energy transfer – characteristics of photoreactions – photoreduction and photooxidation, photosensitization.Photoreactions of ketones and enones – Norrish Type I and II reactions – Paterno-Büchi reaction – Fries rearrangement – photochemistry of alkenes, dienes and aromatic compounds – di-π-methane rearrangement– photochemistry of α,β-unsaturated carbonyl compounds – photolytic cycloadditions and photolytic rearrangements – photo additions – Barton reaction	
	UNIT –V Pericyclic Reactions	**15**
	Concerted reactions – orbital symmetry and concerted symmetry – Woodward and Hoffmann rules – selection rules for electrocyclic reactions – frontier molecular orbital approach – correlation diagram – examples. Selection rules for cycloaddition reactions – frontier molecular orbital approach – correlation diagram – examples. Sigmatropic rearrangements – 1,3, 1,5 and 1,7-hydrogen shifts – examples – Cope and Claisen rearrangements – 1,3-dipolar cycloaddition reactions	

LECTURE	**TUTORIAL**		**TOTAL**
60	**15**		**75**

TEXT BOOKS

1. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure; 7th Ed., Wiley, New York, 2013.
2. I.L. Finar, Organic Chemistry; Vol.II, 7th Ed., Pearson education Ltd, New Delhi, 2009.
3. R. T. Morrison and R. N. Boyd, Organic Chemistry, 7th Ed., Pearson, New Delhi, 2011.
4. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry; Parts A and B, 5th Ed., Springer, Germany, 2007.
5. T. H. E. Lowry and K. S. Richardson, Mechanism and Theory in Organic Chemistry; Addison-Wesley, USA, 1998.
6. P. S. Kalsi, Stereochemistry; Wiley eastern limited; New Delhi, 1993.
7. D. Nasipuri, Stereochemistry of Organic Compounds - Principles and Applications; 2nd Ed., New Age International, New Delhi, 1994.
8. E. L. Eliel, and S. H. Wilen, Stereochemistry of Organic Compounds; John Wiley, New York, 1994.
9. J. D. Coyle, Organic Photochemistry; Wiley, New York, 1998.

REFERENCE BOOKS

1. R. K. Bansal, Organic Reaction Mechanisms; 11th Ed., Tata McGraw Hill, Noida, 2006.
2. Jagdamba Singh, Jaya Singh, Photochemistry and Pericyclic Reactions, New Academic Science, 2009.
3. J. Clayden, N. Greeves, S. Warren, and P. Wothers, Organic Chemistry; 1st Ed., Oxford University Press, UK, 2000.
4. G. R. Chatwal, Organic Phtochemistry; 1st Ed., Himalaya Publications house, Bangalore, 1998.
5. S. Sankararaman, Pericyclic Reactions - A Textbook: Reactions, Applications and Theory; Wiley-VCH, New York, 2005.
6. J. M. Coxon, and B. Halton, Organic Photochemistry; 2nd Ed., Cambridge, University Press, UK, 1987.

	E RESOURCES 1. http://nptel.ac.in/courses/104103071/21 2. https://www.youtube.com/watch?v=Ih7tQ7rY2Wc 3. http://nptel.ac.in/courses/104101005/ 4. https://www.youtube.com/watch?v=12hmgzeiGo4 5. https://www.youtube.com/watch?v=WEeFhsjn-lo

COURSE CODE	COURSE NAME	L	T	P	C
YCY102	INORGANIC CHEMISTRY- I	4	1	0	5
C:P:A	4.5: 0 : 0.5				
		L	T	P	H
		4	1	0	5

COURSE OUTCOMES- On the successful completion of the course, students will be able to		DOMAIN	LEVEL
CO1	***Describe*** the basic concepts of main group elements.	Cognitive	Remember
CO2	***Explain*** the reactions of coordination compounds and ***estimate*** the physical constants of the reactions.	Cognitive	Understand
CO3	***Summarize*** the theories and bonding nature of coordination compounds.	Cognitive	Understand
CO4	***Identify*** and ***understand*** the reaction mechanism of four and six coordinated compounds.	Cognitive and Affective	Understand Receive
CO5	***Rewrite*** the basic concepts of photochemistry and its applications to coordinated compounds.	Cognitive	Understand

UNIT - I Main Group Chemistry **15**

Chemistry of boron – borane, higher boranes, carboranes, borazines and boron nitrides – chemistry of silicon – silanes, higher silanes, multiple bonded systems, disilanes, silicon nitrides. P-N compounds, cyclophosphazanes and cyclophosphazenes – S-N compounds – S_2N_2, S_4N_4, (SN)x, polythiazyl S_xN_4 compounds – S-N cations and anions, S-P compounds – molecular sulphides such as P_4S_3, P_4S_7, P_4S_9 and P_4S_{10} – homocyclic inorganic systems – oxocarbon anion. Ionic model – lattice energy – Born-Lande equation – Kapustinskii equation – high Tc superconductors – solid state reactions – tarnish reaction decomposition, solid-soild reaction and photographic process – factors affecting reaction rate.

UNIT – II Principles of Coordination Chemistry **15**

Studies of coordination compounds in solution – detection of complex formation in solution – stability constants – stepwise and overall formation constants. Simple methods (potentiometric, pH metric and photometric methods) of determining the formation constants. Factors affecting stability – statistical and chelate effects – forced configurations.

UNIT – III Theories of Metal-Ligand Bond **15**

Crystal field theory – splitting of d-orbitals under various geometries – factors affecting splitting – CFSE and evidences for CFSE (structural and thermodynamic effects). Spectrochemical series – Jahn-Teller distortion – spectral and magnetic properties of complexes – site preferences.Limitations of CFT – ligand field theory – MO theory – sigma- and pi-bonding in complexes – Nephelauxetic effect – the angular overlap model.

UNIT –IV Reaction Mechanism in Coordination Complexes **15**

Kinetics and mechanism of reactions in solution – labile and inert complexes – ligand displacement reactions in octahedral and square planar complexes – acid hydrolysis, base hydrolysis and anation reactions. Trans effect – theory and applications – electron transfer reactions – electron exchange reactions – complementary and non-complementary types – inner sphere and outer sphere processes – application of electron transfer reactions in inorganic

	complexes – isomerisation and racemisation reactions of complexes. Molecular rearrangements of four- and six-coordinate template effect and its applications for the synthesis of macrocyclic ligands.	
	UNIT –V Inorganic Photochemistry	**15**
	Electronic transitions in metal complexes, metal-centered and charge-transfer transitions – various photophysical and photochemical processes of coordination compounds. Unimolecular charge-transfer photochemistry of cobalt(III) complexes , photoreduction – ligand-field photochemistry of chromium(III) complexes – Adamson's rules, photoactive excited states, Photochemistry of organometallic compounds – metal carbonyl compounds – compounds with metal-metal bonding – Reinecke's salt, chemical actinometer.	

LECTURE	**TUTORIAL**		**TOTAL**
60	**15**		**75**

TEXT BOOKS

1. M. C. Day, J. Selbin and H. H. Sisler, Theoretical Inorganic Chemistry; Literary Licensing (LLC), Montana, 2012.
2. F. A. Cotton and G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry; 6th Ed., A Wiley - Interscience Publications, John Wiley and Sons, USA, 1999.
3. J. E. Huheey, Inorganic Chemistry; 4th Ed., Harper and Row publisher, Singapore, 2006.
4. W. Adamson, Concept of Inorganic Photochemistry; John Wiley and Sons, New York, 1975.
5. S. F. A. Kettle, Physical Inorganic Chemistry – A Coordination Chemistry Approach, Spectrum; Academic Publishers, Oxford University Press, New York, 1996.

REFERENCE BOOKS

1. A. W. Adamson and P. D. Fleischauer, Concepts of Inorganic Photochemistry; R. E. Krieger Pubs, Florida, 1984.

2. J. Ferraudi, Elements of Inorganic Photochemistry; Wiley, New York, 1988.

3. F. Basolo and R. G. Pearson, Mechanism of Inorganic Reactions; 2nd Ed., John Wiley, New York, 1967.

4. R. K. Sharma, Inorganic Reactions Mechanism; Discovery Publishing House, New Delhi, 2007.

E RESOURCES

1. https://www.youtube.com/watch?v=YChUH_XSZJ0
2. https://www.youtube.com/watch?v=7gNByyjaYrY
3. https://www.youtube.com/watch?v=Ox3pnVN47gw
4. https://www.youtube.com/watch?v=wq4XHcNBBgg

COURSE CODE	COURSE NAME	L	T	P	C
YCY103	PHYSICAL CHEMISTRY- I	4	1	0	5
C:P:A	4.5: 0 : 0.5				
		L	T	P	H
		4	1	0	5

COURSE OUTCOMES- On the successful completion of the course, students will be able to		DOMAIN	LEVEL
CO1	***Identify*** the basic concept of Electrochemistry and related laws	Cognitive	Remember
CO2	***Describe*** the theories of classical mechanics and quantum mechanics of a microscopic particles and ***predict*** the energy of the particles	Cognitive	Understand Apply
CO3	***Recognize*** the various theories of chemical kinetics of reactions.	Cognitive	Remember
CO4	***Explain*** the fundamentals of thermodynamic and ***Label*** the various thermodynamic parameters.	Cognitive and Affective	Understand Receive
CO5	***Generalized*** the photo physical properties of chemical reactions.	Cognitive	Understand

UNIT - I Electrochemistry I **15**

Ion transport in solution - migration, convention and diffusion -Fick's laws of diffusion conduction - influence of ionic atmosphere on the conductivity of electrolytes-The Debye Huckel-Onsager equation for the equivalent conductivity of electrolytes - experimental verification of the equation - conductivity at high field and at high frequency - conductivity of non aqueous solutions-effect of ion association on conductivity. The electrode-electrolyte interface-electrical double layer-electro capillary phenomena-Lippmann equation - the Helmholtz- Perrin - Guoy-Chapmann and Stern models.

UNIT – II Quantum Chemistry – I **15**

Inadequacy of classical mechanics – black body radiation – Planck's quantum concept – photoelectric effect – Bohr's theory of hydrogen atom – hydrogen spectra – wave-particle dualism – uncertainty principle – decline of old quantum theory. Schrödinger equation – postulates of quantum mechanics – operator algebra: linear operator, Hermitian operators, eigen functions and eigenvalues, angular momentum operator – commutation relations and related theorems – orthogonality and normalization. Applications of wave mechanics to simple systems – particle in a box, one and three dimensional, particle with finite potential barrier – the quantum mechanical tunneling.

UNIT – III Chemical Kinetics – I **15**

Theories of reaction rate – absolute reaction rate theory (ARRT) – transmission coefficient, reaction coordinate – potential energy surfaces – kinetic isotope effect – Hinshelwood theory –Slater's treatment. Principle of microscopic reversibility – steady-state approximation – chain reactions: thermal and photochemical reactions between hydrogen and halogens – explosions and hydrogen-oxygen reactions.

UNIT –IV Statistical Thermodynamics **15**

Thermodynamic probability – probability theorems – relation between entropy and probability (Boltzmann-Planck equation), ensembles, phase space, Ergodic hypothesis, microstates and macrostates, Maxwell-Boltzmann distribution law– partition functions – translational, rotational, vibrational and electronic partition functions. Relationship between

	partition functions and thermodynamic properties – heat capacities of monatomic crystals – Einstein theory and Debye theory. Quantum statistics – Bose-Einstein (B.E.) and Fermi-Dirac (F.D.) distribution equations – comparison of B.E. and F.D. statistics with Boltzmann statistics – applications of quantum statistics to liquid helium, electrons in metals and Planck's radiation law – concept of negative Kelvin temperature.	
	UNIT –V Fast Reaction Techniques, Photochemistry and Radiation Chemistry	**15**
	Introduction – flow methods (continuous and stopped flow methods) – relaxation methods (T and P jump methods) – pulse techniques (pulse radiolysis, flash photolysis). Photophysical processes of electronically excited molecules – Jablonski diagram. – Stern-Volmer equation and its applications – experimental techniques in photochemistry – chemical actinometers – lasers and their applications. Differences between radiation chemistry and photochemistry – sources of high energy radiation and interaction with matter – radiolysis of water, solvated electrons – definition of G value, Curie, linear energy transfer (LET) and Rad – scavenging techniques – use of dosimetry and dosimeters in radiation chemistry – applications of radiation chemistry.	

	LECTURE	**TUTORIAL**		**TOTAL**
	60	**15**		**75**

TEXT BOOKS

1. F. A. Cotton, Chemical Applications of Group Theory; 3rd Ed., John Wiley and Sons, Singapore, 2003.
2. K. Chandra, Introductory Quantum Chemistry; 4th Ed., Tata McGraw Hill, Noida, 1994.
3. D. A. Mcquarrie, Quantum Chemistry; University Science Books, Sausalito, 2008.
4. K. J. Laidler, Chemical Kinetics; 3rd Ed., Tata McGraw Hill, Noida, 1987.
5. J. W. Moore and R. G. Pearson, Kinetics and Mechanism; 3rd Ed., John Wiley and Sons, New York, 1981.
6. M. Mortimer and P. G. Taylor, Chemical Kinetics and Mechanism; 1st Ed., Royal Society of Chemistry, UK, 2002.
7. J. N. Gurtu and A. Gurtu, Advanced Physical Chemistry; 5th Ed., Pragathi Prakashan, Meerut, 2006.
8. J. I. Steinfeld, J. S. Francisco and W. L. Hase, Chemical Kinetics and Dynamics; 2nd Ed., Prentice Hall, New Jersey, 1999.
9. P. W. Atkins, Physical Chemistry; 7th Ed., Oxford University Press, Oxford, 2001.
10. J. Rajaram and J. C. Kuriacose, Thermodynamics for Students of Chemistry - Classical, Statistical and Irreversible; Pearson Education, New Delhi, 2013.
11. Horia Metiu, Physical Chemistry, Thermodynamics; Taylor and Francis, Singapore, 2006.
12. K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry; 3rd Ed., New Age International Pvt. Ltd., New Delhi, 2014.

REFERENCE BOOKS

1. R. L. Flurry, Jr, Symmetry Groups: Theory and Chemical Applications; Prentice Hall, New Jersy, 1980.
2. S. F. A. Kettle, Symmetry and Structure; 2nd Ed., John Wiley and Sons, Chichester, 1995.
3. N. Levine, Quantum Chemistry; 5th Ed., Prentice Hall, New Jersey, 2000.

E RESOURCE

1. https://www.youtube.com/watch?v=pGerRhxNQJE
2. https://www.youtube.com/watch?v=R-x9KdNjQmo
3. https://www.youtube.com/watch?v=F_NmS-Wy2lE
4. https://www.youtube.com/watch?v=6QXtnmB1vqk
5. https://www.youtube.com/watch?v=1zZ6rvh1cgw

COURSE CODE	COURSE NAME	L	T	P	C
YCY104	Inorganic Chemistry Practical - I	0	0	6	3
PREREQUISITE	Nil	L	T	P	H
C:P:A	0.6: 2.2:0.2	0	0	6	6

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Recognize*** the chemical reaction takes place in the separation of inorganic mixture and in the colorimetric experiment and ***relate*** the results.	Cognitive and Psychomotor	Remember Perception
CO2	***Identify*** the various cations present in the given mixture and ***estimate*** the amount of metal ion present in the whole of the given solution by colorimetrically.	Cognitive and Psychomotor	Understand Set
CO3	***Interpret*** the results and ***labels*** the various specific metal ions present in the given solution.	Cognitive and Affective Phsycomotor	Apply Receive Mechanism
	Inorganic Chemistry Practical I		**6 hours each**
	To perform the semi-micro qualitative analysis. To estimate the metal ions using colorimeter.		
	Semi-micro qualitative analysis of a mixture containing two common cations (Pb, Bi, Ca, Cd, Fe, Cr, Al, Co, Ni, Mn, Zn, Ba, Sr, Ca, Mg, NH4) and two less common cations (W, Tl, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li). Estimation of copper, ferric, nickel, chromium and manganese ions using photoelectric colorimeter		
	TEXT BOOKS V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Ed., National Pubs, London, 1988. G. Svehla, Text Book of Macro and Semimicro Qualitative Inorganic Analysis; 5th Ed., Longman group Ltd, London, 1987. A. I. Vogel, Text Book of Quantitative Inorganic Analysis; 6th Ed., Longman, New Delhi, 2000		

LECTURE	TUTORIAL	TOTAL
90	0	90

COURSE CODE	COURSE NAME	L	T	P	H
YCY105	Physical Chemistry Practical - I	0	0	6	3
PREREQUISITE	Nil	L	T	P	H
C:P:A	0.6: 2.2:0.2	0	0	6	6

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Describe*** the definition and significance of physical parameters like rate constant, activation energy, order and various laws and also ***relate*** the results.	Cognitive and Psychomotor	Remember Perception
CO2	***Estimate*** the physical parameters of the reactions and ***explain*** the relation between these parameters.	Cognitive and Psychomotor	Understand Set
CO3	***Interpret*** the results and ***recognize*** the relation of physical parameters and its significance in the reaction.	Cognitive and Affective Phsycomotor	Apply Receive Mechanism
	Inorganic Chemistry Practical I		6 hours each
	Experiments. 1. Kinetics-acid hydrolysis of ester–comparison of strengths of acids. 2. Kinetics-acid hydrolysis of ester–determination of energy of activation (Ea). 3. Kinetics-saponification of ester–determination of ethyl acetate by conductometry. 4. Kinetics-persulfate-iodine reaction – determination of order, effective of ionic strength on rate constant. 5. Determination of molecular weight of substance by transition temperature method. 6. Determination of molecular weight of substances by Rast method. 7. Determination of Critical Solution Temperature (CST) of phenol-water system and effect of impurity on CST. 8. Study of phase diagram of two components forming a simple eutectic. 9. Study of phase diagram of two compounds forming a compound. 10. Study of phase diagram of three components system. 11. Determination of molecular weight of substances by cryoscopy. 12. Determination of integral and differential heat of solutions by colorimetry. 13. Polymerization-rate of polymerization of acrylamide. 14. Distribution law – study of Iodine-Iodine equilibrium. 15. Distribution law – study of association of benzoic acid in benzene. 16. Adsorption – oxalic acid/acetic acid on charcoal using Freundlich isotherm.		

TEXT BOOKS

1. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Ed., National Pubs, London, 1988.
2. G. Svehla, Text Book of Macro and Semimicro Qualitative Inorganic Analysis; 5th Ed., Longman group Ltd, London, 1987.
3. A. I. Vogel, Text Book of Quantitative Inorganic Analysis; 6th Ed., Longman, New Delhi, 2000

LECTURE	TUTORIAL	TOTAL
90	**0**	**90**

	SEMESTER II				
COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YCY201	**INORGANIC CHEMISTRY-II**	**4**	**1**	**0**	**5**
C:P:A	**4.0:0.5:0.5**	**L**	**T**	**P**	**H**
		4	**1**	**0**	**5**

COURSE OUTCOMES: ***On the successful completion of the course, students will be able to***		**DOMAIN**	**LEVEL**
CO1	***Recall*** and ***Explain*** the basic concepts of structure and bonding of organometallic compounds; ***Display*** the geometries of organometallic molecules using 18 electron rule.	Cognitive Psychomotor	Remember Understand Set
CO2	***Summarize and Report*** reaction mechanism of inorganic and organometallic compounds.	Cognitive Affective	Understand Respond
CO3	***Explain*** the physical and chemical properties of carbenes and ***Interpret*** the mechanism of their chemical reactions.	Cognitive Affective	Understand Apply Respond
CO4	***Describe*** the principles of bioinorganic chemistry and the application of various concepts.	Cognitive Psychomotor	Analyze Perception
CO5	***Identify*** the various metalloenzymes/ metalloporphyrins and their chemical properties.	Cognitive	Remember

SYLLABUS:

UNIT I -Structure and bonding in Organometallics:	
The 18 electron rule – applications and limitations – isolobal concept and its usefulness. Nitrosyl complexes – bridging and terminal nitrosyls, bent and linear nitrosyls – dinitrogen complexes – metallocene and arene complexes – metal carbenes. Classification based on captivity and polarity of M-C bond, organometallic compounds of lanthanides and actinides – fluxional organometallic compounds – organometallics in medicine, agriculture, horticulture and industry.	**15**
UNIT II -Reaction mechanism and Catalysis:	
Ligand substitution-oxidative addition and reductive elimination-1,1 and 1,2-insertion-addition and elimination reactions-alkene isomerization - hydroboration hydrocyanation – hydrogenation of olefins -Wilkinson's catalyst - hydroformylation of olefins- Wacker-Schmidt synthesis- Monsanto acetic acid process- Eastman Halcon process- Fischer-Tropsch process- hydrosilylation.	**15**
UNIT III Carbenes:	
Fischer and Schrock carbenes - bonding and reactivity- Grubbs catalyst- carbenes structure, synthesis and reactions-alkene metathesis – mechanism- C-H and C-C	**15**

activation- agnostic bonds -Ziegler-Natta polymerization of olefins-Heck reaction- The Pauson Khand reaction- Ene reaction.	
UNIT IV -General Principles of Bioinorganic Chemistry:	
Occurrence and availability of inorganic elements in biological systems – biomineralization – nucleation and crystal growth – various biominerals – calcium phosphate–iron biominerals – strontium and barium sulphate. Function and transport of alkali and alkaline earth metal ions: characterization of K^+, Na^+, Ca^{2+} and Mg^{2+} – complexes of alkali and alkaline earth metal ions with macrocycles – ion channels – ion pumps, catalysis.	**15**
UNIT V -Metalloporphyrins/Metalloenzymes:	
Dioxygen transport and storage-hemoglobin and myoglobin: electronic and spatial structures-hemeythrin and hemocyanine- synthetic oxygen carriers, model systems-blue copper proteins (Cu)-iron-sulfur proteins (Fe)-cytochromeselectron transport chain-carbon monoxide poisoning- iron enzymes- peroxidase, catalase and cytochrome P-450, copper enzymes- superoxide dismutase, vitamin B12 and B12 coenzymes, photosynthesis- photosystem-I &II, nitrogen fixation, cisplatin.	**15**

	LECTURE	**TUTORIAL**	**PRACTICAL**		**TOTAL HOURS**
Hours	**60**	**15**	**-**		**75**

References Books

1. J. E. Huheey, Inorganic Chemistry; 4th Ed., Harper and Row Publishers, Singapore, 2006.
2. K. F. Purcell and J. C. Kotz, Inorganic Chemistry; Thomson Learning, Boston, 1980.
3. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry; Panima Publishing Company, New Delhi, 1997.
4. W. Kaim and B. Schewederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life; 2nd Ed., John Wiley and Sons, New York, USA, 2013.
5. G. L. Eichhorn, Inorganic Biochemistry; Volumes 1 and 2, 2nd Ed., Elsevier Scientific Publishing Company, New York, 1975.
6. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry; 6th Ed., John Wiley and Sons, New York, 1999.
7. R. C. Mehrotra and A. Singh, Organometallic Chemistry; 2nd Ed., New Age International Ltd. New Delhi, 2014.
8. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals; 3rd Ed., John Wiley and Sons, New York, 2001.
9. S. E. Kegley and A. R. Pinhas, Problems and Solutions in Organometallic Chemistry; 2nd Ed., University Science Books, Oxford University Press, 1986.

10. A. J. Pearson, Advances in Metal-Organic Chemistry, Vol. 1; Jai Press, Inc., Greenwich, 1989.

Text books

1. A. W. Parkins and R. C. Poller, An Introduction to Organometallic Chemistry; 1987, Oxford University Press, Chennai.
2. I. Haiduc and J. J. Zuckerman, Basic Organometallic Chemistry; Walter De Gruyter Inc, USA, 1985.
3. P. Powell, Principles of Organometallic Chemistry; 2nd Ed., Chapman and Hall, London, 1988.
4. B. Douglas, D. H. McDaniel and J. J. Alexander, Concepts and Models of Inorganic Chemistry; 3rd Ed., John Wiley and sons, New York, 1994.
5. M. Bochmann, Organometallics 1: Complexes with transition metal-carbon bonds; Oxford Chemistry Primers Series, No. 12, and M. Bochmann, Organometallics 2: Complexes with transition metal-carbon bonds; No. 13, 1994.
6. J. P. Collman, L. S. Hegedus, J. R. Norton and R. G. Finke, Principles and Applications of Organotransition Metal Chemistry, University Science Books, California, 1987

E-Resources

1. https://nptel.ac.in/courses/104103069/33
2. https://nptel.ac.in/courses/104105038/21
3. https://onlinecourses.nptel.ac.in/noc18_cy09/preview

COURSE CODE	COURSE NAME	L	T	P	C
YCY202	PHYSICAL CHEMISTRY-II	4	1	0	5
C:P:A	4.5:0:0.5	L	T	P	H
		4	1	0	6

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Explain*** the various symmetry elements and symmetry operations	Cognitive	Understanding
CO2	***Describe*** the physical aspects of molecular spectroscopy and interaction of electromagnetic radiation with monoatomic and diatomic molecules.	Cognitive	Remember
CO3	***Interpret*** third law of thermodynamics and thermodynamic properties of real gases	Cognitive Affective	Apply Receiving
CO4	***Describe*** the principle of dynamics of electron transfer and electro deposition of metals.	Cognitive Affective	Remember Responding
CO5	***Apply*** and ***Identify*** the various concepts of adsorption and free energy reaction at interphase.	Cognitive	Apply Remember

SYLLABUS:

UNIT I -Concept of Group Theory	
Symmetry elements and operations – point groups – assignment of point groups to molecules – group postulates and types of groups – group multiplication tables, sub groups, similarity transformations – conjugate elements and classes.Matrix representation of symmetry operations and point groups – reducible and irreducible representations – properties of irreducible representation.The great orthogonality theorem – construction of character table – direct product – projection operators – symmetry of hybrid orbitals.	**15**
UNIT II -Molecular Spectroscopy	
Einstein coefficient of absorption and transition probabilities -basis of selection rules -Representation of spectra -the width and intensity of spectra transitions oscillator strength. Electronic spectra -electronic spectra of molecules -Born Oppenheimer approximation -vibrational coarse structure -Franck-condon principle -dissociation energy -fortrat diagram -Pre-dissociation -various types of transitions -solvent effect on spectra. Infra red spectra -vibrational spectra -selection rules -harmonic and anharmonic oscillators -vibration and rotation spectra of diatomic molecules -vibration spectra of polyatomic molecules -normal vibration and normal coordinates -Influence of rotation on the spectra of polyatomic molecules -parallel and perpendicular bands -FTIR. Laser Raman spectra -rotational Raman spectra of linear	**15**

molecules -vibrational Raman spectra -rotational fine structure -Fermi resonance.	
UNIT III- Classical Thermodynamics	
Third law, thermodynamics, need for it, Nernst heat theorem and other forms of stating the third law. Thermodynamic quantities at absolute zero, apparent exceptions to the third law - thermodynamics of systems of variable composition, partial molar properties, chemical potential, relationship between partial molar quantities, Gibbs Duhem equation and its applications (the experimental determination of partial molar properties not included) - thermodynamic properties of real gases, fugacity concept, calculation of fugacity of real gas, activity and activity coefficient, concept, definition, standard states and experimental determinations of activity and activity coefficient of electrolytes.	**15**
UNIT IV- Electrochemistry II	
Dynamics of electron transfer – Marcus theory – tunneling – the rate of charge transfer – current density – Butler-Volmer equation – Taft equation – 29 polarization and overvoltage – mechanism of hydrogen evolution and oxygen evolution reactions. Principles of electrodeposition of metals – corrosion and passivity – Pourbaix and Evans diagrams – methods of protection of metals from corrosion. Power storage systems – fuel cells – construction and functioning – applications – photovoltaic cells	**15**
UNIT V- Surface Phenomena	
Adsorption and free energy reaction at interphase -potential energy diagram - Lennard-Jones plot -surface area determination -heats of adsorption -determination - adsorption from solution -Gibbs adsorption theorem -solid-liquid interface -Wetting and contact angle -solid-gas interfaces -soluble and insoluble films. Surface tension: methods of measuring surface tension -electrical phenomena at interface including electro kinetic phenomenon -Micelles and reverse micelles -solubilisation -micro emulsion or micellar emulsions. Role of surface in catalysis: semiconductor catalysis -n-and p-type surfaces -kinetics of surface reaction involving adsorbed species. Langmuir-Hinshelwood mechanism of bimolecular reaction -Langmuir-Rideal mechanism -Rideal-Eley mechanism.	**15**

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**

Reference Books

1. K. Chandra, Introductory Quantum Chemistry, 4th ed., Tata McGraw Hill, 1994.
2. R. K. Prasad, Quantum Chemistry, 2nd ed., New Age International Publishes (2000),
3. I. N. Levine, Quantum Chemistry, 4th ed., Prentice Hall of India Pvt Ltd., (1994),
4. D. A. McQuarrie, Quantum Chemistry, University Science Books (1998),
5. S. Glasstone, Introduction to Theoretical Chemistry, Affiliated East-West Press
6. G. N. Barrow, Introduction to Molecular Spectroscopy, International Mc.Graw Hill Edition (1993),
7. G. N. Barrow, Introduction to Molecular Spectroscopy, International McGraw Hill Student Edition (1984),
8. B. P. Straughan and S. Walker, Spectroscopy, Vol.I to III, Chapman Hall, London (1976),
9. S. Glasstone, Thermodynamics for Chemists, East-west Affiliated Pvt Ltd, New Delhi (1969),
10. R. P. Rastogi and R. R. Misra, An Introduction to Chemical Thermodynamics Vikas Publishing House Pvt Ltd., (1992),

Text Books

1. Kloz and P. M. Rosenberg, Chemiscal Thermodynamics: Basics Theory and Methods, 3rd ed., W. A. Benjamin, NY (1974),
2. K. J. Laidler, Chemical Kinetics,2nd ed, Tata McGraw Hill (1975),
3. A. A. Frost and R. G. Pearson, Kinetics and Mechanisms, John Wiley & Sons (1953),

E-Resources

https://nptel.ac.in/courses/103106070/33
https://nptel.ac.in/courses/113108051/2
https://onlinecourses.nptel.ac.in/noc18_cy15/preview

COURSE CODE	COURSE NAME	L	T	P	C
YCY203	INORGANIC PRACTICAL-II	0	0	6	3
C:P:A	0.6: 2.2:0.2	L	T	P	H
		0	0	6	6

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Identify*** the various Metals ions in the solution using volumetric method	Cognitive Psychomotor	Remember Perception
CO2	***Estimate*** the amount of Metal ions present in solution using gravimetric method.	Cognitive Psychomotor	Understand Set
CO3	***Synthesis*** of various inorganic compounds.	Cognitive Psychomotor Affective	Apply Set Receiving

1.	**Titrimetry (V) and Gravimetry (G)** A mixture of solution(s) should be given for estimation 1. Cu (V) and Ni (G); 2. Cu (V) and Zn (G); 3. Fe (V) and Zn (G); 4. Fe (V) and Ni (G); 5. Zn (V) and Cu (G).
2.	**Preparation of the following compounds:** 1. Tetramminecopper (II) sulphate. 2. Potassium trioxalatochromate (III). 3. Potassium trioxalatoaluminate (III). 4. Trithioureacopper (I) chloride. 5. Trithioureacopper (I) sulphate.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	-	-	90	90

Reference Book

1. A. I. Vogel, "Quantitative Inorganic Analysis", ELBS, 3rd Edition, 1971.
2. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Ed., National Pubs, London, 1988.
3. G. Svehla, Text Book of Macro and Semimicro Qualitative Inorganic Analysis; 5th Ed., Longman group Ltd, London, 1987.

COURSE CODE	COURSE NAME	L	T	P	C
YCY204	PHYSICAL PRACTICAL-II	0	0	6	3
C:P:A	0.6: 2.2:0.2	L	T	P	H
		0	0	6	6

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Identify*** the strength of various types of solutions using conductometric method.	Cognitive Psychomotor	Remember Perception
CO2	***Estimate*** the dissociation constants of acids using conductometric method.	Cognitive Psychomotor	Understand Set
CO3	***Estimate*** the dissociation constants, solubility and activity coefficients of various ions using potentiometric method.	Cognitive Psychomotor Affective	Apply Set Receiving

Any ten experiments (to be decided by the course teacher) out of the following experiments.

1. Conductometry - Acid- alkali titrations.
2. Conductometry - Precipitation tritrations.
3. Conductometry - Displacement titrations.
4. Conductometry - Determination of dissociation constant of weak acids.
5. Conductometry - Solubility product of sparingly soluble silver salts.
6. Conductometry- Verification of Onsager equation
7. Conductometry - Determination of degree of hydrolysis and hydrolysis constant of a substance.
8. Conductometry - To determine the relative strength of two acids.
9. Potentiometric titrations - Acid alkali titrations.
10. Potentiometric titrations - Precipitation titrations.
11. Potentiometric titrations - Redox titrations.
12. Potentiometry - Determination of dissociation constant of weak acids.
13. Potentiometry - Determination of solubility of silver salts.
14. Potentiometry - Determination of activity and activity coefficient of ions.
15. Potentiometry - pH titration of ortho -phosphoric acid.
16. Potentiometry- To determine the pH of a buffer solution using quinhydrone electrode.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	-	-	90	90

Reference:

1. J. B. Yadav, "Advanced Practical Physical chemistry", 20th edn. GOEL publishing House, Krishna Pakashan Media Ltd., (2001).
2. Findlay's "Practical Physical Chemistry" Revised and edited by B. P. Levitt 9th ed., Longman, London, 1985.
3. J. N. Gurtur and R. Kapoor, "Advanced Experimental chemistry", Vol. I. Chand & Co., Ltd

COURSE CODE	COURSE NAME	L	T	P	C
	SOLID STATE CHEMISTRY-IA	**4**	**1**	**0**	**5**
YCY205A					
C:P:A	**4.5:0:0.5**	**L**	**T**	**P**	**H**
		4	**1**	**0**	**5**

COURSE OUTCOMES: ***On the successful completion of the course, students will be able to***		**DOMAIN**	**LEVEL**
CO1	***Explain*** the concepts of crystal structure and basics of crystal engineering of organic solids.	Cognitive	Understand
CO2	***Summarize*** and ***Report*** the chemical properties of Metallo organic frameworks and their applications.	Cognitive Affective	Understand Respond
CO3	***Interpret*** various method for preparation and crystallization of solids.	Cognitive Affective	Apply Receive
CO4	***Describe*** the magnetic and optical properties of inorganic solids.	Cognitive Affective	Remember Respond
CO5	***Apply*** and ***Identify*** the various concepts of solid state chemistry with respect to organic solids.	Cognitive	Apply Remember

SYLLABUS:

UNIT I- Crystal Structure and Crystal Engineering of Organic Solids	
Types of close packing – hcp and ccp – packing efficiency – SC, BCC, and FCC, radius ratio rule – applications – polyhedral description of solids – structure types: Na_2O, Cs_2O, rutile, perovskite (ABO_3), ReO_3, K_2NiF_4, spinels and antispinels. Hydrogen bonded supramolecular patterns involving water / carboxyl / halide motifs – concepts of different types of synthons based on non-covalent interactions – principles ofcrystalengineering and non-covalentsynthesis– polymorphism and pseudopolymorphism – supramolecular isomorphism, polymorphism and crystal engineering of pharmaceutical phases.	**15**
UNIT II- Metal Organic Frameworks	
M.O.Fs (Metal Organic Frameworks) – organometallic systems – combinations of different interactions to design molecular rods, triangles, ladders, networks, etc. Design of nanoporous solids. Interligand hydrogen bonds in metal complexes – implications for drug design – crystal engineering of NLO and OLED materials.	**15**
UNIT III- Preparative Methods in Solid State Chemistry	
Experimental procedure, coprecipitation as a precursor to solid state reaction, other precursor methods, kinetics of solid state reactions – crystallizations of solutions, melts, glasses and gels, solutions and gels: zeolite synthesis – precipitation from solution or melt: flux method, epitaxial growth of thin layers, verneuil flame fusion method. Graphite intercalation compounds, transition metal dichalcogenide and other intercalation compounds, ion exchange reaction, synthesis of new metastable phases by 'Chimie Douce'.	**15**

Vapour phase transport, hydrothermal methods, comparison of different methods – high pressure and hydrothermal methods and dry high pressure methods.	
UNIT IV -Magnetic Materials and Optical Properties	
Selected examples of magnetic materials and their properties – metals and alloys, transition metal oxides, spinels, garnets, ilmenite and perovskites. Magnetoplumbites – applications – structure/property relations – transformer, information storage, magnetic bubble memory devices, permanent magnets. Luminescence, Lasers and phosphors – definitions and general comments, configurational coordinate model, some phosphor materials, anti-Stokes phosphors – lasers – the ruby laser, Neodymium lasers	**15**
UNIT V- Organic Solid State Chemistry	
Topochemical control of solid state organic reactions – intramolecular reactions – conformational effects – intermolecular reactions – molecular packing effects – photodimerization of 2-ethoxycinnamic acid (α form, β form, γ form) – photopolymerization of 2,5-distyrylpyrazine – photopolymerizations of diacetylenes. Asymmetric syntheses – dimerization of anthracene – control of molecular packing arrangements.	**15**

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**

REFERENCE BOOKS

1. R. West, Solid State Chemistry and Its Applications; 2nd Ed., John Wiley and sons, New York, 2014 (Unit III – V).
2. J. M. Lehn, Supramolecular Chemistry; VCH, Weinheim, 1995.
3. G. R. Desiraju, Crystal Engineering: The Design of Organic Solids; Elsevier, Amsterdam, 1989.
4. G. R. Desiraju, and T. Steiner, The Weak Hydrogen Bond in Structural Chemistry and Biology; Oxford University Press: Oxford, 2002.
5.

TEXT BOOKS

1. J. M. Lehn, Transition Metals in Supramolecular Chemistry; Vol 5, John Wiley and Sons, New York, 1999.
2. G. A. Jeffrey, Introduction to Hydrogen Bonding; Oxford University Press, New York, 1997. C. N. R. Rao, Current Science, 2001, 81, 1030.

i.

E-RESOURCES

(i) http://www.pubs.acs.org/journals/cgdefu/index.html

(ii) http://www.rsc.org/Publishing/ Journals /ce/ index.asp

COURSE CODE	COURSE NAME	L	T	P	C
YEC205B	SUPRAMOLECULAR CHEMISTRY-IB	4	0	0	5
C:P:A	4.0:0.5:0.5	L	T	P	H
		4	1	0	5

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Recall*** and ***Explain*** the basic concepts of supramolecular chemistry; ***Display*** the synthons based interactions and polymorphism.	Cognitive Psychomotor	Remember Understand Set
CO2	***Summarize and Report*** the chemical properties of Metallo organic frameworks and their applications.	Cognitive Affective	Understand Respond
CO3	***Explain*** the concepts of co-receptor molecules and multiple rcognition.	Cognitive Affective	Understand Apply Respond
CO4	***Describe*** the reactivity of supromoleclar compounds and the mechanism of catalysis.	Cognitive Psychomotor	Analyze Perception
CO5	***Identify*** the applications of various supramolecular compounds.	Cognitive	Remember

SYLLABUS:

UNIT I- Concepts of Supramolecular Chemistry	
Concepts and languages of supramolecular chemistry – various types of non-covalent interactions – hydrogen bonds, C-H···X interactions, halogen bonds – π-π interactions, non–bonded interactions – various types of molecular recognition.Crystal engineering of organic solids – hydrogen bonded supramolecular patterns involving water / carboxyl / halide motifs – concepts of different types of synthons based on non-covalent interactions – principles of crystal engineering and non-covalent synthesis – polymorphism and pseudopolymorphism – supramolecular isomorphism / polymorphism – crystal engineering of pharmaceutical phases.	**15**
UNIT II -Metallo-Organic Frameworks	
M.O.F (Metallo Organic Frameworks) – organometallic systems – combinations of different interactions to design molecular rods, triangles, ladders, networks, etc. – design of nanoporous solids – interligand hydrogen bonds in metal complexes – implications for drug design – crystal engineering of NLO materials, OLED.	**15**
UNIT III- Co-receptor Molecules and Multiple Recognition	
Dinuclear and polynulclear metal ion cryptates – linear recognition of molecular length by ditopic co-receptors – heterotopic co-receptors – cyclophane receptors, amphiphilic receptors and large molecular cages – multiple recognition in metalloreceptors – supramolecular dynamics.	**15**
UNIT IV- Supramolecular Reactivity and Catalysis	

Catalysis by reactive macrocyclic cation receptor molecules – catalysis by reactive anion receptor molecules – catalysis with cyclophane type receptors – supramolecular metallocatalysis – cocatalysis – catalysis of synthetic reactions – biomolecular and abiotic catalysis. Supramolecular chemistry in solution – cyclodextrin, micelles, dendrimers, gelators – classification and typical reactions – applications.	**15**
UNIT V- Supramolecular Devices	
Supramolecular devices and sensors – various types of supramolecular devices – an overview – supramolecular photochemistry – molecular and supramolecular photonic devices – light conversion and energy transfer devices – molecular and supramolecular electronic devices – electronic conducting devices – molecular wires, modified and switchable molecular wires – molecular and supramolecular ionic devices – tubular mesophases, molecular protonics – switching devices – electro-photo switch – ion and molecule sensors – role of supramolecular chemistry in the development of nanoscience and technology.	**15**

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**

REFERENCES

1. J. M. Lehn, Supramolecular Chemistry; VCH, Weinheim, Germany, 1995.
2. G. R. Desiraju, Crystal Engineering: The Design of Organic Solids; Elsevier, United States, 1989.
3. G. R. Desiraju, and T. Steiner, The Weak Hydrogen Bond in Structural Chemistry and Biology; Oxford University Press, Oxford, 1999.

TEXT BOOKS

1. G. A Jeffrey, Introduction to Hydrogen Bonding; Oxford University Press: UK, 1997.
2. J. M. Lehn, Transition Metals in Supramolecular Chemistry; John Wiley and Sons: New York, 1999.
3. G. R. Desiraju, Current Science; 2001, 81, 1038.

E-RESOURCES

(i) http://www.pubs.acs.org/journals/cgdefu/index.html
(ii) http://www.rsc.org/Publishing/ Journals /ce/ index.asp

	SEMESTER III	L	T	P	C
COURSE CODE	**COURSE NAME**	**4**	**1**	**0**	**5**
YCY301	**ORGANIC CHEMISTRY II**	**L**	**T**	**P**	**H**
C: P: A	**4.5:0:0.5**	**4**	**1**	**0**	**5**

COURSE OUTCOMES:		**Domain**	**Level**
CO1	***Recall*** and ***summarize*** the nucleophilic substitution reactions of aliphatic and aromatic compounds.	Cognitive	Remember Understand
CO2	***Outline*** the reaction mechanism of electrophilic substitution reactions and explain the structure and orientation of the substituted products.	Cognitive	Remember Understand
CO3	***Identify*** the reagents of various rearrangement reaction and ***illustrate*** the mechanism of the addition and elimination reactions	Cognitive	Apply Understand
CO4	***Recognize*** and ***Interpret*** the preparation and properties ***of*** various heterocyclic compounds	Cognitive Affective	Understand Receive
CO5	***Understand*** and ***Examine*** the structural components of various of natural products.	Cognitive Affective	Analyze Receive

UNIT I - NUCLEOPHILIC SUBSTITUTION REACTIONS **15**

Aliphatic nucleophilic substitution – mechanisms – SN1, SN2, SNi – ion-pair inSN1 mechanisms – neighbouring group participation, non-classicalcarbocations – substitutions at allylic and vinylic carbons. Reactivity – effect of structure, nucleophile, leaving group and stereochemical factors – correlation of structure with reactivity – solvent effects – rearrangements involving carbocations – Wagner-Meerwein and dienone-phenol rearrangements.

Aromatic nucleophilic substitutions – SN1, SNAr, Benzyne mechanism – reactivity orientation – Ullmann, Sandmeyer and Chichibabin reaction – rearrangements involving nucleophilic substitution – Stevens – Sommelet- Hauser and von-Richter rearrangements.

UNIT II - ELECTROPHILIC SUBSTITUTION REACTIONS **15**

Aromatic electrophilic substitution reaction – orientation, reactivity and mechanisms based on transition state theory with suitable reactions – substitutions in thiophene and pyridine – N-oxide quantitative treatment of the structural effects on reactivity. Substituent effects – origins of Hammett equation – principles of Hammett correlation – effect of structure on reaction mechanisms Hammett parameters – σ and ρ, modified forms of Hammett equation, Taft Equation.

Aliphatic electrophilic substitution – SE2, SEi and SE1 mechanisms – diazonium coupling reactions – metals as electrophile in substitution reactions and decomposition of diazonium salts.

UNIT III - ADDITION AND ELIMINATION REACTIONS **15**

Addition to carbon-carbon multiple bonds – electrophilic, nucleophilic and free radical additions – orientation of the addition – stereochemical factors influencing the addition of bromine and hydrogen bromide, hydroxylation, 1,2- dihydroxylation – hydroboration leading to formation of alcohols – oxidation and ozonolysis. Addition to carbonyl and conjugated carbonyl systems – mechanism – Grignard reagents – 1,2- and 1,4-additions (lithium dimethylcuprate) – addition to carbon-oxygen double bond – Benzoin, Knoevenagel, Stobbe, Darzens glycidic ester condensation and Reformatsky reactions.

Elimination reactions – mechanisms; E1, E2, E1cB – stereochemistry of elimination, Hofmann's and Zaitsev's rules – competition between elimination and substitution – pyrolytic

cis-elimination, Chugaev reaction – examples such as Hofmann degradation, Cope elimination – Bredt's rule with examples.

UNIT IV - HETEROCYCLES	**15**

Nomenclature: Trivial, systematic and replacement nomenclature – nonaromatic heterocycles – synthesis of tetrahydrofurans – pyrrolidines – tetrahydropyrans – piperidines. Synthesis and reactivity of heterocycles: aziridines – oxiranes – thiiranes – azetidines – oxetanes – oxazoles – imidazoles – thiazoles – isooxazoles. Synthesis and reactivity of aromatic heterocycles: pyrazoles – isothiazoles – triazoles – pyrimidines – purines – triazines – pyridazines – pyrazines.

UNIT V - NATURAL PRODUCTS	**15**

Terpenoids: introduction – biosynthesis of menthol, camphor – total synthesis: Takasago synthesis of menthol, Corey's synthesis of longifolene, Curran's synthesis of hirsutene.
Steroids: introduction – partial synthesis of androsterone and testosterone (from Cholesterol) – total synthesis: Johnson's synthesis of progesterone and Vollhardt's synthesis of estrone.
Alkaloids: introduction – biosynthesis of nicotine, camptothecin – total synthesis: Corey's synthesis of epibatidine, Comin's asymmetric synthesis of Camptothecin and Woodward's synthesis of reserpine.

LECTURE	**TUTORIALS**	**SELF STUDY**	**PRACTICAL**	**TOTAL**
60	**15**	**-**	**-**	**75**

TEXT BOOKS

1. S. H. Pine and J. B. Hendrickson, D. J. Cram and G. S. Hammond, Organic Chemistry; 5th Ed., McGraw Hill, Noida, (1987).
2. T. H. E. Lowry and K. S. Richardson, Mechanism and Theory in Organic Chemistry; 3rd Ed., Benjamin-Cummings Publishing, USA, (1997).
3. J. March and M. B. Smith, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th Ed., Wiley, New York, (2007).
4. J. Clayden, N. Greeves, S. Warren, and P. Wothers, Organic Chemistry, 2nd Ed., Oxford University Press, UK, (2012).
5. I. L. Finar, Organic Chemistry; Vol.II, 7th Ed., Pearson Education Ltd., New Jersey, (2009).

REFERENCES

1. R. K. Bansal, Reaction Mechanism in Organic Chemistry; Tata McGraw Hill, Noida, (1990)
2. F. A. Carey, and R. J. Sundberg, Advanced Organic Chemistry, Parts A and B, 5th Ed., Springer, Germany, (2007).
3. E. J. Corey, and X-M. Cheng, The Logic of Chemical Synthesis; 1st Ed., Wiley-Interscience, New York, (1995).
4. T. L. Gilchrist, Heterocyclic Chemistry; 3rd Ed., Prentice Hall, New Jersey, 1997.
5. R. K. Bansal, Heterocyclic Chemistry; 3rd Ed., Wiley Eastern Ltd, New Delhi, 1999.
6. K. C. Nicolaou and E. J. Sorensen, Classics in Total Synthesis, Targets, Strategies, Methods; Wiley VCH, Germany, 1996.
7. Longifolene: F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry; Vol.2. 5th Ed., Springer, Berlin, 2008.
8. Androsterone and Testosterone: J. Chem. Soc. Perkin Trans. I; 1986, 117.
9. Epibatidine: J. Org. Chem; 1993, 58, 5600.
10. Estrone, Estradiol and 2-Methoxyestradiol: J. Org. Chem; 2009, 74, 6362.

COURSE CODE	COURSE NAME	L	T	P	C
YCY302	PHYSICAL METHODS IN CHEMISTRY-I	4	1	0	5
PREREQUISITE	NIL	L	T	P	H
C:P:A	4.5:0:0.5	4	1	0	5

COURSE OUTCOMES		DOMAIN	LEVEL
After the completion of the course, students will be able to			
CO1	***Explain*** the basic principles of molecular spectroscopy.	Cognitive	Understand
CO2	***Relate*** the fundamentals of NMR spectroscopy and interpret the NMR spectra of organic compounds.	Cognitive	Remember Understand
CO3	***Explain*** the principles of UV, and IR spectroscopy ***&*** ***Identify*** the IR and UV active organic compounds	Cognitive	Understand Apply
CO4	***Apply*** the techniques of ESR, ORD and Mass spectroscopy of organic compounds.	Cognitive Affective	Apply Respond
CO5	***Examine*** the X-ray, electron, neutron diffractions of simple compounds.	Cognitive Affective	Analyze Receive

UNIT I	PRINCIPLES OF MOLECULAR SPECTROSCOPY	15

Interaction of electromagnetic radiation with molecular systems, Microwave spectroscopy – rotational spectra of diatomic molecules, rigid and non-rigid rotors – intensity of spectral lines – effects of isotopic substitution – microwave spectra of polyatomic molecules – linear and symmetric top molecules – infrared spectra – diatomic molecules, simple harmonic and anharmonic oscillators – diatomic vibrating rotator rotation – vibration spectrum of carbon monoxide – interaction of rotation and vibration (breakdown of Born-Oppenheimer approximation) – influence of the rotation on the spectrum of polyatomic molecules, linear and symmetric top molecules, parallel and perpendicular vibrations – influence of nuclear spin. Raman spectra – rotational Raman spectra of linear and symmetric top molecules – vibrational Raman spectra – rotational fine structure – electronic spectra of diatomic molecules – vibrational coarse structure – intensity of vibrational lines in electronic spectra – rotational fine structure – fortrat diagram.

UNIT II	NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY	15

^{1}H NMR Spectroscopy – multiplicity – coupling constant – spin-spin splitting – vicinal and geminal coupling constants – Karplus equation – long range coupling constants, influence of stereochemical factors on chemical shift of protons. Simplification of complex spectra – double resonance techniques, shifts reagents – chemical spin decoupling of rapidly exchangeable protons (OH, SH,
COOH, NH, NH_2) – an elementary treatment of NOE phenomenon. ^{13}C NMR Spectroscopy – broad band decoupling – off resonance decoupling – chemical shifts of common functional groups – FT NMR and its importance-DEPT spectra – identification of small compounds based on NMR data – 2D techniques: 1H–1H COSY, ^{1}H–^{13}C HETCOSY – NOESY.

UNIT III	UV-VISIBLE AND IR SPECTROSCOPY	15

UV-Visible spectroscopy – introduction – instrumentation, sampling techniques – Woodward-Fieser and Scott's rules for conjugated dienes and polymers, ketones, aldehydes, α,β-unsaturated acids, esters, nitriles, and amides – differentiation of geometrical isomers and positional isomers – disubsitituted benzene derivatives – study of steric effect in aromaticity.
Infrared spectroscopy – Introduction – instrumentation, sampling techniques – factors influencing group frequencies – quantitative studies – hydrogen bonding (intermolecular and

intramolecular).

UNIT IV	ESR, ORD AND MASS TECHNIQUES	15

ESR – basic principles – comparison between ESR and NMR spectra – hyperfine splitting – applications to organic free radicals.

Optical rotatory dispersion and circular dichroism – introduction to theory and terminology – cotton effect – ORD curves – axial halo-ketone rule and its applications – the octant rule – its applications – applications of ORD to determine absolute configuration of monocyclic ketones – comparison between ORD and CD – their interrelationships.

Mass Spectrometry – instrumentation – resolution – ESI, EI, CI and FAB methods – base peak, isotopic peaks, metastable peaks – importance of metastable peaks, parent peak, recognition of molecular ion peak – fragmentation – general rules – pattern of fragmentation for various classes of compounds, McLafferty rearrangement – nitrogen rule.

UNIT V	X-RAY DIFFRACTION	15

X-Ray diffraction by single crystal method – space groups – systematic absences in X-ray data and identification of lattice types, glide planes and screw axes – X-ray intensities – structure factor and its relation to intensity and electron density – phase problem – structure solution by heavy atom method and direct method – determination of absolute configuration of molecules – a brief account of Cambridge Structural Database (CSD) and Protein Data Bank (PDB).

Electron diffraction by gases – scattering intensity vs. scattering angle, Wierl equation – measurement techniques. Neutron diffraction by crystals – magnetic scattering – measurement techniques – elucidation of structure of magnetically ordered unit cell.

LECTURE	TUTORIAL	SELF STUDY	PRACTICAL	TOTAL
60	15	-	-	75

TEXT BOOKS

1. C. N. Banwell, Fundamentals of Molecular Spectroscopy; 4th Ed., McGraw Hill Education, Noida, 1994.
2. B. P. Straughan and S. Walker, Spectroscopy; Vol.3, Halstead Press, Sydney, 1978.
3. G. M. Barrow, Introduction to Molecular Spectroscopy; McGraw Hill, New York,1964.
4. P. K. Ghosh, Introduction to Photoelectron Spectroscopy; John Wiley, New York, 1989.
5. P. M. Silverstein and amd F. X. Western, Spectroscopic Identification of Organic Compounds; 8th Ed., John Wiley, New York, 2014.

REFERENCES

1. W. Kemp, Organic Spectroscopy; 3rd Ed., Palgrave, New York, 1991.
2. J. R. Dyer, Applications of Absorption Spectroscopy of Organic Compounds, PHI Learning, New Delhi, 2009.
3. Y. R. Sharma, Elementary Organic Spectroscopy – Principles and Chemical applications; S. Chand, New Delhi, 1992.
4 . P. S. Kalsi, Spectroscopy of Organic Compounds; 6th Ed., New Age International Publishers, New Delhi, 2004.
5. W. Clegg, Crystal Structure Determination; Oxford University press, UK, 1998.
6. G. H Stout and L. H. Jensen, X-ray Structure Determination: A Practical Guide; John Wiley and Sons, New York, 1992.
7. J. P. Glusker and K. N. Trueblood, Crystal Structure Analysis: A Primer; 3rd Ed., Oxford University Press, UK, 2010.

8. D. N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques; University
Press, Hyderabad, 2001.

E REFERENCES

1. Web Pages: Cambridge Structural Database (CSD)-
http://www.ccdc.cam.ac.uk/products/csd/Protein Data Bank (PDB)
2. http://www.rcsb.org/pdb/home/home.do

COURSE CODE	COURSE NAME	L	T	P	C
YCY303	ORGANIC CHEMISTRY PRACTICAL –I	0	0	6	3
PREREQUISITE	Nil	L	T	P	H
C:P:A	1.8: 0.8:0.4	0	0	6	6

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Interpret*** the individual organic components present in the given organic mixture.	Cognitive Psychomotor	Understand Perception
CO2	***Estimate*** the melting point/boiling point of the synthesized compounds /individual component present in the mixture.	Cognitive Psychomotor	Understand Set
CO3	***Predict*** the nature of functional group present in the given mixture.	Cognitive Psychomotor Affective	Apply Set Receive

ORGANIC CHEMISTRY PRACTICAL –I

1. Qualitative analysis of an organic mixture containing two components

Mixtures containing two components are to be separated (pilot separation) and purified (bulk separation) – The physical constants are to be reported (analysis).

2. Preparation of organic compounds (single stage)

1. Methyl-*m*-nitrobenzoate from methylbenzoate (nitration)
2. Glucose pentaacetate from glucose (acetylation)
3. Resacetophenone from resorcinol (acetylation)
4. Benzophenone oxime from benzophenone (addition)
5. *o*-Chlorobenzoic acid from anthranilic acid (Sandmayer reaction)
6. *p*-Benzoquinone from hydroquinone (oxidation)
7. Phenylazo-2-naphthol from aniline (diazotization)

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	0	0	90	90

TEXT BOOKS

1. J. Mohan, Organic Analytical Chemistry: Theory and Practice; Narosa, (2003).
2. V. K. Ahluwalia, P. Bhagat, and R. Agarwal, Laboratory Techniques in Organic Chemistry; I. K. International, (2005).
3. N. S. Gnanaprakasam and G. Ramamurthy, Organic Chemistry Lab Manual; S.V.Printers, (1987).
4. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford and P. W. G. Smith, Vogel's Textbook of Practical Organic Chemistry; 5th Ed., Prentice Hall, (1989).

COURSE CODE	COURSE NAME	L	T	P	C
YEC304A	PHARMACEUTICAL CHEMISTRY	4	1	0	5
PREREQUISITES	Nil	L	T	P	H
C:P:A	4:0:1	4	1	0	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Recall*** the various terminology of pharmaceutical chemistry.	Cognitive	Remember Understand
CO2	***Outline*** the structural aspects of antibiotics and ***relate*** their functions..	Cognitive	Understand
CO3	***Illustrate*** the biological activities of analgesic and antipyretics.	Cognitive Affective	Remember Understand Receive
CO4	***Summarize*** the activities of anaesthetics and local anaesthetics.	Cognitive Affective	Understand Respond
CO5	***Inference*** the various concepts of clinical chemistry.	Cognitive Affective	Analyze Respond

UNIT I	BASICS OF PHARMACEUTICALCHEMISTRY	15

Definitions – the terms – drugs, pharmacology, pharmacy, chemotherapy, therapeutics – pharmacologically active principles in plants – first aid – important rules of first aids, cuts, fractures, bleeding for blood, maintaining breathing burns and first aid box – tuberculosis (t.b.), jaundice, piles, typhoid, malaria, cholera – causes – symptoms, diagnosis – prevention and treatment – medicinally important compounds of iron – ferrous gluconate, ferrous sulphate and ferric ammonium citrate.

UNIT II	ANTIBIOTICS	15

Definition – introduction – classification and biological actions – penicillin, chloramphenicol, streptomycin and tetracycline – structure, properties and therapeutic uses – chemical structure and pharmacological activity – effect of unsaturation, chain length, isomerism, halogens, amino groups, hydroxyl groups and acid groups.

UNIT III	ANALGESIC AND ANTIPYRETICS	15

Narcotic analgesic – analgesic action of morphine – derivatives of morphine – heroin and apomorphine – synthetic analgesics – pethidine, methadone – nonnarcotic analgesic – aspirin, paracetamol and phenacetin – analgin – preparation, properties and uses – ibuprofen and ketoprofen – structure and uses.

UNIT IV	ANAESTHETICS AND LOCAL ANAESTHETICS	15

Characteristics of anaesthetics – classification of anaesthetics – general anaesthetics – volatile anaesthetics – ether, chloroform and halothane – advantages and disadvantages – non-volatile anaesthetics (intravenous anaesthetics) – methohexitone and propanidid – structure and uses – cocaine and amethocaine – structure and uses – benzocaine and procaine – structure,
synthesis and uses.

UNIT V	CLINICAL CHEMISTRY	15

Determination of sugar (glucose) in serum – *o*-toluidine method – diagnostic test for sugar in urine – Benedict's test – detection of diabetes – detection of cholesterol in urine – detection of anaemia – estimation of haemoglobin (Hb concentration) – red cell count.

LECTURE	TUTORIAL	SELF STUDY	PRACTICAL	TOTAL
60	15	-	-	75

TEXT BOOKS

1. Jayashree Ghosh, A Text Book of Pharmaceutical Chemistry; 5th Ed., S.Chand and Company Ltd., New Delhi, (2014).

REFERENCES
1. S. Lakshmi; Pharmaceutical Chemistry; 1st Ed., S. Chand and Company Ltd., New Delhi, (1995). 2. Bhagavathi Sundari; Applied Chemistry; 1st Ed., MJP Publishers, Chennai, (2006).

COURSE CODE	COURSE NAME	L	T	P	C
YCY304B	ELECTR-ORGANIC CHEMISTRY	4	1	0	5
PREREQUISITES	Nil	L	T	P	H
C:P:A	4.4:0:0.6	4	1	0	5

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Describe*** the basic concepts of electron transfer reactions and also the fundamentals aspects of electrochemical methods.	Cognitive	Remember Understand
CO2	***Illustrate*** the structure and activity of enzymes and cofactors.	Cognitive Affective	Understand Respond
CO3	***Identify*** the properties of lipids and nucleic acids.	Cognitive Affective	Understand Apply Respond
CO4	***Summarize*** the concept of bioenergetics.	Cognitive	Understand
CO5	***Compare*** the principles of lead and analogue synthesis.	Cognitive Affective	Analyze Receive

UNIT I	BASIC CONCEPTS OF ELECTRO ORGANIC SYNTHESIS	15

Introduction, fundamental aspects of electron transfer reaction : oxidation, reduction reactions vs electron transfer reactions in organic chemistry and electrochemistry - Standard potentials : Mechanism and theory of outer sphere electron transfer reactions – Fundamental aspects of electrode phenomena, monitoring a half-reactions, general view of an electrode reaction, adsorption phenomena – Mass transfer in electrochemistry, fundamental aspects, steady state electrochemical methods, Transient electrochemical methods.

UNIT II	METHODS FOR STUDIES OF ELECTROCHEMICAL REACTIONS	15

Introduction, linears sweep voltammetry and cyclic voltammetry, Experimental setup, simple electrotransfer reaction, electron transfer reaction followed by chemical reaction and solutions, limiting experimental factors – potential step and current step method, chronoamperometry, chronocoulometry, chronopotentiometry – polarography – methods for determination of number of electrons.

UNIT III	CATHODIC REDUCTIONS	15

Introduction, formation of radical anions, dianions and polyanions, experimental aspects, thermodynamics kinetics, addition of electrophilic reagents and related reaction, dimerization. Electrochemical reduction of halogenated compounds: monohalogenated alkanes, halogenated aromatic compounds, acyl halides, aliphatic alpha – halo carbonyl compounds, cathodic reduction of nitro and related compounds, Aliphatic nitro compounds, aromatic nitro compounds(preparation of para amino phenol nitrobenzenes, nitramines and azides). Eletrochemical reduction of carbonyl compounds, general aspects.

UNIT IV	ANODIC OXIDATION OF ORGANIC COMPOUNDS	15

Introduction, general mechanistic consideration, directs anodic oxidation, indirect anodic oxidation. Anodic oxidation of hydrocarbons, nitrogen containing compounds. Electrosynthesis of Bioactive materials Introduction, simple Kolbe oxidation: application to synthesis of (+) - α onxerin and (+) - pentacyclosqualene, Kolbe cyclisation and Tandem cyclization.

UNIT V	SPECIAL TOPIC IN ELECTRO ORGANIC SYNTHESIS	15

Paired electro organic synthesis, simple examples – electrogenerated reagents Homogeneous redox catalysts – General aspects of indirect electron exchanges, pure redox catalysis (general case) – use of indirect electrochemical reactions in sythesis, oxidations, reductions – Electrogenarated superoxides. Electrochemical partial fluorination: Introduction, Anodic fluorination of aromatic compounds, olefins, carbonyl compounds, heterocyclic compounds. Electro enzymatics synthesis: Introduction, principles of redox catalytic enzyme activation and co-factor regeneration – electroenzymatic reductions and oxidation (simple examples only).

LECTURE	TUTORIAL	SELF STUDY	PRACTICAL	TOTAL
60	**15**	**-**	**-**	**75**

TEXT BOOKS

1. Organic electrochemistry by Henning Lund & Ole Hammerich, , 4th edition, Publisher: Marcel Dekker, Inc, New York
2. S. Warren, Designing Organic Synthesis: The Disconnection Approach; 2nd Ed., Wiley, New York, 2008.

REFERENCES

1. N. C. Price and L. Stevens, Fundamental of Electrochemistry; Oxford UniversityPress, UK, (1999)
2. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Part-A and Part-B; 5th Ed.,Springer, Germany, (2008).
3. H. B. Kagan, Asymmetric Synthesis; Thieme Medical Publishers, Germany, (2009)

COURSE CODE	COURSE NAME	L	T	P	C

YCY305	ANALYTICAL CHEMISTRY	4	1	0	5
PREREQUISITES	**NIL**	**L**	**T**	**P**	**H**
C:P:A	**4.4:0:0.6**	**4**	**1**	**0**	**5**

COURSE OUTCOMES		**Domain**	**Level**
CO1	***Describe*** the basic principle of instrumental methods	Cognitive	Remember, Understand
CO2	***Classify*** the various types of analytical error and show their significance.	Cognitive	Remember, Understand
CO3	***Inspect*** the application of various techniques in chromatography.	Cognitive Affective	Analyze Receive
CO4	***Illustrate*** the principles and instrumentation of thermoanalytical and fluorescence techniques.	Cognitive	Understand, Analyze
CO5	***Examine*** the concept of electroanalytical techniques.	Cognitive Affective	Analyze, Respond

UNIT I: INSTRUMENTAL METHODS OF ANALYSIS **15**

Principles and applications of extended X-ray absorption fine structure (EXAFS) – surface extended X-ray absorption (SEXAFS) – atomic absorption spectroscopy (AAS) – flame emission spectroscopy (FES) – turbidimetry – theory and applications.

UNIT II: DATA AND ERROR ANALYSIS **15**

Various types of error – accuracy, precision, significant figures – frequency distributions, the binomial distribution, the Poisson distribution and normal distribution – describing data, population and sample, mean, variance, standard deviation, way of quoting uncertainty, robust estimators, repeatability and reproducibility of measurements.

Hypothesis testing, levels of confidence and significance, test for an outlier, testing variances, means t-Test, paired t-Test – analysis of variance (ANOVA) – correlation and regression.

Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals – general polynomial equation fitting, linearizing transformations, exponential function fit – r and its abuse – multiple linear regression analysis, elementary aspects.

UNIT III: CHROMATOGRAPHY **15**

Solvent extraction – principles of ion exchange, paper, thin-layer and column chromatography techniques – columns, adsorbents, methods, Rf values, McReynold's constants and their uses – HPTLC, HPLC techniques – adsorbents, columns, detection methods, estimations, preparative column – GC-MS techniques – methods, principles and uses.

UNIT IV: THERMOANALYTICAL METHODS AND FLUORESCENCE SPECTROSCOPY **15**

Principles – instrumentations and applications of thermogravimetry analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning - Calorimetry (DSC) –thermometric titrations – types – advantages.

Basic aspects of synchronous fluorescence spectroscopy – spectral hole burning – flow cytometry – fluorometers (quantization) – instrumentation – applications.

UNIT V: ELECTROANALYTICAL TECHNIQUES **15**

Electrochemical sensors, ion-sensitive electrodes, glass – membrane electrodes, solid-liquid

membrane electrodes – ion-selective field effect transistors (ISFETs) – sensors for the analysis of gases in solution.

Po larography – principles and instrumentation – dropping mercury electrode – advantages – Ilkovic equation – applications of polarography – polarographic maxima – oscillographic polarography, AC polarography – cyclic voltammetry – advantages over polarographic techniques – chronopotentiometry – advantages – controlled potential coulometry – amperometric titrations: principles – techniques – applications – estimation of lead.

LECTURE	TUTORIAL	SELF STUDY	PRACTICAL	TOTAL
60	15	-	-	75

TEXT BOOKS

1. D. B. Hibbert and J. J. Gooding, Data Analysis for Chemistry; Oxford UniversityPress, UK, 2006.
2. J. Topping, Errors of Observation and Their Treatment; 4th Ed., Chapman Hall, London, (1984).
3. A. Braithwaite and J. F. Smith, Chromatographic Methods; 5th Ed., Springer, Germany; (1995).
4. V. K. Srivastava and K. K. Srivastava, Introduction to Chromatography; 2nd Ed.,Holden Day,
   New York, (1985).
5. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis; 6th
   Ed., CBS Publishers and Distributors, Chennai, (1986).
6. D. A. Skoog, D. M. West and D. J. Holler, Fundamentals of Analytical Chemistry, 7th Ed., Harcourt College Publishers, Singapore, (2004).
7. A. Sharma, S. G. Schulman, Introduction to Fluorescence Spectroscopy; Wiley- Interscience, New York, (1999).

REFERENCES

1. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy; 4th Ed., Tata McGraw-Hill, New Delhi, (1994).
2. A. I. Vogel, Text Book of Quantitative Inorganic Analysis; 6th Ed., Longman, New Delhi, (2000).
3. D. C. Harris, Quantitative Chemical Analysis; 4th Ed., W. H. Freeman Publications, New York,
   (1995).
4. S. C. Gupta, Fundamentals of Statistics; 6th Ed., Himalaya Publications, Delhi, (2006).

	SEMESTER IV			

COURSE CODE	COURSE NAME	L	T	C
YCY401	PHYSICAL METHODS IN CHEMISTRY-II	4	1	5
		L	T	H
C:P:A	3.75:0.75:0.5	4	1	5

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Recall*** and ***Explain*** the electronic spectroscopy of metal complexes	Cognitive Psychomotor	Remember Understand Set
CO2	***Interpret*** the IR and Raman spectra of inorganic compounds	Cognitive Affective	Understand Respond
CO3	***Identify*** the chemical environment of NMR active nuclei present in the inorganic compounds	Cognitive Affective	Understand Apply Respond
CO4	***Analyze*** EPR, and magnetic properties the mechanism of metal complexes.	Cognitive Psychomotor	Analyze Perception
CO5	***Compare the*** Mossbauer spectra of iron and tin compounds.	Cognitive Psychomotor	Analyze Perception

SYLLABUS:

UNIT I	ELECTRONIC SPECTROSCOPY	
Microstates, terms and energy levels for $d^1 - d^9$ ions in cubic and square fields– intensity of bands – group theoretical approach to selection rules – effect of distortion and spin-orbit coupling on spectra – evaluation of 10Dq and β for octahedral complexes of cobalt and nickel – applications to simple coordination compounds – charge transfer spectra. Optical rotatory dispersion and circular dichroism and magnetic circular dichroism – applications to metal complexes.		**15**
UNIT II	**INFRARED AND RAMAN SPECTROSCOPY**	
Vibrations in simple molecules (H_2O, CO_2) and their symmetry notation for molecular vibrations – group vibrations and the limitations – combined uses of IR and Raman spectroscopy in the structural elucidation of simple molecules like N_2O, ClF_3, NO_3^-, ClO_4^- effect of coordination on ligand vibrations – uses of groups vibrations in the structural elucidation of metal complexes of urea, thiourea, cyanide, thiocyanate and dimethyl sulfoxide. Effect of isotopic substitution on the vibrational spectra of molecules – vibrational spectra of metal carbonyls with reference to the nature of bonding –geometry and number of C-O stretching vibrations (group theoretical treatment) – applications of Raman spectroscopy – resonance Raman spectroscopy. SERS		**15**
UNIT III	**NMR SPECTROSCOPY**	

Examples for different spin systems – chemical shifts and coupling constants (spin-spin coupling) involving different nuclei (1H, 19F, 31P, 13C) interpretation and applications to inorganic compounds – Effect of quadrupolar nuclei (2H,10B, 11B) on the 1H NMR spectra. Systems with chemical exchange – evaluation of thermodynamic parameters in simple systems – study of fluxional behavior of molecules – NMR of paramagnetic molecules – isotropic shifts contact and pseudo-contact interactions – lanthanide shift reagents.	**15**
UNIT IV **EPR SPECTROSCOPY AND MAGNETIC PROPERTIES**	
Theory of EPR spectroscopy – spin densities and McConnell relationship factors affecting the magnitude of g and A tensors in metal species – zero-field splitting and Kramers degeneracy – spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes – applications of EPR to a few biological molecules containing Cu(II) and Fe(III) ions. Magnetic properties – types of magnetism – dia-, para-, ferro- and anti ferromagnetism– magnetic properties of free ions – first-order Zeeman effect – second-order Zeeman effect – states KT – states<<<KT – determination of magnetic moments and their applications to the elucidation of structures of inorganic compounds – temperature independent paramagnetism – magnetic properties of lanthanides and actinides – spin crossover in coordination compounds.	**15**
UNIT V **MOSSBAUER AND OTHER SPECTROSCOPIC TECHNIQUES**	
Isomer shifts – quadrupole splitting – magnetic interactions – applications to iron and tin compounds. NQR spectroscopy – characteristics of quadrupolar nucleus – effects of field gradient and magnetic field upon quadrupolar energy levels – NQR transitions - applications of NQR spectroscopy. SPS, Auger electron spectroscopy	**15**

REFERENCE BOOKS:

1. R. S. Drago, Physical Methods in Inorganic Chemistry; Affiliated East-West Press Pvt. Ltd., New Delhi, 2012.
2. R. S. Drago, Physical Methods in Chemistry; Saunders College Publications, Philadelphia, 1992.
3. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Ed., Wiley-Eastern Company, New Delhi, 1999.
4. P. J. Wheatley, The Determination of Molecular Structure; 2nd Ed., Dover Publications, Mineola, 1981.
5. G. J. Leigh, N. Winterton, Modern Coordination Chemistry; Royal Society of Chemistry, UK, 2002.
6. E. A. V. Ebsworth, Structural Methods in Inorganic Chemistry; 3rd Ed., ELBS, Great Britain, 1987.
7. W. Kemp, Organic Spectroscopy; 3rd Ed., Palgrave, New York, 2011.
8. J. R. Dyer, Applications of Absorption Spectroscopy of Organic Compounds, PHI Learning, New Delhi, 2009.

COURSE CODE	COURSE NAME	L	T	P	C
YCY402	ORGANIC CHEMISTRY PRACTICAL-II	0	0	6	3
		L	T	P	H
C:P:A	1.8: 0.8:0.4	0	0	6	6

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Identify*** the various functional groups present in a mixture of two components	Cognitive Psychomotor	Remember Perception
CO2	***Predict*** the organic component present in the mixture by pilot separation, bulk separation.	Cognitive Psychomotor	Understand Set
CO3	***Experiments with*** various reagents and identify the components.	Cognitive Psychomotor Affective	Apply Set Receiving

9. Y. R. Sharma, Elementary Organic Spectroscopy – Principles and Chemical Applications; S. Chand and Co., New Delhi, 1992.
10. P. S. Kalsi, Spectroscopy of Organic Compounds; 6th Ed., New Age International Publishers, New Delhi, 2004.

	LECTURE	TUTORIAL	SELF-STUDY	TOTAL HOURS
Hours	60	15	-	75

ORGANIC CHEMISTRY PRACTICAL-II	
1.	**Quantitative analysis of organic compounds:** Estimation of phenol, aniline, ketone, glucose, nitrobenzene, saponification value of an oil and Iodine value of an oil.
2.	**Preparation of organic compounds (Double stage)** 1. p-bromo acetanilide from aniline (acetylation and bromination). 2. acetyl salicylic acid from methyl salicylate (hydrolysis and acetylation). 3. 1,3,5-tribromobenzene from aniline (bromination, diazotization and hydrolysation). 4. p-nitroaniline from acetanilide (nitration and hydrolysis). 5. benzillic acid from benzoin (rearrangement). 6. p-amino benzoic acid from p-nitro toluene (oxidation and reduction). 7. benzanilide from benzophenone (rearrangement). 8. p-bromoaniline from acetanilide (bromination and hydrolysis). 9. m-nitroaniline from nitrobenzene (nitration and reduction). 10. 1,2,4-triacetoxy benzene from hydroquinone (oxidation and acylation).

COURSE CODE	COURSE NAME	L	T	C
YEC403A	GREEN CHEMISTRY	4	1	5
		L	T	H
C:P:A	3.75:0.75:0.5	4	1	5

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Recall*** and ***Explain*** the concepts of green chemistry and their principles.	Cognitive Psychomotor	Remember Understand Set
CO2	***Summarize and Report*** the addition and condensation reactions along with their applications.	Cognitive Affective	Understand Respond
CO3	***Explain*** the oxidation- reduction reactions and ***Identify*** the mechanism of these chemical reactions.	Cognitive Affective	Understand Apply Respond
CO4	***Categorize*** the various types of the polymers	Cognitive Psychomotor	Analyze Perception
CO5	***Examine*** the principles of nuclear chemistry	Cognitive Psychomotor	Analyze Perception

SYLLABUS:

UNIT I	Introduction to Green Chemistry	
Introduction to green chemistry – twelve principles of green chemistry – planning a green synthesis in a chemical laboratory – evaluating the type of reaction involved – rearrangement, addition, substitution, elimination and pericyclic reactions. Selection of appropriate solvent – aqueous phase reaction – reactions in ionic liquids – organic synthesis in solid state – solid supported organic synthesis – selection of starting materials – use of protecting group – use of catalyst – use of microwaves and sonication.		**15**

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	0	0	90	90

TEXT BOOKS

1. J. Mohan, Organic Analytical Chemistry: Theory and Practice; Narosa, (2003).
2. V. K. Ahluwalia, P. Bhagat, and R. Agarwal, Laboratory Techniques in Organic Chemistry; I. K. International, (2005).
3. N. S. Gnanaprakasam and G. Ramamurthy, Organic Chemistry Lab Manual; S.V.Printers, (1987).
4. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford and P. W. G. Smith, Vogel's Textbook of Practical Organic Chemistry; 5th Ed., Prentice Hall, (1989).

UNIT II	Addition and Condensation Reactions	

Addition reactions – Michael addition in [aqueous medium and solid state] –Diels-Alder reactions in aqueous phase. Condensation reactions – Aldol condensation of aldehydes with nitroalkanes and nitriles – Aldol condensation in solid phase – benzoin condensation under catalytic conditions – applications.		**15**
UNIT III	**Oxidation and Reduction Reactions**	
Oxidation reactions – Baeyer-Villiger oxidation in aqueous phase and solid state – enzymatic Baeyer-Villiger oxidation. Reduction reactions – Clemmensen reduction – mechanism – limitations – applications		**15**
UNIT IV	**Phase-Transfer Catalyst Reactions**	
Phase-transfer catalyst reactions – Heck reaction – Michael addition reaction –oxidation of toluene to benzoic acid – Reimer-Tiemann reaction Baker – Venkataraman synthesis – Williamson ether synthesis – Dozen reaction.		**15**
UNIT V	**Sonication Reactions**	
Sonication reactions – Barbier reaction – Reformatsky reaction – Simmons-Smith reaction – Strecker synthesis – Ullmann coupling reaction – Wurtz reaction – Bouveault reaction.		**15**

REFERENCE BOOKS:

1. V. K. Ahluwalia, Green Chemistry; 2nd Ed., Ane Books Pvt Ltd., New Delhi, 2016.
2. P. T. Anastas and J. C. Warner, Green chemistry Theory and Practice; Oxford University Press, New York, 2005.
3. V. K. Ahluwalia and K. Agarwal, Organic Synthesis, Special Techniques; 2nd Ed., Narosa Publishing House, New Delhi, 2007.

	LECTURE	TUTORIAL	SELF-STUDY	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**

COURSE CODE	COURSE NAME	L	T	C
YEC403B	INDUSTRIAL CHEMISTRY	4	1	5
		L	T	H
C:P:A	3.75:0.75:0.5	4	1	5

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Illustrate*** the basic ideas of an industry and industrial wastes.	Cognitive Psychomotor	Remember Understand Set
CO2	***Rephrase*** and ***Report*** the preparation and properties of petroleum and petrochemicals.	Cognitive Affective	Understand Respond
CO3	***Identify*** the role and functions of portland cement.	Cognitive Affective	Understand Apply Respond
CO4	***List*** the various process involved in the paper industry	Cognitive Psychomotor	Analyze Perception
CO5	***Outline*** the preparation and mode of action of soaps, detergents and perfumes.	Cognitive Psychomotor	Analyze Perception

SYLLABUS:

UNIT I	Basic Ideas and Industrial Wastes	

Basics idea about unit operation – flow chart – chemical conversion – batch versus continuous processing – chemical process selection – design – chemical process control. Types of industrial wastes – treatment of wastes or effluent with organic impurities – treatment of wastes or effluent with inorganic impurities – treatment of some important chemical wastes.		**15**
UNIT II	**Petroleum and Petrochemicals**	
Introduction – saturated hydrocarbons from natural gas – uses of saturated hydrocarbons – unsaturated hydrocarbons – acetylene, ethylene, propylene, butylene – aromatic hydrocarbons – toluene and xylene. Preparation of rectified spirit from beat – methylated spirit – preparation of absolute alcohol from rectified spirit – petrochemicals in India.		**15**
UNIT III	**Manufacture of Cement**	
Introduction – types of cement – high alumina cement, water proof cement, slag cement, acid resisting cement, white cement, coloured cement, Pozzolana cement. Setting of cement – properties of cement – testing of cement – uses of cement –concrete – cement industries in India.		**15**
UNIT IV	**Pulp and Paper and Manufacture of Paper**	
Introduction – manufacture of pulp – types of pulp – sulphate or craft pulp, soda pulp, Rag pulp – beating, refining, filling, sizing and colouring. Calendaring – uses – paper industries in India.		**15**
UNIT V	**Soaps, Detergents and Perfumes**	
Introduction – types of soaps – hard and soft soaps – manufacture of soap (hot and continuous process only) – cleansing action of soap – detergents – surface active agents – biodegradability of surfactants, amphoteric detergents. Introduction – production of natural perfumes – flower perfumes – jasmine, rose and lily – production of synthetic perfumes – muscone and nitro-musks.		**15**

REFERENCE BOOKS:

1. B. K. Sharma, Industrial Chemistry; 8th Ed., Goel Publishing House, New Delhi, 1997.
2. R. N. Shreve, and J. A. Brink Jr. Chemical Process Industries; 4th Ed., McGraw Hill, Toronto, 1977.
3. A. C. S. Brain, Production and Properties of Industrial Chemicals; Reinhold, New York, 1989.

	LECTURE	TUTORIAL	SELF-STUDY	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**

COURSE CODE	COURSE NAME	L	T	C
YEC404A	SELECTED TOPICS IN CHEMISTRY	4	1	5
		L	T	H
C:P:A	4.5:0.5:0.5	4	1	5

COURSE OUTCOMES: *On the successful completion of the course, students will be able to*		DOMAIN	LEVEL
CO1	***Rephrase*** the quantum chemical approach to chemical bonding.	Cognitive Psychomotor	Remember Understand Set
CO2	***Compare*** the role of various reagents used in organic synthesis.	Cognitive Affective	Understand Respond
CO3	***Apply*** the retro-synthetic approach in the synthesis of complex organic molecules.	Cognitive Affective	Understand Apply Respond
CO4	***Categorize*** the types of polymer reactions.	Cognitive Psychomotor	Analyze Perception
CO5	***Illustrate*** the principles of nuclear chemistry.	Cognitive Affective	Understand Apply Respond

SYLLABUS:

UNIT I	**Quantum Chemical Approach to Chemical Bonding and Molecular Structure:**	

Diatomic molecules: Born-Oppenheimer approximation–MO theory (H_2 and H_2^+), VB theory (H_2 and H_2^+) – comparison. HMO calculations – evaluation of coefficients and eigenvalues for simple molecules – electron density – bond order and free valence index. Extended HMO theory – applications to simple systems – hybridization schemes.		**15**
UNIT II	**NAMED REACTIONS AND APPLICATIONS IN ORGANIC SYNTHESIS**	
Bamford-Stevens reaction – Barton-McCombie reaction (Barton Deoxygenation) – Baylis-Hillman reaction – Biginelli reaction – Corey-Chaykovsky reaction – Enamines and selective mono- and dialkylation via enamine reactions, Henry reaction – Hosomi-Sakurai reaction – Hunsdiecker reaction – Julia olefinationand its modifications – Mitsunobu reaction – Mukaiyama-Aldol addition –Nazarov cyclization – Peterson olefination – Prevost reaction – Prins reaction – Staudinger reaction Ugi reaction – Weinreb ketone synthesis – Wittig reaction and its modifications –Yamaguchi macrolactonization – Palladium based reactions: Fukuyama coupling –Heck reaction – Hiyama coupling – Sonogashira coupling – Stille coupling – Suzuki coupling – Tsuji-Trost Reaction.		**15**
UNIT III	**SYNTHETIC METHODOLOGY**	
Introduction to disconnections – synthons and synthetic equivalents – synthon approach – electron donors (nucleophiles) – electron acceptors (electrophiles) Introduction of functional groups – umpolung reactions – one group disconnections: alcohols, olefins, ketones, acids – two group disconnections: 1, 2-, 1,3-, 1,4- and 1,5-difunctional compounds – convergent syntheses. Functional group interconversion – functional group addition – carbon-heteroatom bonds – methods for 3- and 4-membered rings - synthesis of mono- and difunctional open chain molecules – mono and bicyclic molecules with substituents.		**15**
UNIT IV	**POLYMER CHEMISTRY**	
Introduction – structure – classification of polymers – polymerisation methods – importance of polymers. Molecular weight of polymers – number average and weight average – determination of molecular weight by osmometry – light scattering, viscosity and sedimentation methods. Kinetics of polymerisation reactions, polycondensation reactions, ionic and free radical polymerisation, copolymerisation – coordination polymers, conducting polymers,Ziegler-Natta catalyst.		**15**
UNIT V	**FUNDAMENTAL OF NUCLEAR CHEMISTRY**	

The nucleus – subatomic particles and their properties – nuclear binding energy–nuclear structure – Liquid-drop model and nuclear-shell model – n/p ratio – nuclear forces – modes of radioactive decay – alpha, beta and gamma particles – orbital electron capture – nuclear isomerism – internal conversion. Q-Values of nuclear reaction, coloumbic barrier, nuclear cross section, threshold energy and excitation function – different types of nuclear reactions with accelerated particles. Projectile capture and particles emission, spallation, fragmentation, nuclear fission, nuclear fusion – proportional counter, Geiger-Muller counter, scintillation counter and Cherenkov counter – linear accelerator, cyclotron and synchrotron.	**15**

REFERENCE BOOKS:

1. R. K. Prasad, Quantum Chemistry; 4th Ed., New Age International Publishers, New Delhi, 2009.
2. A. K. Chandra, Introductory Quantum Chemistry; 4th Ed., Tata McGraw Hill, New Delhi, 1994.
3. D. A. Mcquarrie, Quantum Chemistry; University Science Books, 2nd Ed., 2007.
4. I. N. Levine, Quantum Chemistry; 7th Ed., Prentice Hall, New Jersey, 2013.
5. L. Kurti and B. Czako, Strategic Applications of Named Reactions in Organic Synthesis; Elsevier, 2005.
6. A. Hassner and C. Stumer, Organic Synthesis Based on Named and Unnamed Reactions; Elsevier Science Ltd., UK, 1994.
7. G. Brahmachari, Organic Name Reactions: A Unified Approach; Alpha Science Intl. Ltd, UK, 2006.
8. S. Warren, Designing Organic Synthesis: The Disconnection Approach; 2nd Ed., Wiley, New York, 2008.
9. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Parts A and B, 5th Ed., Springer, Germany, 2007.
10. W. Carruthers and I. Coldham, Modern Methods of Organic Synthesis, 4th Ed., Cambridge University Press, Cambridge, 2004

	LECTURE	TUTORIAL	SELF-STUDY	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**

COURSE CODE	**COURSE NAME**	**L**	**T**	**C**
YEC404B	**CHEMISTRY OF NANOSCIENCE AND NANOTECHNOLOGY**	**4**	**1**	**5**
		L	**T**	**H**
C:P:A	**4.4:0:0.6**	**4**	**1**	**5**

COURSE OUTCOMES: ***On the successful completion of the course, students will be able to***		**DOMAIN**	**LEVEL**
CO1	***Outline*** the synthetic methods of nanomaterials.	Cognitive Psychomotor	Remember Understand Set
CO2	***Compare*** the properties and characterization of nanomaterials.	Cognitive Affective	Understand Respond

CO3	***Predict*** the reactions of nanoparticles	Cognitive Affective	Understand Apply Respond
CO4	***Classify*** the applications of carbon clusters and nanostructures.	Cognitive Psychomotor	Analyze Perception
CO5	***List*** the role and significance of nanoparticles in nanodevice.	Cognitive Psychomotor	Analyze Perception

SYLLABUS:

UNIT I	**Synthetic Methods**	
Definition of nanodimensional materials – historical milestones – unique properties due to nanosize, quantum dots, classification of nanomaterials.General methods of synthesis of nanomaterials – hydrothermal synthesis, solvothermal synthesis – microwave irradiation– sol-gel and precipitation technologies – combustion flame – chemical vapour condensation process – gas-phase condensation synthesis – reverse micelle synthesis – polymer-mediated synthesis–protein microtubule-mediated synthesis – synthesis of nanomaterials using microorganisms and other biological agents – sonochemical synthesis –hydrodynamic cavitation. Inorganic nanomaterials – typical examples – nano TiO_2/ZnO/CdO/CdS, organic nanomaterials – examples – rotaxanes and catenanes		**15**
UNIT II	**Characterisation of Nanoscale Materials**	
Principles of Atomic Force Microscopy (AFM) – Transmission Electron Microscopy(TEM) Resolution and Scanning Transmission Electron Microscopy (STEM) – Scanning Tunneling Microscopy (STM) – Scanning Nearfield Optical Microscopy (SNOM).Scanning ion conductance microscope, scanning thermal microscope, scanning probe microscopes and surface plasmon spectroscopy.		**15**
UNIT III	**Reactions in Nanoparticles**	
Reactions in nanospace – nanoconfinement – nanocapsules Cavitands, cucurbiturils, zeolites, M.O.Fs, porous silicon, nanocatalysis.		**15**
UNIT IV	**Carbon Clusters and Nanostructures**	
Nature of carbon bond − new carbon structures − carbon clusters – discovery of C60−alkali doped C60−superconductivity in C60−larger and smaller fullerenes. Carbon nanotubes – synthesis − single walled carbon nanotubes − structure and characterization − mechanism of formation − chemically modified carbon nanotubes −doping − functionalizing nanotubes − applications of carbon nanotubes. Nanowires −synthetic strategies − gas phase and solution phase growth – growth control − properties.		**15**
UNIT V	**Nanotechnology and Nanodevices**	
DNA as a nanomaterial – DNA – knots and junctions, DNA – nanomechanical device designed by Seeman. Force measurements in simple protein molecules and polymerase – DNA complexes–molecular recognition and DNA based sensor. Protein nanoarray, nanopipettes, molecular diodes, self-assembled nanotransistors, nanoparticle mediated transfection.		**15**

REFERENCE BOOKS:

1. C. N. R. Rao, A. Muller and A. K. Cheetham (Eds), The Chemistry of Nanomaterials: Vol. 1 and 2; Wiley-VCH;Germany, Weinheim, 2004.
2. C. P. Poole, Jr: and F. J. Owens, Introduction to Nanotechnology; Wiley Interscience, New Jersey, 2003.
3. K. J. Klabunde (Ed), Nanoscale Materials in Chemistry; 2nd Ed., Wiley-Interscience, New York, 2009.
4. T. Pradeep, Nano: The Essentials in Understanding Nanoscience and Nanotechnology; 1st Ed., Tata McGraw Hill, New York, 2007.
5. H. Fujita (Ed.), Micromachines as Tools in Nanotechnology; Springer-Verlag, Berlin, 2003.
6. Bengt Nolting, Methods in Modern Biophysics; 3rd Ed., Springer-Verlarg, Berlin, 2009.
7. H. Gleiter, Nanostructured Materials: Basic Concepts, Microstructure and Properties, Elsevier, Chennai, 2000.
8. W. Kain and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life; 2nd Ed., John-Wiley R Sons, New York, 2013.

	LECTURE	TUTORIAL	SELF-STUDY	TOTAL HOURS
Hours	**60**	**15**	**-**	**75**