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 2022

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

FACULTY OF HUMANITIES, SCIENCES & MANAGEMENT
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CURRICULUM & SYLLABUS (I to IV Semester)
FOR
M.Sc. CHEMISTRY

(FULL TIME – 2 Years)

REGULATION 2022

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

CURRICULUM AND SYLLABUS FOR

MASTER OF SCIENCE

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

REGULATION - 2022

(Applicable to the students admitted from the academic year 2022-2023 onwards)

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

VISION

To be a institution of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society.

MISSION

- **UM1:** Offering well balanced programmes with scholarly faculty and state – of – art facilities to impart high level of knowledge.
- **UM2:** Providing student – centered education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and collaborative work.
- **UM3:** Involving progressive and meaningful research with concern for sustainable development.
- **UM4:** Enabling the students to acquire the skills for global competencies.
- **UM5:** Inculcating Universal values, Self-respect, Gender equality, Dignity and Ethics

DEPARTMENT OF CHEMISTRY

VISION

To prepare the students with basic scientific knowledge in Chemistry for technological development and to provide resources for industry and society through education and research to achieve environmental protection, energy generation and drug development.

MISSION

- **DM1.** To provide in-depth knowledge in Chemistry to impart technology.
- **DM2.** To create new idea to improve the technology by offering Doctoral programme.
- **DM3.** To undertake project in thrust areas with societal requirements.
- **DM4.** To develop novel method for clean technology, Bio energy and drug development.

Programme Educational Objectives (PEOs)

PEO1	Proficient in applying a broad understanding of the basic principles of chemistry to the solution of chemical problems
PEO2	Able to become a highly professional teacher/professor or renowned scientist
PEO3	Able to plan, coordinate, communicate, organize, make decision and lead a team to solve problems and develop application using chemistry.
PEO4	Professional, ethical, responsible and will contribute to society through active management.

Mapping of Department Mission with University Mission:

	DM1	**DM2**	**DM3**	**DM4**	**Total**
UM1	3	3	2	1	**9**
UM2	3	2	3	1	**9**
UM3	2	2	3	3	**10**
UM4	3	2	3	2	**10**
UM5	2	2	3	3	**10**

3–High Relation, 2–Medium Relation, 1–Low Relation, 0–No Relation

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

REGULATION - 2022

	SEMESTER I							
Category	**Course Code**	**Course Name**	**L**	**T**	**SS**	**P**	**H**	**C**
Core Course-I	YCY101	Organic Chemistry I	4	1	0	0	5	5
Core Course-II	YCY102	Inorganic Chemistry I	4	1	0	0	5	5
Core Course-III	YCY103	Physical Chemistry I	4	1	0	0	5	5
Core Course-IV (Lab)	YCY104	Inorganic Chemistry Practical I	0	0	0	6	5	3
Core Course-V (Lab)	YCY105	Physical Chemistry Practical I	0	0	0	6	5	3
Elective Core - I	YCYE01 YCYE02	(A) Green Chemistry/ (B) Industrial Chemistry	3	1	0	0	4	4
		Library					1	
		Total	**15**	**4**	**0**	**12**	**30**	**25**

	SEMESTER- II							
Category	**Course Code**	**Course Name**	**L**	**T**	**SS**	**P**	**H**	**C**
Core Course-VI	YCY201	Inorganic Chemistry II	4	1	0	0	5	5
Core Course-VII	YCY202	Physical Chemistry II	4	1	0	0	5	5
Core Course-VIII	YCY203	Physical Methods in Chemistry-I	4	1	0	0	5	5
Core Course- IX (Lab)	YCY204	Inorganic Chemistry Practical II	0	0	0	6	5	3
Core Course- X (Lab)	YCY205	Organic Chemistry Practical -I	0	0	0	6	5	3
Elective Core - II	YCYE03 YCYE04	(A) Pharmaceutical Chemistry/ (B) Electro-Organic Chemistry	3	1	0	0	4	4
		Library					1	
		Total	**15**	**4**	**0**	**12**	**30**	**25**

	SEMESTER -III							
Category	**Course Code**	**Course Name**	**L**	**T**	**SS**	**P**	**H**	**C**
Core Course - XI	YCY301	Organic Chemistry II	4	1	0	0	5	5
Core Course - XII	YCY302	Physical Methods in Chemistry-II	4	1	0	0	5	5
Core Course – XIII (Lab)	YCY303	Organic Chemistry Practical -II	0	0	0	6	5	3
Core Course – XIV (Lab)	YCY304	Physical Chemistry Practical II	0	0	0	6	5	3
Elective Compulsory-I	YEC305	Analytical Chemistry	3	1	0	0	4	4
Elective Compulsory-II	YCYON33	MOOC / NPTEL Course / Applications of Nanoscience	1	1	0	0	2	4
Elective Core -III	YCYE05 / YCYE06	(A) Selected topics in Chemistry / (B) Chemistry of Nanoscience and Nanotechnology	3	1	0	0	4	4
		Total	**15**	**5**	**0**	**12**	**30**	**28**

	SEMESTER- IV							
Category	**Course Code**	**Course Name**	**L**	**T**	**SS**	**P**	**H**	**C**
Course -XV	YCY401	Dissertation – Project work	0	0	0	20	20	10
Elective Core -IV	YCYE07 / YCYE08	(A) Solid State Chemistry / (B) Supramolecular Chemistry	3	1	0	0	4	4
		Total	**3**	**1**	**0**	**20**	**24**	**14**

M.Sc. CHEMISTRY (2022 - 2023)

Courses	**Total No. Of courses**	**Total Marks**	**Total Credits**
Core Course	**08**	**800**	**40**
Core Practical	**06**	**600**	**18**
Elective Core	**04**	**400**	**16**
Elective Compulsory	**02**	**200**	**08**
Project	**01**	**100**	**10**
Total	**21**	**2100**	**92**

SEMESTER - I					
COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YCY101	**ORGANIC CHEMISTRY- I**	**4**	**1**	**0**	**5**
C:P:A	**4.5: 0 : 0.5**				
		L	**T**	**P**	**H**
		4	**1**	**0**	**5**

Learning Objectives:

1. To learn the concept of organic reactive intermediates.
2. To learn and understand the theories and mechanism of aliphatic nucleophilic substitution reactions.
3. To learn and understand the theories and mechanism of aromatic electrophilic substitution reactions.
4. To understand the concepts of addition and elimination reactions.
5. To learn and understand the concept of stereochemistry and conformational analysis

COURSE OUTCOMES- On the successful completion of the course, students will be able to		**DOMAIN**	**LEVEL**
CO1	***Identify*** the various types of reactive intermediates and ***explain*** their reactivity in organic reactions.	Cognitive	Remember Understand
CO2	***Describe*** the mechanism of nucleophilic substitution reaction	Cognitive	Understand
CO3	***Illustrate*** the mechanism of electrophilic substitution reactions.	Cognitive	Understand
CO4	***Explain*** the fundamental concepts of various addition and elimination reactions	Cognitive Affective	Understand Receive
CO5	***Describe*** and ***give*** example of stereo chemistry of organic compounds	Cognitive	Remember Understand

	UNIT I -REACTIVE INTERMEDIATES	**15**
	Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, carbenoids, benzynes and nitrenes.	
	UNIT II - NUCLEOPHILIC SUBSTITUTION REACTIONS	**15**
	Aliphatic nucleophilic substitution – mechanisms – SN1, SN2, SNi – ion-pair inSN1 mechanisms – neighbouring group participation, non-classical carbocations – 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 III - 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 IV - 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 leadingto 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 tocarbon-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 – V 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.	

	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.

	REFERENCE BOOKS
	1. R. K. Bansal, Organic Reaction Mechanisms; 11th Ed., Tata McGraw Hill, Noida, 2006. 2. J. Clayden, N. Greeves, S. Warren, and P. Wothers, Organic Chemistry; 1st Ed., Oxford University Press, UK, 2000. 3. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, 1993. 4. 7. Stuart Warren, Organic Synthesis: Disconnection Approach, Wiley India (P) Ltd, 2007. 5. M. B. Smith, Organic Synthesis, Academic Press, 3rd Ed, 2011.
	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

Learning Objectives:

1. To learn the chemistry of boron, silicon, P-N compounds, S-N compounds and other main group elements.
2. To learn and understand the bonding theories which describe the bonding in coordination complexes.
3. To understand the theoretical aspects of electronic spectra and its application for the structural elucidation of coordination compounds
4. To understand the reaction kinetics mechanisms involved in coordination complexes.
5. To learn and understand the concepts of photochemistry and features of Photoelectron Spectroscopy

COURSE OUTCOMES- On the successful completion of the course, students will be able to		DOMAIN	LEVEL
CO1	***Recall*** the basics of main group elements and ***explain*** the structure-property relations of main group compounds	Cognitive	Remember Understand
CO2	***Discuss*** the theories and bonding nature of Coordination compounds.	Cognitive	Understand
CO3	***Describe*** the theory and ***interpret*** electronic spectra of Coordination compounds	Cognitive	Understand Apply
CO4	***Identify*** and ***understand*** the type and nature of electron transfer reactions in four and six coordination compounds.	Cognitive Affective	Understand Receive
CO5	***Rewrite*** the basics of photochemistry and ***explore*** its applications towards coordinated compounds.	Cognitive	Understand

UNIT – I Inorganic Chain and Cluster Compounds **15**

Chemistry of boron – boranes, higher boranes, borazines , boron nitrides, hydroborate ions – Preparation, properties and structure. Carboranes- Types such as nido-closo, arachno-preparation, properties and Structure. Metal clusters: Chemistry of low molecularity metal clusters only, Structure of Re_2Cl_8; multiple metal-metal bonds.

Types of inorganic polymers, comparison with organic polymers, silanes, higher silanes, multiple bonded systems, silicon nitrides, siloxanes. P-N compounds, cyclophosphazenes and cyclophosphazanes. S-N compounds – S_4N_4, (SN)x. Isopoly and heteropoly acids – Structure and bonding of 6- and 12 – isopoly and heteropoly anions. Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three dimensional silicates.

UNIT – II Stability of Complexes and Theories of Metal-Ligand Bonding **15**

Stability of Complexes: 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.

Metal-Ligand Bonding: 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 – III Electronic Spectra of Coordination Complexes	**15**

Spectroscopic term symbols for d^n ions – derivation of term symbols and ground state term symbol, Hund's rule, Selection rules – breakdown of selection rules, spin orbit coupling, band intensities, weak and strong field limits – correlation diagram, Energy level diagrams. Orgel diagram for weak field Oh and Td complexes – Splitting of energy level due to Jahn-Teller distortion. Modified orgel diagram – Limitiations of orgel diagram Tanabe–Sugano(T-S) diagrams – Evaluation of Dq and B values for d^2 –d^8 complexes charge transfer spectra. Complications in band classification between Lf(d-d) and CT bands. Comparison between d-d bands and CT bands – Numerical problems, Lanthanides and Actinides- Spectral properties.

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 inorganiccomplexes – 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 and Photoelectron Spectroscopy	**15**

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.

Photoelectron Spectroscopy (PES) - Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2, CH_4, NH_3) – evaluation of vibrational constants of the above molecules, Koopman's theorem- applications and limitations.

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

TEXT BOOKS

1. Day,J.SelbinandH.H.Sisler,Theoretical Inorganic Chemistry; Literary Licensing(LLC), Montana, 2012.
2. N. H. Ray, Inorganic Polymers, Academic Press, 1978.
3. F.A.Cotton and G.Wilkinson, C.A.Murillo and M.Bochmann, Advanced Inorganic Chemistry; 6thEd., A Wiley - Interscience Publications, John Wiley and Sons,USA, 1999.
4. J.E.Huheey,Inorganic Chemistry;4th Ed.,Harper and Row publisher, Singapore,2006.
5. W.Adamson, Concept of Inorganic Photochemistry; John Wiley and Sons, NewYork,1975.
6. S.F.A.Kettle,Physical Inorganic Chemistry –A Coordination ChemistryApproach ,Spectrum; Academic Publishers, Oxford University Press, New York, 1996.
7. R. S. Drago, Physical methods in chemistry; Saunders college publications, Philadelphia, 1992

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

Learning Objectives:

1. To understand the kinetics of chemical reaction and mechanisms involved in catalysis.
2. To gain on understanding of the Ionic activity, ionic interactions, Debye-Hückel-Bjerrum model, Debye-Hückel limiting law and Debye-Hückeleory of strong electrolytes.
3. To learn and understand the Electro kinetic phenomena, voltammetry and
4. design, applications of the batteries and Fuel Cells, Corrosion and its Protection
5. To understand the concept of different laws of thermodynamics and describe the theories of classical thermodynamics.
6. To understand about the various applications of Quantum Statistics

COURSE OUTCOMES- On the successful completion of the course, students will be able to		DOMAIN	LEVEL
CO1	***Recognize*** and ***explain*** the features of various kinetic theories involved in chemical reactions and Catalysis.	Cognitive	Remember Understand
CO2	***Illustrate*** the ionic activity, ionic interactions, Debye-Hückel-Bjerrum model, Debye-Hückel limiting law and Debye-Hückeleory of strong electrolytes.	Cognitive	Understand
CO3	***Apply*** the Electro kinetic phenomena for the development of Batteries and Fuel Cells and for the application of Corrosion Protection	Cognitive	Understand Apply
CO4	***Explain*** the concept of different laws of thermodynamics and ***describe*** the theories of classical thermodynamics.	Cognitive Affective	Understand
CO5	***Summarize the*** various applications of Quantum Statistics.	Cognitive	Understand

	UNIT - I CHEMICAL KINETICS AND CATALYSIS	**15**
	Absolute reaction rate theory -Thermodynamic terms-Significance of entropy and volume of activation. Reactions in solution: factors determining reaction rates in solutions, effect of dielectric constant and ionic strength, - Bronsted –Bjerrum equation-Primary and Secondary salt effect, influence of solvent on reaction rates. Acid base catalysis-Bronsted relations, catalytic coefficients and their determination. Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of pH and temperature on enzyme catalysis, Mechanism of enzyme inhibition kinetics of surface reactions- unimolecular reactions-Bimolecular reactions-Langmuir Hinshelwood and Elay-Rideal mechanism. Chemical dynamics: Study of fast reactions by stopped flow techniques- relexation method, flash photolysis and the nuclear magnetic resonance method. Linear free energy relationship-Hammett equation, Taft equation-Separation of polar, resonance and steric effects.	
	UNIT – II ELECTROCHEMISTRY - I	**15**
	Deviation from ideal behaviour.ion-solvent and ion-ion interactions. Debye-Hückel-Bjerrum model, Ion association and triple ion formations.Expression for the mean activity coefficient.Debye-Hückel limiting law and its applications -Diverse ion effect.Van't Hoff factor and its relation to colligative properties.Debye-Hückel theory of strong electrolytes.Debye-Hückel length and potential around a central ion, its interpretation. Transport of ions in Solution: Electrolytic conduction- Debye - Hückel-Onsager treatment of strong electrolytes- ionic atmosphere- Anomalous conductance of non aqueous electrolytes	
	UNIT – III ELECTROCHEMISTRY- II	**15**
	Electrical double layer - Electrocapillary phenomena - Surfactants - Lipmann's equation, Electrokinetic phenomena. Zeta potential and its applications.Structure of electrical double layer – Helmholtz-Perrin, Guoy-Chapmann and Stern models. Butler-Volmer equation for one electron transfer reaction - equilibrium and exchange current densities- and symmetry factor - transfer coefficient. Cyclic voltammetry and Stripping voltammetry - principle – instrumentation- Corrosion and passivation of metals - Pourbaix diagram - Evans diagram –Batteries and Fuel cells-Ion selective electrodes	
	UNIT- IV CLASSICAL THERMODYNAMICS	**15**
	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.	
	UNIT –V STATISTICAL THERMODYNAMICS	**15**

	Objectives of statistical thermodynamics, Concept of distributions, Types of ensembles. Thermodynamic probability, Most probable distribution Law- Classical statistics-Maxwell-Boltzmann (MB) statistics-Quantum statistics-Bose-Einstein (BE) and Fermi-Dirac (FD) statistics-Derivation of distribution function-MB, BE and FD statistics-comparison-Partition functions-Translational, rotational, vibrational and electronic partition function –Calculation of thermodynamic parameters and equilibrium constants in terms of partition function; Debye and Einstein heat capacity of solids.

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

TEXT BOOKS

1. K. J. Laidler, Chemical Kinetics; 3rd Ed., Tata McGraw Hill, Noida, 1987.
2. J. W. Moore and R. G. Pearson, Kinetics and Mechanism; 3rd Ed., John Wiley and Sons, New York, 1981.
3. M. Mortimer and P. G. Taylor, Chemical Kinetics and Mechanism; 1st Ed., Royal Society of Chemistry, UK, 2002.
4. J. N. Gurtu and A. Gurtu, Advanced Physical Chemistry; 5th Ed., Pragathi Prakashan, Meerut, 2006.
5. J. I. Steinfeld, J. S. Francisco and W. L. Hase, Chemical Kinetics and Dynamics; 2nd Ed., Prentice Hall, New Jersey, 1999.
6. P. W. Atkins, Physical Chemistry; 7th Ed., Oxford University Press, Oxford, 2001.
7. J. Rajaram and J. C. Kuriacose, Thermodynamics for Students of Chemistry - Classical, Statistical and Irreversible; Pearson Education, New Delhi, 2013.
8. Horia Metiu, Physical Chemistry, Thermodynamics; Taylor and Francis, Singapore, 2006.

REFERENCE BOOKS

1. M. C. Gupta, Statistical Thermodynamics, Wiley Eastern, New Delhi, 1990.
2. Yi-Chen Cheng, Macroscopic and Statistical Thermodynamics, World Scientific, 2006.
3. D. A. McQuarrie, Text Book of Physical Chemistry, University Science Books, Mill Valley, California, 1983.
4. R. A. Alberty and R. J. Silbey, Physical Chemistry, John Wiley and Sons, New York, 1992.

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	CORSE NAME	L	T	P	C
YCY104	INORGANIC CHEMISTRY PRACTICAL I	0	0	6	3
PREREQUISITE	Nil	L	T	P	H
C:P: A	1: 1.2:0.8	0	0	6	3

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 and anions 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 photoelectric 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, NH_4) and two less common cations (W, Tl, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li).

Semi-micro qualitative analysis of a mixture containing anions with interfering radicals (carbonate, sulphide, sulphate, nitrate, chloride, bromide, fluoride, borate, oxalate, arsenite, arsenate and phosphate).

Estimation of copper, iron, nickel, chromium and manganese ions using photoelectric colorimeter

HOURS	LECTURE	TUTORIAL	PRACTICALS	TOTAL
	0	0	90	90

TEXT BOOKS

1. Venkateswaran V. Veerasamy R. Kulandaivelu A.R., Basic principles of Practical Chemistry, 2nd edition, New Delhi, Sultan Chand & sons (1997).
2. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edition, , Pearson Education India, 2008.
3. Dr.V.V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, The National Publishing Company, Chennai.

COURSE CODE	YCY105	L	T	P	C
CORSE NAME	PHYSICAL CHEMISTRY LAB	0	0	6	3
PREREQUISITE	NIL	L	T	P	H
C:P:A	1: 1.2:0.8	0	0	6	3

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

Experiments to be exercised **2**

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	PRACTICAL	TOTAL
	0	90	90

COURSE CODE	COURSE NAME	L	T	C
YCYE01	GREEN CHEMISTRY	4	1	5
		L	T	H
C:P:A	4.2:0:0.8	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**

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
YCYE02	INDUSTRIAL CHEMISTRY	4	1	4
		L	T	H
C:P:A	4.2:0:0.8	4	1	5

COURSE OUTCOMES: On the successful completion ofthe 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**

SEMESTER II					
COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YCY201	**INORGANIC CHEMISTRY-II**	**4**	**1**	**0**	**5**
C:P:A	**4.5:0:0.5**	**L**	**T**	**P**	**H**
		4	**1**	**0**	**5**

Learning Objectives:

1. To learn the concepts, structure and bonding of organometallic compounds.
2. To understand the reaction mechanisms and catalytic role of organometallic compounds.
3. To understand the concepts of bioinorganic chemistry and its applications.
4. To understand the structure and packing in solids
5. To learn and understand the concepts of nuclear chemistry and applications of radioisotopes.

COURSE OUTCOMES: On the successful completion of the course, students will be able to		**DOMAIN**	**LEVEL**
CO1	***Recall*** and ***discuss*** the basic concepts of structure and bonding of organometallic compounds; ***Demonstrate*** the possible synthetic methods of organometallic complexes which are very useful in the modern era.	Cognitive Psychomotor	Remember Understand Set
CO2	***Summarize*** and ***Report*** the reaction mechanisms and catalytic role organometallic compounds.	Cognitive Affective	Understand Respond
CO3	***Describe*** the basic of bioinorganic chemistry and applications of various concepts. ***Identify*** the various metalloenzymes/ metalloporphyrins and their structure-function relations.	Cognitive Affective	Understand Apply Respond
CO4	***Analyze*** and ***Explain*** the various types of solid state packing and the types of chemical forces	Cognitive Psychomotor	Understand Analyze Perception
CO5	***Recite*** the principles of nuclear chemistry and ***illustrate*** the applications of radioisotopes	Cognitive Affective	Remember Understand Apply

SYLLABUS:

UNIT I – ORGANOMETALLICS-I: STRUCTURE AND BONDING

Types of organometallic compounds on the basis of the nature of M-C bond. EAN rule: 18e- and 16e- rules – determinator of oxidation state, configuration, coordination number of the metal centre – Types and application 18e- / 16e- rules. Carbonyls – isolated concept.- Structure of carbonlys (simple and polynuclear) Nitrosyls – bridging and terminal nitrosyls, bent and linear nitorsyls. Dinitrogen compounds donors – Alkyl and Aryl – preparation and properties; chain carbon donors – olefins, acetylene and allyl complexes – synthesis, structure and bonding; cyclic carbon donors – (metallocene) – synthesis, structure and bonding.	**15**
UNIT II -ORGANOMETALLICS-II: REACTIONS , CATALYSIS AND CARBENES	
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. Fischer and Schrock carbenes - bonding and reactivity- Grubbs catalyst- carbenes structure, synthesis and reactions-alkene metathesis – mechanism- C-H and C-C activation- agnostic bonds -Ziegler-Natta polymerization of olefins- Ene reaction.	**15**
UNIT III- BIOINORGANIC CHEMISTRY:	
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. 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 B_{12} and B_{12} coenzymes, photosynthesis- photosystem-I &II, nitrogen fixation, cisplatin	**15**
UNIT IV- CHEMISTRY OF SOLID STATE: STRUCTURE	
Weak Chemical forces: van der Waals forces, Hydrogen bonding, Close packing of atoms and ions HCP and BCC types of packing voids, radius ratio – derivation – its influence on structures. Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant. Representative structures of AB and AB_2 types of compounds - rock salt, cesium chloride, wurtzite, zinc blende, rutile, fluorite, antifluorite, cadmium iodide and nickel arsenide. Structure of graphite and diamond. Spinels -normal and inverse types and perovskite structures.	**15**

Band theory of solids- non-stoichiometry- point defects – linear defects- effects due to dislocations-electrical properties of solids-conductor, insulator, semiconductor-intrinsic-impurity semiconductors-optical properties-lasers and phosphors-elementary study of liquid crystals.	
UNIT V - NUCLEAR AND RADIATION CHEMISTRY	
Properties of nucleus – different types of nuclear forces , Nuclear structure and nuclear stability, Nuclear models- – liquid drop model, shell model of nucleus, Radioactivity and nuclear reactions, nuclear reactions induced by charged particles – Q value – nuclear reaction cross section, significance and determination – theory of nuclear fission, nuclear fusion, stellar energy. Hot atom chemistry, Nuclear fission and fusion reactors. The interaction of nuclear radiations with matter. Radiation hazards and therapeutics. Detectors and their principles. Tracer Application of radioisotopes in agriculture, industry and medicine. Isotope dilution and radio-activation methods of analysis.	**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. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry; 6th Ed., John Wiley and Sons,
6. A. R. West, Basic Solid State Chemistry, John Wiley, **1991**
7. H. J. Arniker, Essentials of Nuclear Chemistry, 2nd Ed, Wiley Eastern Co, **1987**.
8. G. Friedlander, J. W. Kennedy and J. M. Miller, Nuclear and Radiochemistry, Wiley, **1964**

New York, 1999.

9. R. C. Mehrotra and A. Singh, Organometallic Chemistry; 2nd Ed., New Age International Ltd. New Delhi, 2014.
10. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals; 3rd Ed., John Wiley and Sons, New York, 2001

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. David L. Nelson and Michael M. Cox, Leninger Principles of Biochemistry, WH Freeman, 2017.

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

Learning Objectives:

1. To learn the concepts and applications of symmetry elements and symmetry operations.
2. To learn and under the concepts of quantum mechanics to apply for the energy calculations in simple and multielectron systems.
3. To understand the concepts of molecular spectroscopy and interaction of electromagnetic radiation with monoatomic and diatomic molecules.
4. To understand the photo physical properties of various type of chemical reactions.
5. To learn the various concepts of adsorption and free energy reaction at interphase.

COURSE OUTCOMES: On the successful completion of the course, students will be able to		DOMAIN	LEVEL
CO1	***Explain*** rules and concepts of group theory for the determining of type of vibrations and hybridizations.	Cognitive	Understanding
CO2	***Describe*** the principles and postulates of quantum mechanics and ***illustrate*** the wave mechanical treatment for simple, multielectron systems and predict the energy level in the molecular systems.	Cognitive	Understand Apply
CO3	***Describe*** the physical aspects of molecular spectroscopy and interaction of electromagnetic radiation with diatomic and polyatomic molecules	Cognitive	Remember
CO4	***Generalize*** the photo physical properties of chemical reactions.	Cognitive	Understand
CO5	***Apply*** and ***identify*** the various concepts of adsorption and free energy reaction at interphase.	Cognitive	Apply Remember

SYLLABUS:	
UNIT- I GROUP THEORY AND ITS APPLICATIONS	
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. Applications of group theory- Determination of representations of vibrational modes in non-linear molecules such as water, ammonia, BF_3, CH_4 and XeF_4.Determination of Hybrid orbitals in non-linear molecules – Examples: H_2O, NH_3, BF_3, CH_4 and XeF_4.	**15**
UNIT- II QUANTUM CHEMISTRY	
Black body radiation-Planck's quantum theory-Wave particle duality-Uncertainty Principle. Operators-linear, commutation, Hermitian and Hamiltonian operators. Eigen functions and Eigen values-Postulates of quantum mechanics. Derivation of Schrodinger's time-independent wave equation and its application to particle in a one dimensional box, particle in a three dimensional box, quantum tuneling, harmonic oscillator, rigid rotor and hydrogen atom. Born-Oppenheimer approximation-Hydrogen molecule ion. LCAO-MO and VB treatments of the hydrogen molecule. Antisymmetry and Pauli's exclusion principle. Slater detrimental wave function, term symbols and spectroscopic states-Russell Saunders coupling. The variation theorem and Perturbation theory.Applications of variation method and perturbation theory to the helium atom.	**15**
UNIT –III M O L E C U L A R S P E C T R O S C O P Y	
Micro wave spectroscopy- Theory- selection rules, –Instrumentation, Principle of micro wave oven; Energy levels in atoms and molecules- Fourier transformation Rotational spectra of diatomic and polyatomic molecules–P,Q,R branches- effect of isotopic substitution. Non-rigid rotator- Linear molecules. Theory of Rotational Raman spectra. 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. Vibrational spectra of diatomic molecules – selection rules –overtones, combination and hot bands - Fermi resonance Energy of diatomic molecule, simple harmonic and unharmonic oscillator, rotational character of vibration spectra, Theory of Vibrational Raman spectroscopy-Coherant Antistokes Raman Spectroscopy (CARS).	**15**
UNIT IV- PHOTOCHEMISTRY AND RADIATION CHEMISTRY	
Photophysical processes of electronically excited molecules – Jablonski diagram, Primary and Secondary Processes, quantum yield and its determination-chemical actinometer. Excimers and exciplexes-Kinetics of collisional quenching-Stern Volmer equations. Photosensitization, Chemiluminescence. Photosynthesis, solar energy conversions. Semiconductor photo catalysis, lasers. Radiation Chemistry-linear energy transfer, G-value, dosimeters, radiolysis of water, solvated electrons.	**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 -microemulsion or micellar emulsions	**15**

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

REFERENCE BOOKS

1. F.A. Cotton, Chemical Application of Group Theory, John Wiley and Sons Inc. New York, 1971.
2. K.V. Raman, Group theory and its applications to Chemistry, Tata McGraw-Hill Publishing Company, 1990
3 A.K. Chandra, Introductory Quantum Chemistry, 4th ed., Tata McGraw Hill, 1994.
4 R. K. Prasad, Quantum Chemistry, 2nd ed., New Age International Publishes (2000),
5 I. N. Levine, Quantum Chemistry, 4th ed., Prentice Hall of India Pvt Ltd., (1994),
6 S. Glasstone, Introduction to Theoretical Chemistry, Affiliated East-West Press
7 G. N. Barrow, Introduction to Molecular Spectroscopy, International Mc.Graw Hill Edition (1993),
8 G. Friedlander, J. W. Kennedy and J. M. Miller, Nuclear and Radiochemistry, Wiley, 1964.
9 K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry; 3rd Ed., New Age International Pvt. Ltd., New Delhi, 2014.

TEXT BOOKS

1. G. N. Barrow, Introduction to Molecular Spectroscopy, International McGraw Hill Student Edition (1984),
2. B. P. Straughan and S. Walker, Spectroscopy, Vol.I to III, Chapman Hall, London (1976),
3. D. A. McQuarrie, Quantum Chemistry, University Science Books (1998),
4. R. L. Flurry, Jr, Symmetry Groups: Theory and Chemical Applications; Prentice Hall, New Jersy, 1980.
5. 2. S. F. A. Kettle, Symmetry and Structure; 2nd Ed., John Wiley and Sons, Chichester, 1995.

E-Resources

https://www.youtube.com/watch?v=R-x9KdNjQmo
https://onlinecourses.nptel.ac.in/noc18_cy15/preview
https://www.youtube.com/watch?v=6QXtnmB1vqk

COURSE CODE	COURSE NAME	L	T	P	C
YCY203	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: On the successful completion of the course, students will be able to		DOMAIN	LEVEL
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 Wileyand Sons, New York, 1992.
7. J. P. Glusker and K. N. Trueblood, Crystal Structure Analysis: A Primer; 3rd Ed., OxfordUniversity 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
YCY204	INORGANIC CHEMISTRY PRACTICAL-II	0	0	6	3
C:P:A	1: 1.5:0.5	L	T	P	H
		0	0	6	6

Learning Objectives:

1. To learn and understand the volumetric and gravimetric analysis of metal ions present in solution.
5. To learn the synthetic procedure of various inorganic compounds.

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
YCY205	ORGANIC CHEMISTRY PRACTICAL –I	0	0	6	3
PREREQUISITE	Nil	L	T	P	H
C:P:A	1: 1.4:0.6	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
YCYE03	PHARMACEUTICAL CHEMISTRY	4	1	0	4
PREREQUISITES	**Nil**	**L**	**T**	**P**	**H**
C:P:A	**4.2:0:0.8**	**4**	**1**	**0**	**5**

COURSE OUTCOMES: On the successful completion of thecourse, students will be able to		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
YCYE04	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 thecourse, 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)

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.

	15

LECTURE	**TUTORIALS**	**SELF STUDY**	**PRACTICAL**	**TOTAL**

	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: On the successful completion of the course, students will be able to		**DOMAIN**	**LEVEL**
CO1	***Outline*** the reaction mechanisms of various rearrangement reactions.	Cognitive	Remember Understand
CO2	***Identify*** the oxidation and reducing reagents for organic synthesis.	Cognitive	Understand
CO3	***Recognize*** the effect of light in organic reactions and ***understand*** the mechanism of photochemistry.	Cognitive Affective	Understand Receiving
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 - MOLECULAR REARRANGMENTS & NAME REACTIONS **15**

A study of mechanism of the following rearrangements: Beckmann, Curtius, Hofmann, Schmidt, Lossen, Wolff, Pinacol, Wagner Meerwin, Demjanov, Dienone-Phenol, Favorski, Benzidine, Claisen, Cope, Sommlet-Hauser, Pummerer and Von-Richter rearrangements. A study of the following name reactions: Dieckmann cyclization, Hofmann-Loffler Freytag reaction, Mitsunobu reaction, Shapiro reaction, Eschenmoser-Tanabe and Ramburg-Backlund reactions.

UNIT II - OXIDATION AND REDUCTIONS REACTIONS **15**

Oxidation with Cr (including PCC, PDC, Jones) and Mn (including MnO_2 and $BaMnO_4$) reagents; Oxidation with LTA, DDQ and SeO_2; Oxidation using DMSO either with DCC or Ac_2O or Oxaloyl chloride; Oxidation using IBX and Dess-Martin Periodinane (DMP) reagent. Reduction with $NaBH_4$, $NaCNBH_3$, $Zn(BH_4)_2$ $LiAlH_4$, $Li(tBuO)_3AlH$, DIBAL-H, Red-Al, Et_3SiH and Bu_3SnH; Reduction using selectrides; Birch reduction

UNIT-III 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 IV – HETEROCYCLES

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

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

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 Edition,,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. 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.

Longifolene: F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry; Vol.2.

COURSE CODE	COURSE NAME	L	T	C
YCY302	PHYSICAL METHODS IN CHEMISTRY-II	4	1	5
		L	T	H
C:P:A	4:0.5:0.5	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 vibrationalspectra 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.
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,

COURSE CODE	COURSE NAME	L	T	P	C
YCY303	ORGANIC CHEMISTRY PRACTICAL-II	0	0	6	3
		L	T	P	H
C:P:A	1: 1.4:0.6	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 thecomponents.	Cognitive Psychomotor Affective	ApplySet Receiving

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).

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	-	-	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
YCY304	PHYSICAL CHEMISTRY PRACTICAL-II	0	0	6	3
C:P:A	1: 1.4:0.6	L	T	P	H
		0	0	6	6

Learning Objectives:

1. To learn and understand the conductometric method of analysis of various types of solutions.
2. To learn the determination of dissociation constants, solubility and activity coefficients of various ions using potentiometric method.

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
YEC305	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: On the successful completion of the course, students will be able to		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 functionfit – 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-liquidmembrane electrodes – ion-selective field effect transistors (ISFETs) – sensors for the analysisof gases in solution. Polarography – 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).
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4. V. K. Srivastava and K. K. Srivastava, Introduction to Chromatography; 2nd Ed.,HoldenDay, 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).
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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).

COURSE CODE	COURSE NAME	L	T	C
YCYE05	SELECTED TOPICS IN CHEMISTRY	4	1	5
		L	T	H
C:P:A	4.5:0:0.5	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 MOLECULARSTRUCTURE	15

Diatomic molecules: Born-Oppenheimer approximation–MO theory (H_2 and H_2^+), VBtheory (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.

UNIT II	NAMED REACTIONS AND APPLICATIONS IN ORGANIC SYNTHESIS	15

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.

UNIT III	SYNTHETIC METHODOLOGY	15

Introduction to disconnections – synthons and synthetic equivalents – synthonapproach – 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.		
UNIT IV	**POLYMER CHEMISTRY**	**15**
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.		
UNIT V	**FUNDAMENTAL OF NUCLEAR CHEMISTRY**	**15**
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.		

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

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

COURSE CODE	COURSE NAME	L	T	C
YCYE06	CHEMISTRY OF NANOSCIENCE AND NANOTECHNOLOGY	4	1	4
		L	T	H
C:P:A	3.4:0:0.6	4	1	5

COURSE OUTCOMES: On the successful completion ofthe 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 ofC60−alkali doped C60−superconductivity in C60−larger and smaller fullerenes.Carbon nanotubes – synthesis − single walled carbon nanotubes − structure andcharacterization − 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.
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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**

SEMESTER - IV					
COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YCYE07	**SOLID STATE CHEMISTRY**	**4**	**1**	**0**	**4**
C:P:A	**4.5:0:0.5**	**L**	**T**	**P**	**H**
		4	**1**	**0**	**5**

Learning Objectives:

1. To learn the concepts of crystal structure and crystal engineering of organic solids.
2. To understand the mechanisms involved in the reactions of metallo organic framworks.
3. To identify and understand the methods of preparation and crystallization of metallo organic solids.
4. To understand the concepts of magnetic and optical properties of inorganic solids.

To learn and understand the various concepts of solid state chemistry with respect to organicsolids.

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	**15**

Types of close packing – hcp and ccp – packing efficiency – SC, BCC, andFCC, 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.

UNIT II- METAL ORGANIC FRAMEWORKS	**15**

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.

UNIT III- PREPARATIVE METHODS IN SOLID STATE CHEMISTRY	**15**

Experimental procedure, coprecipitation as a precursor to solid state reaction, other precursor

methods, kinetics of solid state reactions – crystallizationsof 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'. 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	**15**
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	
UNIT V- ORGANIC SOLID STATE CHEMISTRY	**15**
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 ofanthracene – control of molecular packing arrangements.	

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

REFERENCE BOOKS

1. R. West, Solid State Chemistry and Its Applications; 2nd Ed., John Wiley andsons, 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 Chemistryand Biology; Oxford University Press: Oxford, 2002.

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, NewYork, 1997. C. N. R. Rao, Current Science, 2001, 81, 1030.

E-RESOURCES

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

COURSE CODE	COURSE NAME	L	T	P	C
YCYE08	SUPRAMOLECULAR CHEMISTRY	4	0	0	4
C:P:A	4.2:0:0.8	L	T	P	H
		4	0	0	5

Learning Objectives:

1. To learn and describe the basic concepts of supramolecular chemistry and the synthons based interactions and polymorphism..
2. To understand the the chemical properties of Metallo organic frameworks and their applications.
3. To identify and understand the concepts of co-receptor molecules and multiple rcognition.
4. To understand the reaction mechanism of supromoleclar compounds.
5. To learn and understand the applications of various supramolecular compounds.

COURSE OUTCOMES: On the successful completion of thecourse, 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 **15**

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.

UNIT II -METALLO-ORGANIC FRAMEWORKS **15**

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.

UNIT III- CO-RECEPTOR MOLECULES AND MULTIPLE RECOGNITION **15**

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.	
UNIT IV- SUPRAMOLECULAR REACTIVITY AND CATALYSIS	**15**
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.	
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.

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