ACHARYA NAGARJUNA UNIVERSITY

A State Government University, Accredited with "A" Grade by NAAC

Nagarjuna Nagar - 522 510, Guntur, Andhra Pradesh, India.

M.Sc. CHEMISTRY

SYLLABUS

2022 - 2023 onwards

UNIVERSITY COLLEGE OF SCIENCES

PROGRAM CODE:

ANUCS06


ACHARYA NAGARJUNA UNIVERSITY
సత్యం సర్వం ప్రతిష్ఠితమ్

ABOUT UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY (ANU)

- A Brief Profile

Acharya Nagarjuna University, a State University established in 1976, has been constantly striving towards achieving progress and expansion during its existence for over four decades, in terms of introducing new courses in the University Colleges, affiliated colleges and professional colleges. Spread over 300 acres of land on the National High Way (NH-16) between Vijayawada and Guntur of Andhra Pradesh, the University is one of the front ranking and fastest expanding Universities in the state of Andhra Pradesh. The University was inaugurated on 11th September, 1976 by the then President of India, Sri Fakruddin Ali Ahmed and celebrated its Silver Jubilee in 2001. The National Assessment and Accreditation Council (NAAC) awarded "A" grade to Acharya Nagarjuna University and also has achieved 108 International ranks, 39 National ranks UI Green Metrics rankings and many more It is named after Acharya Nagarjuna – one of the most brilliant preceptors and philosophers, whose depth of thought, clarity of perception and spiritual insight were such that even after centuries, he is a source of inspiration to a vast number of people in many countries. The University is fortunate to be situated on the very soil where he was born and lived, a soil made more sacred by the aspiration for light and a state of whole someness by generations of students. With campus student strength of over 5000, the University offers instruction for higher learning in 68 UG & PG programs and guidance for the award of M.Phil. and Ph.D. in 48 disciplines spread over six campus colleges and one PG campus at Ongole. It also offers 160 UG programs in 440 affiliated colleges in the regions of Guntur and Prakasam Districts. It has a Centre for Distance Education offering 87 UG & PG programs. Characterized by its heterogeneous students and faculty hailing from different parts of the state and the country, the University provides most hospitable environment for pursuing Higher Learning and Research. Its aim is to remain connected academically at the forefront of all higher educational institutions. The University provides an excellent infrastructure and on- Campus facilities such as University Library with over one lakh books & 350 journals; Computer Centre; University Scientific Instrumentation Centre; Central Research Laboratory with Ultra-modern Equipment; Well-equipped Departmental Laboratories; Career Guidance and Placement Cell; Health Centre; Sports Facilities with Indoor & Outdoor Stadiums and Multipurpose Gym; Sports Hostel; Separate hostels for Boys, Girls, Research Scholars and International Students; Pariksha Bhavan (Examinations Building); Computers to all faculty members; Wi-Fi connectivity to all Departments and Hostels; Canteen, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichmann & Dr. S.John David Auditorium cum Seminar Hall; Post office; Telecom Centre; State Bank of India; Andhra Bank; Energy Park; Silver Jubilee Park; Fish ponds; internet center; xerox center; cooperative stores; Water harvesting structures.

VISION, MISSION & OBJECTIVES OF THE UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY

VISION

To generate sources of knowledge that dispels ignorance and establish truth through teaching, learning and research.

MISSION

To promote a bank of human talent in diversified faculties – Commerce & Management Studies, Education, Engineering & Technology, Humanities, Law, Natural Sciences, Pharmacy, Physical Education & Sports Sciences, Physical Sciences and Social Sciences that would become an investment for a prosperous society.

OBJECTIVES

- To inspire and encourage all who would seek knowledge through higher education and research.
- To provide quality instruction and research for the advancement of science and technology.
- To promote teaching and research studies in disciplines of societal relevance.
- To bridge the gap between theory and practice of the principles of higher education.
- To develop human talent necessary for the industry.
- To open up avenues of higher education and research through non-formal means.
- To invite and implement collaborations with other institutes of higher learning on a continuous basis for mutual academic progress.
- To motivate and orient each academic department/centre to strive for and to sustain advanced levels of teaching and research so that the university emerges as an ideal institute of higher learning.
- To focus specially on the studies involving rural economy, justifying its existence in the rural setting.

VISION

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MISSION OF THE COLLEGE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

VISION OF THE COLLEGE:

University College of Sciences envisages to be a good team of people with scientific temperament, research bent and a flair for Teaching & Learning for the betterment of the Community, Society, State and the Country at large.

MISSION OF THE COLLEGE:

The College intends to incubate and nurture the Leaders, Mentors, Educators and researchers who can transform the country and contribute to advances in science while addressing the challenges faced by the society for the betterment of human life.

VISION & MISSION OF THE DEPARTMENT

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF CHEMISTRY
M.Sc. CHEMISTRY

VISION OF THE DEPARTMENT:

The Department envision establishing itself as a place of excellence for chemistry education and research programmes globally. The Department of Chemistry at Acharya Nagarjuna University is dedicated to the instruction, training, and intellectual growth of Post Graduate students through promotion of innovation, creative endeavors, and scholarly inquiry and to be a global destination of higher education and research. By maintaining its research programs, the Department of Chemistry enhances the recognition and reputation of Acharya Nagarjuna University locally, regionally, nationally, and internationally.

MISSION OF THE DEPARTMENT:

- The mission of the Department of Chemistry is to serve the State and the Nation by educating students, by advancing scientific knowledge, and by catalysing economic development.
- To create and maintain the programs of excellence in the areas of research, education, and public outreach.
- To offer research projects with high emphasis on concept-theory-practical training to build up research interest for the transformation of budding chemists into productive scientists, excellent teachers, entrepreneurs, and innovative independent researchers.
- Our specific goal is to become a nationally recognized centre of chemical sciences for modern education with a state of art centralized research facility.
- To serve a beacon of change, through multi-disciplinary learning, for creation of knowledge community, by building a strong character and nurturing a value-based transparent work ethics, promoting creative and critical thinking for holistic development and self-sustenance for the people of India.
- The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research, and innovation in pure and applied areas of learning.
- To bridge the gap between academia and industry by regularly updating the curriculum on par with recent developments in science and encourage doing in house projects.
- To educate and invoke the students to deliver their maximum out puts in competitive examination sand meet industrial competences.
- To develop chemists with excellent analytical and synthetic skills through the curriculum with more laboratory components and industrial visits/internships.

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF CHEMISTRY
M.Sc. CHEMISTRY

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's):

Programme Educational Objectives (PEOs) are extensive reports that define the probable activities of graduates of a certain academic program in their professional careerand life. The M.Sc. Chemistry program will enable the student to

PEO1	Understand the core and advanced chemistry concepts thoroughly.
PEO2	Have societal, health, safety, and cultural issues relevant to the science practices and Provide a strong foundation for acquiring advanced knowledge in chemistry.
PEO3	Acquire critical thinking supported by advanced analytical skills to address chemistry related problems.
PEO4	Demonstrate the ability to perform accurate quantitative measurements with an understanding of the theory and use of sophisticated instruments, analyze and interpret
PEO5	Enhance skills for employability through activities, such as, seminar, communication, skills, industrial visit, internship, and research project dissertation.

PROGRAMME SPECIFIC OUTCOMES (PSO's):

Upon successful completion of M.Sc. Chemistry program, the student will be able to

PSO1	Acquire the knowledge recent advancement in the scientific field.
PSO2	Understand the features of molecules in organic /inorganic/physical domain
PSO3	Develop computational and experimental skills to explore molecular level phenomena.
PSO4	Apply technical skill in a sophisticated laboratory environment & secure challenging position in Industry & Academics.
PSO5	Enhance employability through laboratory activities, solving problems and co-curricular activities.

PROGRAMME OUTCOMES (PO's):

On successful completion of M.Sc. program (Two years), the student will be able to expected to know, understand, or be able to do upon successful completion of a program.The Program outcomes for M.Sc. Chemistry students are:

PO1	Think critically and analyze pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at variableconclusions.
PO2	Prepare and present scientific and technical information resulting from laboratory outputs.
PO3	Design methodologies, analyze, and evaluate innovative scientific research problems.
PO4	Pursue higher education/become an employee/ entrepreneur/ professional training in Chemistry or related fields, or transition into a Chemistry-related career.
PO5	Work independently as well as in a team to exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams and in multidisciplinary settings.
PO6	Apply chemistry knowledge and skills to address real-world problems and encounters, and develop innovative resolutions.
PO7	Project management: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational; skills and the ability to manage time and resources.
PO8	Environment and society: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO9	Effectively communicated with spoken and written in scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO10	Commitment to professional ethics and responsibilities.

STRUCTURE

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF CHEMISTRY
COURSE STRUCTURE

For M.Sc. ANALYTICAL CHEMISTRY / M.Sc. INORGANIC CHEMISTRY / M.Sc. ORGANIC CHEMISTRY

SEMESTER-I

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – I	**Mandatory Core**	**R22CH11**	Inorganic Chemistry-I	**4**	**4**	**30**	**70**	**100**
		R22CH12	Organic Chemistry-I	**4**	**4**	**30**	**70**	**100**
	Compulsory	**R22CH13**	Foundation for Chemistry	**4**	**4**	**30**	**70**	**100**
	Elective Foundation (Opt' 1)	**R22CH14A**	Physical Chemistry-I	**4**	**4**	**30**	**70**	**100**
		R22CH14B	Polymer Science					
		R22CH14C	Nuclear Chemistry And Applications					
	Core Practical-I	**R22CH15**	Inorganic & Physical Chemistry	**4**	**6**	**30**	**70**	**100**
	Core Practical-II	**R22CH16**	Organic Chemistry	**4**	**6**	**30**	**70**	**100**
	Audit course	**R22CH17**	*Human Values and Professional Ethics*	***2***	***2***	***50***	**-**	**-**
	SUB-TOTAL			**24**				**600**

For M.Sc. ANALYTICAL CHEMISTRY / M.Sc. INORGANIC CHEMISTRY / M.Sc. ORGANIC CHEMISTRY

SEMESTER-II

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER - II	**Mandatory Core**	**R22CH21**	Physical Chemistry-II	**4**	**4**	**30**	**70**	**100**
		R22CH22	Organic Chemistry-II	**4**	**4**	**30**	**70**	**100**
	Compulsory	**R22CH23**	Essential Lab Techniques for Industry	**4**	**4**	**30**	**70**	**100**
	Elective Foundation (Opt' 1)	**R22CH24A**	Inorganic Chemistry-II	**4**	**4**	**30**	**70**	**100**
		R22CH24B	Nano Science & Technology					
		R22CH24C	Material Science					
	Core Practical-I	**R22CH25**	Inorganic & Physical Chemistry	**4**	**6**	**30**	**70**	**100**
	Core Practical-II	**R22CH26**	Organic Chemistry	**4**	**6**	**30**	**70**	**100**
	Core Practical-III	**R22CH27**	Comprehensive Viva-voce (1^{st} & 2^{nd} Semester)	**2**	**--**	**--**	**50**	**50**
	Skill Development	**R22CH28**	*Communicative English*	***2***	***2***	***50***	**--**	**--**
	SUB-TOTAL			**26**				**650**

M.Sc. ANALYTICAL CHEMISTRY

SEMESTER-III

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – III	**Mandatory Core**	**R22AC31**	Applied Inorganic Analysis	**4**	**4**	**30**	**70**	**100**
		R22AC32	Analysis of Applied Industrial Products	**4**	**4**	**30**	**70**	**100**
	Core Elective-I	**R22AC33A**	Optical Thermal & Radiochemical Methods of Analysis	**4**	**4**	**30**	**70**	**100**
		R22AC33B	Applications of Synthetic Products					
		R22AC33C	Basics of Biotechnology					
	Open Elective-II	**R22AC34A**	Principles and techniques in Classical Analysis	**4**	**4**	**30**	**70**	**100**
		R22AC34B	Food Chemistry & Analysis					
		R22AC34C	Green Chemistry					
	Core Practical-I	**R22AC35**	Classical Methods of Analysis	**4**	**6**	**30**	**70**	**100**
	Core Practical -II	**R22AC36**	Instrumental Methods of Analysis	**4**	**6**	**30**	**70**	**100**
	Skill Enhancement	**R22AC37**	*MOOC's Online Course*	***2***	**--**	***50***	**--**	**--**
	SUB-TOTAL			**24**				**600**

M.Sc. ANALYTICAL CHEMISTRY

SEMESTER-IV

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – IV	**Mandatory Core**	**R22AC41**	Advanced Methods of Analysis	**4**	**4**	**30**	**70**	**100**
		R22AC42	Analysis of Drugs, Foods, Diary Products & Biochemical	**4**	**4**	**30**	**70**	**100**
	Core Elective-I	**R22AC43A**	Separation Techniques & Electro Analytical Techniques	**4**	**4**	**30**	**70**	**100**
		R22AC43B	Analytical Chemistry of Oils & Fats					
		R22AC43C	Quality Control & Quality Assurance in Pharma Industry					
	Open Elective-II	**R22AC44A**	Environmental Chemistry & Analysis	**4**	**4**	**30**	**70**	**100**
		R22AC44B	Forensic Science in Solving Crime					
		R22AC44C	Engineering Chemistry					
	Core Practical-I	**R22AC45**	Classical & Instrumental Methods of Analysis	**4**	**6**	**30**	**70**	**100**
	Core Practical-II (Multi Disciplinary)	**R22AC46**	Project Work / Spectral Problems	**4**	**6**	**--**	**100**	**100**
	Core Practical-III	**R22AC47**	Comprehensive Viva-voce (3rd & 4th Semester)	**2**	**--**	**--**	**50**	**50**
	SUB-TOTAL			**26**				**650**

M.Sc. INORGANIC CHEMISTRY

SEMESTER-III

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – III	**Mandatory Core**	**R22IC31**	Advances in Inorganic Chemistry	**4**	**4**	**30**	**70**	**100**
		R22IC32	Physical Inorganic Chemistry	**4**	**4**	**30**	**70**	**100**
	Generic Elective-I (Opt' 1)	**R22IC33A**	Instrumental Methods in Inorganic Analysis	**4**	**4**	**30**	**70**	**100**
		R22IC33B	Transition Metal Organometallics in Catalysis					
		R22IC33C	Green Chemistry					
	Open Elective-II (Opt' 1)	**R22IC34A**	Bioinorganic Chemistry	**4**	**4**	**30**	**70**	**100**
		R22IC34B	Applications of Synthetic Products					
		R22IC34C	Basics of Biotechnology					
	Core Practical-I	**R22IC35**	Classical Methods of Analysis	**4**	**6**	**30**	**70**	**100**
	Core Practical - II	**R22IC36**	Instrumental Methods of Analysis	**4**	**6**	**30**	**70**	**100**
	Skill Enhancement	**R22IC37**	*MOOC's Online Course*	***2***	**--**	***50***	**--**	**--**
	SUB-TOTAL			**24**				**600**

M.Sc. INORGANIC CHEMISTRY

SEMESTER-IV

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/ Week	Internal Assessment	Semester End Exams	Total
SEMESTER – IV	Mandatory Core	R22IC41	Photo Inorganic Chemistry	4	4	30	70	100
		R22IC42	Physical Methods in Structural Studies	4	4	30	70	100
	Core Elective-I (Opt' 1)	R22IC43A	Instrumental Methods of Inorganic Analysis	4	4	30	70	100
		R22IC43B	Industrial Inorganic Chemistry					
		R22IC43C	Quality Control & Quality Assurance in Pharma Industry					
	Open Elective-II (Opt' 1)	R22IC44A	Environmental Chemistry	4	4	30	70	100
		R22IC44B	Forensic Science in Solving Crime					
		R22IC44C	Engineering Chemistry					
	Core Practical-I	R22IC45	Classical & Instrumental Methods of Analysis	4	6	30	70	100
	Core Practical-II (Multi Disciplinary)	R22IC46	Project Work / Spectral Problems	4	6	--	100	100
	Core Practical-III	R22IC47	Comprehensive Viva-voce (3rd & 4th Semester)	2	--	--	50	50
	SUB-TOTAL			26				650

M.Sc. ORGANIC CHEMISTRY

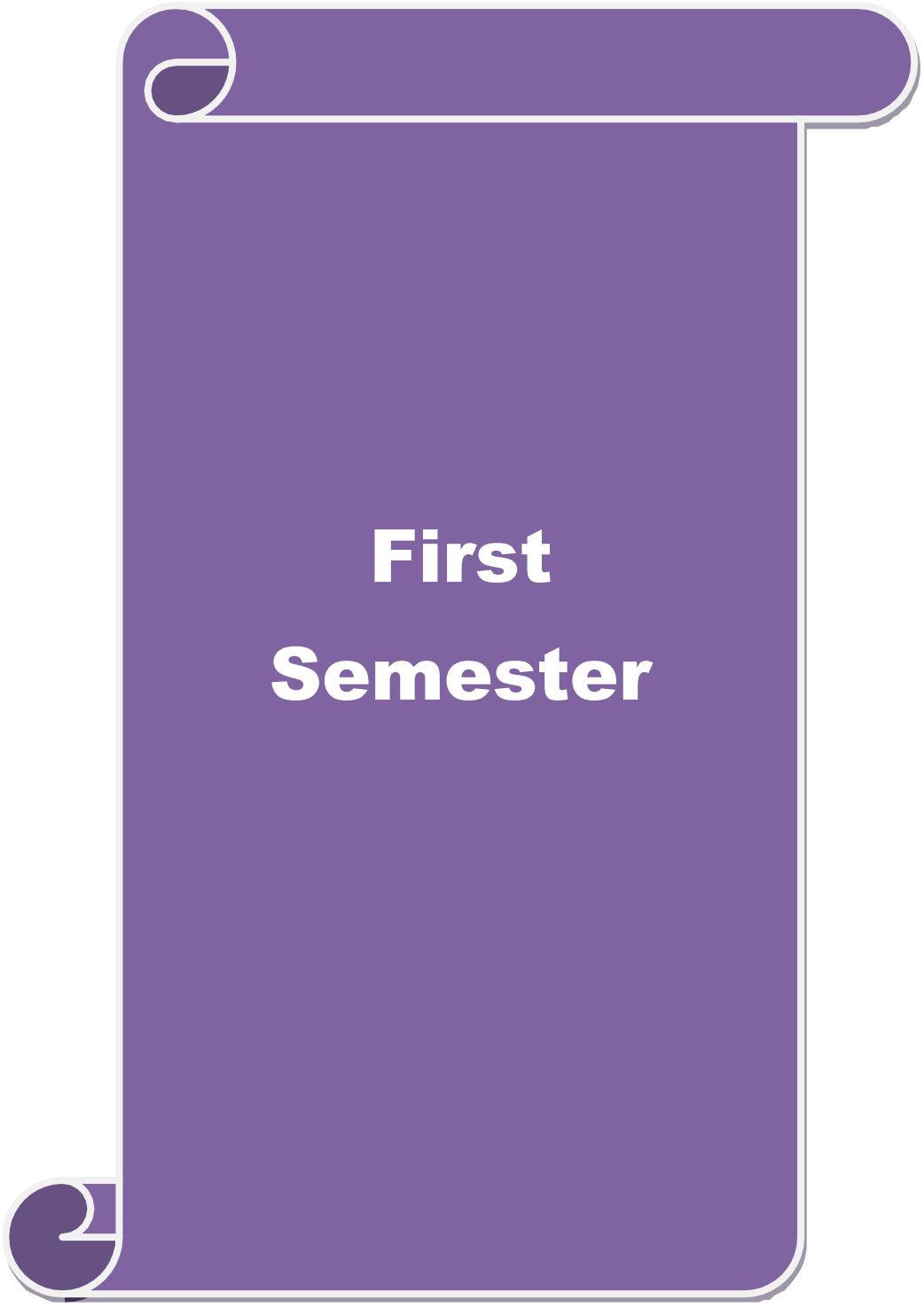
SEMESTER-III

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – III	**Mandatory Core**	**R22OC31**	Organic Spectroscopy-I	**4**	**4**	**30**	**70**	**100**
		R22OC32	Organic Synthesis & Reaction Mechanisms-I	**4**	**4**	**30**	**70**	**100**
	Ge neric Elective-I (Opt' 1)	**R22OC33A**	Alkaloids, Terpenoids, Quinones & Phenothiazines	**4**	**4**	**30**	**70**	**100**
		R22OC33B	Chemistry of Aerospace Materials					
		R22OC33C	Drug Discovery, Design and Development					
	Open Elective-II (Opt' 1)	**R22OC34A**	Chemistry of Natural Products	**4**	**4**	**30**	**70**	**100**
		R22OC34B	Chemistry of High Energy Materials					
		R22OC34C	Applications of Synthetic Products					
	Core Practical-I	**R22OC35**	Multistage Organic Synthesis	**4**	**6**	**30**	**70**	**100**
	Core Practical-II	**R22OC36**	Organic Estimations	**4**	**6**	**30**	**70**	**100**
	Skill Enhancement	**R22OC37**	*MOOC's Online Course*	***2***	**--**	***50***	**--**	**--**
	SUB-TOTAL			**24**				**600**

M.Sc. ORGANIC CHEMISTRY

SEMESTER-IV

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – IV	**Mandatory Core**	**R22OC41**	Organic Spectroscopy-II	**4**	**4**	**30**	**70**	**100**
		R22OC42	Organic Synthesis & Reaction Mechanisms-II	**4**	**4**	**30**	**70**	**100**
	Core Elective-I (Opt' 1)	**R22OC43A**	Advanced Organic Chemistry	**4**	**4**	**30**	**70**	**100**
		R22OC43B	Engineering Chemistry					
		R22OC43C	Quality Control and Quality Assurance in Pharma Industry					
	Open Elective-II (Opt' 1)	**R22OC44A**	Chemistry of Antibiotics and Drugs	**4**	**4**	**30**	**70**	**100**
		R22OC44B	Forensic Science in Solving Crime					
		R22OC44C	Air, Water, Noise & Thermal Pollution					
	Core Practical-I	**R22OC45**	Analysis of Binary Organic Mixture	**4**	**6**	**30**	**70**	**100**
	Core Practical-II (Multi Disciplinary)	**R22OC46**	Project Work / Spectral Problems	**4**	**6**	**--**	**100**	**100**
	Core Practical-III	**R22OC47**	Comprehensive Viva-voce (3rd & 4th Semester)	**2**	**--**	**--**	**50**	**50**
	SUB-TOTAL			**26**				**650**


First
Semester

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF CHEMISTRY

M.Sc. ANALYTICAL CHEMISTRY / M.Sc. INORGANIC CHEMISTRY / M.Sc. ORGANIC CHEMISTRY

SEMESTER-I

R22CH11: INORGANIC CHEMISTRY-I

COURSE OUTCOMES:

- Understand VSPER theory, symmetric and unsymmetric hydrogen bonds in inorganic molecules.
- Understanding the Crystal field theory and Jahn Teller Effects.
- Understand the basics of molecular orbital theory and energetic of hybridization.
- Understand the Jobs method, hard and soft acids and bases.
- Cage compounds of oxygen, phosphorous and sulphar compounds and isopoly and heteropoly anions.

UNIT-I:

Structure and Bonding: VSEPR theory and its role in explaining the structures of inorganic molecules. Walsh diagrams for linear molecule (BeH_2) and bent molecule (H_2O). Molecular Orbital theory - Symmetry of Molecular orbitals, Molecular orbitals in triatomic (BeH_2) molecules and ions (NO^-) and energy level diagrams.

Participation of p and d orbitals in pπ - dπ bonding- Evidences from both non transition and transition metal compounds.

Non-valence cohesive forces, Hydrogen bonding - Symmetric and unsymmetric hydrogen bonds in inorganic molecules.

UNIT-II:

Metal-Ligand Bonding: Crystal Field Theory of bonding in transition metal complexes Splitting of d- orbitals in Octahedral, tetrahedral, trigonal bipyramidal and Square pyramidal fields and energy orders of orbitals.

Tetragonal distortions - Jahn Teller effect. Static and dynamic Jahn - Teller effects. Chelates and Jahn - Teller effect.

Spectrochemical series. Nephelauxetic effect. Calculation of crystal field stabilization energies. Factors affecting crystal field splitting energies. Applications and limitations of CFT.

UNIT-III:

Molecular Orbital Theory: Evidence for covalence in complexes - Experimental evidences from both σ and π bonded complexes.

Molecular Orbital Theory of bonding for octahedral, tetrahedral and square planar complexes. π- bonding and MOT - Effect of π-donor and π-acceptor ligands on Δ_o. Experimental evidence for π-bonding in complexes.

MOT and Resonance. Resonance in homoatomic molecules (H_2) and hetero atomic ions. Molecular Orbital Theory and Hybridization. Bents Rule and energetic of Hybridization.

UNIT-IV:

Metal-Ligand Equilibria in Solutions: Step wise and over all formation constants. Trends in stepwise constants, statistical effect and statistical ratio. Determination of formation constants by Spectrophotometric method (Job's method) and Limitations to Jobs method. Determination of formation constants by pH metric method (Bjerrum's method).

Stability correlations and Irwing -William's series for transition metal ions.

Hard and soft acids and bases (HSAB) – Acid-base strength and HSAB , Electro negetivity and HSAB.Macrocyclic complexes - Crown ethers and Cryptates.

UNIT-V:

Non Metal Cages and Ring Compounds: Preparation and structures of higher boranes, Electron counting rules in boranes-Wades rules and Polyhedral skeletal electron pair theory. Heterocyclic inorganic ring systems Boron-Nitrogen (B-N), Phosphorus–Nitrogen (P-N) and Sulphur-Nitrogen (S-N) cyclic compounds. Cage compounds of Phosphorous-Oxygen (P-O) and Phosphorous-Sulphur (P-S). Preparation and structures of Isopoly and heteropoly anions and their sats.

REFERENCE BOOKS:

1) Inorganic Chemistry Huheey, Harper and Row.
2) Physical methods in Inorganic Chemistry, R.S. Drago. Affiliated East-West Pvt. Ltd.
3) Concise Inorganic Chemistry, J. D. Lee, ELBS.
4) Modern Inorganic Chemistry, W. L. Jolly, McGrawHill.
5) Inorganic Chemistry, K. F. Purcell and J. C. Kotz Holt Saunders international.
6) Concepts and methods of inorganic chemistry, B.E. Douglas and D.H.M.C. Daniel.
7) Introductory Quantum mechanics, A. K. Chandra.
8) Quantum Chemistry, R. K. Prasad.
9) Inorganic Chemistry, Atkins, ELBS.
10) Advanced Inorganic Chemistry, Cotton and Wilkinson, Wiley Eastern.
11) Quantum Chemistry, R. K. Prasad.
12) Concise Coordination Chemistry, R.Gopalan and V.Ramalingam.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2				2				
2	3	2				3				
3	3	2				2				
4	3	1				2				
5	3	2				1				

***1-Low *2- Medium *3- Strong**

R22CH12: ORGANIC CHEMISTRY-I

COURSE OUTCOMES:

- Understand aromaticity in Bezenoid compounds and Non-Benzenoid compounds.
- Knowledge about formation of various heterocyclic compounds with their synthesis and importance of natural products in medicinal chemistry
- Knowledge about stereochemistry and stereo chemical forms for different organic Molecules.
- Understand about conformations of acyclic alkanes and substituted alkanes and some methods for conformational analysis.
- Knowledge on monocyclic and bicyclic cyclohexanes and fused ring conformations for applying it to organic compounds.

UNIT-I:

Aromaticity Benzenoid & Non-Benzenoid: Concept of aromaticity, Huckel's rule for aromaticity in benzenoid compounds, Aromaticity of five membered, six membered rings and fused systems.

***Non benzonoid aromatic compounds*:** Cyclopropenyl cation, Cyclobutadienyl dication, cyclopentadienyl anion, tropyllium cation and cyclooctatetraenyl dianion. Ferrocene. Azulenes, Fulvenes, Annulenes, Fullerenes. Homo aromaticity, and Anti aromaticity.

UNIT-II:

Heterocyclic Compounds and Natural Products:

a) Synthesis, Properties and Reactions of furan, thiophene, pyrrole, pyridine, quinoline, isoquinolineand indole; Skraup synthesis, Fisher indole synthesis.

b) Heterocyclic compounds more than one hetero atom-: synthesis, properties and reactions of Pyrazole,Imidazole, Oxazole Iso-Oxazole, Thiazole.

Natural Products: Importance of natural products as drugs.

Terpenoids: General methods in the structure determination of terpenes. Isoprene rule. Structure determination and synthesis of α-terpeniol, β-carotene, and camphor.

UNIT-III:

Stereochemistry

a) *Molecular representations of organic molecules* –Wedge, Fischer, Newman and Saw-horse formulae, their description and inter-conservation. Stereoisomerism-Definition, classification.

b) *Concept of Chirality and Molecular Symmetry*: Symmetry operations, Recognition of symmetry elements (Cn, Ci and Sn), Dissymmetric and asymmetric molecules. Chiral structures (one and more than one chiral centers); D-L and R–S nomenciature, diastereoisomerism; Threo and Erythro isomers, Racemic mixture, racemization and methods of resolution, stereo specific and stereoselective synthesis. Stereochemistry of compounds containing nitrogen, sulphur and phosphorous.

c) *Geometrical isomerism*–E, Z- nomenclature–Spectral and chemical methods of determining the configuration of geometrical isomers. Determination of configuration in aldoximes and ketoximes.

UNIT-IV:

Conformational Analysis-I

a) *Conformation of acyclic molecules* –alkanes and substituted alkanes (Ethane and 1, 2-disubstituted ethane derivatives like butane, dihalobutane halohydrin, ethylene glycol, butane-2,3-diol, amino alcohols and 1,1,2,2-tetrahalobutanes). Klyne-Prelog terminology for conformers and torsion angles.

b) Factors affecting the conformational stability and conformation equilibrium-Attractive and Repulsive interactrions. Use of Physical and Spectral methods in conformational analysis.

c) Conformational effects on the stability and reactivity of diastereomers in cyclic molecules-steric and stereo electronic factors-examples.

UNIT-V:

Conformational Analysis-II

a) *Conformations of monocyclic compounds*–cyclohexane-chair, boat and twist boat cyclohexanes, energy profile diagram–mono-and di-substituted cyclohexanes–conformations. Effect of conformation on stability and reactivity in mono and disubstituted cyclohexane derivatives.

b) *Conformations of unsaturated acyclic compounds*: Propylene, and 1-Butene.

c) *Elementary treatment of fused and bridged ring systems* –Decalines and Bornanes. Conformation of sugars. Steric strain due to unavoidable crowding.

REFERENCE BOOKS:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).
6) Stereo Chemistry of carbon compounds – E.L. Eliel.
7) Modern organic Reactions, H.O. House, Benjamin.
8) An introduction to chemistry of Heterocyclic compounds, R.M.Acheson.
9) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
10) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
11) Reaction Mechanism in Organic Chemistry, S.M.Mukherji and S.P.Singh, Macmillan.
12) Basic Principles of Organic Chemistry by J. B. Roberts and M. Caserio.
13) Stereo Chemistry of Organic compounds, P. S. Kalsi, New Age International pubs.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	3		2			3		2			
2	3	3	2			2		3			
3	3	2	3								
4	3	3	3								
5	2	3	3								

***1-Low *2- Medium *3- Strong**

R22CH13: FOUNDATION FOR CHEMISTRY

COURSE OUTCOMES:

- Understand the required tools in analytical and inorganic estimations.
- Understand the various types of errors and types.
- Understanding of various types of reaction intermediates and the bonding present in various organic compounds.
- Identify the point group of molecules and apply the concept of group theory to predict the spectroscopic properties.
- Understand the basics on various environmental concerns and types of various biomolecules and their functions with reference to structure.

UNIT-I:

Titrimetric analysis: Acid-base titrations, redox titrations, complexometric titrations, precipation titrations-principle, example and corresponding indicators, Pri., Sec.-standards.

UNIT-II:

Treatment of analytical data: Errors, classification, accuracy, precision, SD, MD, Student-T test F-test, Gassian distributation

UNIT-III:

Reactive Intermediates: Generation, Structure, Stability and reactivity of Carbocations, Carbanions, free radicals, Carbenes, nitrenes and Benzyne; Electrophiles, Nucleophiles, Catalysts-definition and examples.

Nature of bonding in organic molecules: Localised and Delocalized covalent bonds, Delocalised chemical bonding conjugation, cross conjugation, hyper conjugation, tautomerism.

UNIT-IV:

Symmetry and Group theory in Chemistry - Symmetry elements, symmetry operation, definition of group, sub group, relation between order of a finite group and its sub group. Point symmetry group. Schonfiles symbols, representation of groups by Matrices (representation for the Cn, Cnv, Cnh, Dn etc. groups to be worked out, explicitely). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use. Application of group theory in IR and Raman spectroscopy.

UNIT-V:

Environmental Chemistry:

Classification of environmental segments, types of pollutions, acid rains, Global warming.

Chemistry of Biomolecules: Definition, functional uses and examples for Carbohydrates, lipids(fats and oils), enzymes. Chemistry of purines and pyrimidines, Nucleic acids - Structure andfunctions of DNA & RNA.

REFERENCE BOOKS:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic Chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic Chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	3			2				3			
2			2			3		3			
3	3			3		2		3			
4	3			3		2		3			
5	3		2			1		3			

***1-Low *2- Medium *3- Strong**

R22CH14A: PHYSICAL CHEMISTRY-I

(ELECTIVE–A)

COURSE OUTCOMES:

- Knowledge on classical thermodynamics, entropy changes in reversible and irreversible process fugacity.
- Understand Kelvin equation, Gibbs-Adsorption equation - BET equations for vapour pressure and estimation of surface area and catalytic activity of surface by ESCA, X-ray florescence and Auger electron spectroscopy.
- Understand the Classification of surface active agents, CMC and microemulsions.
- Knowledge on Electrochemical cells, Liquid junction potential, conduct metric titrations.
- Understand about complex reactions, chain reactions and photochemical decomposition reactions.

UNIT-I:

Thermodynamics-I: Classical thermodynamics-Brief review of first and second laws of thermodynamics Entropy change in reversible and irreversible processes-Entropy of mixing of ideal gases-Entropy and disorder-Free energy functions-Gibbs-Helmoboltz equation - Maxwell partial relations-Conditions of equilibrium and spontaneity-Free energy changes in chemical reactions: Van't Hoff reaction isotherm- Van't Hoff equation - Classiuss Clapeyron equation - partial molar quantities-Chemical potential - GibbsDuhem equation - partial molar volume-determination of partial molar quantities – Fugacity - Determination of fugacity-Thermodynamic derivation of Raoult's law.

UNIT-II:

Surface Phenomena and Phase Equilibria: Surface tension-capillary action-pressure difference- across curved surface (young - Laplace equation) - Vapour pressure of small droplets (Kelvin equation)- Gibbs- Adsorption equation - BET equation-Estimation of surface area-catalytic activity of surfaces - ESCA, X- ray flouresence and Augar electron spectroscopy.

UNIT-III:

Surface Active Agents: Classification of surface active agents - Micellisation - critical Micelle concentration (CMC) - factors affecting the CMC of surfactants, microemulsions - reverse micelles- Hydrophobic interaction.

UNIT-IV:

Electrochemistry-I: Electrochemical cells - Measurement of EMF - Nernst equation - Equilibrium constant from EMF Data - pH and EMF data-concentration cells with and without transference - Liquid junction potential and its determination - Activity and activity coefficients-Determination by EMF Method - Determination of solubility product from EMF measurements. Debye Huckel limiting law and its verification. Effect of dilution on equivalent conductance of electrolytes - Anamolous behaviour of strong electrolytes. Debye Huckel - Onsagar equation - verification and limitations - Bjerrum treatment of electrolytes-conductometric titrations.

UNIT-V:

Chemical Kinetics: Methods of deriving rate laws - complex reactions - Rate expressions for opposing, parallel and consecutive reactions involving unimolecular steps. Theories of reaction rates - collision theory - Steric factor - Activated complex theory - Thermodynamic aspects - Unimolecular reactions - Lindemann's theory - Lindemann-Hinshelwood theory. Reactions in solutions - Influence of solvent - Primary and secondary salt effects - Elementary account of linear free energy relationships - Hammet - Taft equation - Chain reactions - Rate laws of H_2-Br_2, photochemical reaction of H2 - Cl2 Decomposition of acetaldehyde and ethane - Rice-Hertzfeld mechanism.

REFERENCE BOOKS:

1) Physical Chemistry P.W. Atkins, ELBS
2) Chemical Kinetics - K.J.Laidler, McGraw Hill Pub.
3) Text Book of Physical Chemistry. Samuel Glasstone, Mcmillan Pub.
4) Physical Chemistry, G.W.Castellan. Narosa Publishing House
5) Thermodynamic for Chemists. Samuel Glasstone
6) Electrochemistry, Samuel Glasstone, Affiliated East West
7) Physical Chemistry, W.J. Moore, Prentice Hall
8) Atomic structure and chemical bond. Manas Chanda. Tata McGraw Hill Company Limited.

OUTCOME MAPPING:

Course Outcomes (CO)	ProgramOutcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	3	2	3			3					
2	3	2	3			2					
3	3	3	3			3					
4	3	2	3			2					
5	2	3	2			1					

***1-Low *2- Medium *3- Strong**

R22CH14B: POLYMER SCIENCE
(ELECTIVE–B)

COURSE OUTCOMES:

- Knowledge on polymer science classification, methods and techniques.
- Understand the synthesis of polymers, analysis of polymers.
- Understand the flow of fluids flow equations, measurement of polymer rheological parameters.
- Knowledge on types of polymer molding, Testing for Mechanical, thermal, and electrical conductivity.
- Understand about Polymer Applications: High temperature polymers, Polymer blends and Composites.

UNIT-I:

Introduction to Polymer Science: Monomers, functionality, degree of polymerizations; classification of polymers, polymerization methods: addition and condensation; new techniques of polymerization; copolymerization, monomer reactivity and its significance; azeotropic copolymerization, block and graft copolymers; techniques for copolymerization: bulk, solution, suspension and emulsion.

UNIT-II:

Polymer Synthesis and Characterization: Synthesis of thermoplastics, Fluoropolymers, Thermosetting polymers and Unsaturated polyesters. Polymer Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights. Polymer crystallinity, analysis of polymers using optical and thermal techniques : Infra Red spectroscopy, X-Ray diffraction, DSC, DMTA and TGA.

UNIT-III:

Polymer Rheology: The flow of Newtonian and non-Newtonian fluids and flow equations. Measurements of rheological parameters by capillary rotating, parallel plate and cone-plate rheometer. Mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, Oscillating Disc Rheometer (ODR) and Moving die Rheometer (MDR).

UNIT-IV:

Processing and Testing of Polymers: Types of mouldings: Compression moulding, transfer moulding, injection moulding, blow moulding, reaction injection moulding, extrusion, pultrusion, calendaring, rotational moulding and rubber processing. Testing for Mechanical-static and dynamic tensile, compressive, abrasion, hardness, tear, impact and toughness. Testing for thermal and electrical conductivity, dielectric constant, electric resistance, swelling, ageing and resistance and environmental resistance.

UNIT-V:

Polymer Applications: *High temperature polymers:* synthesis, processing and applications of Aromatic liquid crystalline polyesters, Phenolics, polyimide and polyether ketones.

Polymer blends and Composites: Difference between blends and composites, their significance, miscible and immiscible blends, polymer alloys, polymer eutectics, plastic-plastic, rubber- plastic and rubber-rubber blends. Fibre Reinforced Polymers (FRP), particulate, long and short fiber-reinforced composites.

REFERENCE BOOKS:

1) Text Book of Polymer Science, 3rd Ed. (1984), F. W. Billmayer, Jr., Willey-Interscience.
2) Principles of Polymer Chemistry, P. J. Flory, Cornell Press (recent edition).
3) Principles of Polymerization, G. Odian, 3rd Edition (1991), John Wiley, Singapore
4) Principles of Polymer Sciences, P. Bahadur and N.V. Sastry, Narosa Publishing House, New Delhi (2002)
5) Polymer Sciences, V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar, Wiley Eastern, New Delhi (1986)
6) The Elements of Polymer Science and Engineering, Alfred Rudin, 3 rd Ed. Academic Press, New York (2012).
7) Experiments in Polymer Science, E. A. Coolins, J. Bares and E. W. Billmeyer, Wiley Interscience, New York (1973).
8) High performance materials in Aerospace, H.M.Flower, Ist ed, Chapman & Hall (1995).
9) Advanced Aerospace materials, B.Horst, B.Ilschner, K.C. Russel, Springer-verlag, Berlin (1992).
10) Applications of high temperature Polymers, R.R.Luise, I ed., CRC Press (1996).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3		3		
2	2	3	3	1		3		2		
3	2	3	3	2		2		2		
4	3	3	2	2		2		3		
5	3	2	3	1		3		2		

***1-Low *2- Medium *3- Strong**

R22CH14C: NUCLEAR CHEMISTRY AND APPLICATIONS
(ELECTIVE–C)

COURSE OUTCOMES:

- Understand the Nuclear Theory and Nuclear Reactions, determination of energies of α-β-γ particles.
- Knowledge on detection of radiations-principle and ionization chambers.
- Understand the Radiometric analysis, Applications of radio isotopes Radio carbon dating.
- Knowledge on Nuclear reactors, Neutron sources and moderation.
- Understand the Natural radioactive nuclides, Plutonium isotopes, Biological effects of radiations.

UNIT-I:

Nuclear Theory and Nuclear Reactions: Radioactive decay processes, Natural radioactive series, Determination of half - lives of short- and long-lived isotopes. α-β-γ decays and K-capture nuclear reactions (NR): NR induced by neutron and charged particles. Nuclear fission and fusion, Interaction of radiation and particles with matter. Determination of energies of α-β-γ particles.

UNIT-II:

Detection of Radiations: Types and principles of measuring instruments, GM tubes and GM counter- their characteristics. Ionization chambers: Scintillation counters and solid- s t a t e detectors. Neutron detection methods. Energy production in stars, Stellar evolution and Genesisof chemical elements.

UNIT-III:

Radioisotope tracers: Radiometric analysis, various types of dilution techniques. Applications of radio isotopes in the study of isotopic exchange and electron transfer reactions. Applications ofradio nuclides in therapeutic and diagnostic purposes. Radio carbon dating and age of earth and minerals by various dating techniques. Radiolysis of water and aqueous solutions. Identification reactions and properties of solvated electrons.

UNIT-IV:

Nuclear reactors: Homogenous and heterogenous reactors: Power reactors, Boiling water reactors, Pressurized water reactors, Fast breeder reactors, Research reactors and Reactors for special purposes. Neutron sources and moderation, Criticality factors, moderators, coolants, Cladding and structural materials.

UNIT-V:

Radio Activity in the Environment, Safety and Protection: Natural radio active nuclides and their distributon in the environment, nuclear process in the atmosphere, radio activity contributions to the environment from nuclear tests, nuclear reactors, nuclear fuel reprocessing plants and waste management of radioactive isoptopes like Cs-137,I-131,H-3 and Ra-226. Plutonium isotopes in the environment. Hazards associated with radiations, Biological effects ofradiations, Radioactive waste handling, disposal and treatment.

REFERENCE BOOKS:

1) Principles of Radiochemistry , H.A. CMcKay, Butterworths, London (1971).
2) Essentials of Nuclear Chemistry, H.J.Arnikar, 4th ed, New age International, New Delhi,(1997).
3) Nuclear Chemistry and its Applications, M.Haissinsky, Wesely publishing comp. Inc, London(1964).
4) Radiochemistry , An.N.Nesmeyanov, Mir publishers, Moscow (1974).
5) Nuclear and Radiochemistry , G. Friedlander, J.W.Kennedy, Wiley-Inter. NY, (1981).
6) Nuclear Radiation Detection, W.J.Price, 2nd ed, Mc Graw Hill, NY, (1968).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3		3		
2	3	3	3	2		3		2		
3	3	3	3	3		2		2		
4	3	3	2	2		2		3		
5	3	3	3	2		3		2		

***1-Low *2- Medium *3- Strong**

PRACTICAL-I:

R22CH15: INORGANIC & PHYSICAL CHEMISTRY

LIST OF EXPERIMETNS:

SECTION-I: INORGANIC CHEMISTRY

1) Determination of Zn^{2+} with potassium ferrocyanide (Volumetric).
2) Complexometric titrations: Determination of Mg^{2+}, Ni^{2+} and hardness of water using EDTA.
3) Determination of Fe^{3+} by photochemical reduction.
4) Argentometry: Determination of chloride by argent metric titration using.
   (a) K_2CrO_4 (b) Fluorescein as indicators.

SECTION-II: PHYSICAL CHEMISTRY

1) Relative strengths of acids by studying the hydrolysis of ethylacetate / methyl acetate.
2) Determination of equilibrium constant of $KI_3 \rightarrow KI + I_2$ by partition coefficient method anddetermination of unknown concentration of potassium iodide.
3) Distribution coefficient of Benzoic acid between Benzene and water.
4) Determination of critical solution temperature of phenol-water system Study of the effect ofelectrolyte on the miscibility of phenol-water system.

REFERENCE BOOKS:

1) Vogels Text Books of Quantitative Analysis, Revised. J. Asset, R.C. Denny, G.H. Jeffery and J. Mendhan. ELBS.
2) Synthesis and Characterisation of Inorganic Compounds, W.L. Jolly. Prentice Hall.
3) Practical Inorganic Chemistry by G. Pass and H. Sutcliffe Chapman and Hall.
4) Practical Inorganic Chemistry by. K. Somasekhar Rao and K.N.K. Vani.

PRACTICAL-II:

R22CH16: ORGANIC CHEMISTRY

LIST OF EXPERIMENTS:

1) One step & Two step Organic compounds preparation–Yield of crude and crystallized samples and reporting of the melting point/Boiling points.

   Preparations:

   i) Iodoform ii) n-Dinitro derivative iii) Asprin
   iv) p-Nitroaniline v) Bezophenone vi) Benzoic acid
   vii) p-Bromo Acetanilide viii) Acetanilide ix) any other organic compound.

2) Purification of organic compound-The student has to do Recrystallization to final compound(s) (for both steps) and submit the sample.
3) Distillation of Alcohol, Toluene.
4) Chromatography- The student has to submit purity of the final product with TLC
5) Chromatographic separation of impurities by TLC.
6) Student should practice solvent extraction methods.

Note: Apart from (1) & (2) each student must practice S.No. (3) to (6).

R22CH17: HUMAN VALUES AND PROFESSIONAL ETHICS

COURSE OUTCOMES:

- Knowledge on the nature of ethics and goals.
- Understand the basic moral concepts.
- Understand the non-violance of non-possession.
- Understand crime and theories of punishment.
- Knowledge on the Bhagavd Gita, Buddhism, Jainism.

UNIT-I:

Definition and Nature of Ethics – Is relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics – Goals – Ethical Values in Various Professions.

UNIT-II:

Nature of Values-Good and Bad, Ends and Means, Actual and Potential Values, Objective and Subjective Values, Analysis of Basic Moral Concepts-Right, Ought, Duty, Obligation, Justice, Responsibility and Freedom, Good Behavior and Respect for Elders, Character and Conduct.

UNIT-III:

Individual and Society: Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non Possession) and Aparigraha (Non-stealing). Purusharthas (Cardinal virtues) - Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

UNIT-IV:

Crime and Theories of Punishment – (a) Reformative, Retributive and Deterrent, (b) Views on Manu and Yajnavalkya.

UNIT-V:

Bhagavd Gita – (a) Niskama Karma, (b) Buddhism – The Four Nobel Truths – Arya astanga marga, (c) Jainism - Mahavratas and Anuvratas. Values Embedded in Various Religions, Religious Tolerence, Gandhian Ethics.

REFERENCE BOOKS:

1) Johns S Mackenjie: A Manual of ethics
2) "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3) Management Ethics – Integrity at work by Joseph A. Petrick and John F. Quinn, Response Books, New Delhi.
4) "Ethics in Management" by S.A. Shelekar, Himalaya Publishing House.
5) Harold H. Titus: Ethics for Today
6) Maitra, S.K: Hindu Ethics

7) William Lilly: Introduction to Ethics
8) Sinha: A Manual of Ethics
9) Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed) G.C. Haughton.
10) Sasruta Samhita: Tr. Kaviraj Kunjanlal, Kunjanlal Brishagratha, Chowkamba Sanskrit Series, Vol I,II and III, Varanasi, Vol I PP, 16-20, 21-32 and 74-77 only.
11) Charaka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office. Varanasi I, II, III Vol I PP 183-191.
12) Ethics, Theory and Contemporary Issues. Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13) Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
14) An Introduction to Applied Ethics (Ed.,) John H. Piet and Ayodya Prasad, Cosmo Publications.
15) Text Book for Intermediate First Year Ethics and Human Values, Board of Intermediate Education – Telugu Academy, Hyderabad.
16) I.C. Sharma Ethical Philosophy of India. Nagin & Co Julundhar.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2	2	3		3	3	2
2	3	3	3	2	2	3		2	3	3
3	3	3	3	3	3	2		2	3	3
4	3	3	2	2	3	2		3	3	3
5	3	3	3	2	1	3		2	3	2

***1-Low *2- Medium *3- Strong**

SECOND SEMESTER

M.Sc. ANALYTICAL CHEMISTRY / M.Sc. INORGANIC CHEMISTRY / M.Sc. ORGANIC CHEMISTRY

SEMESTER-II

R22CH21: PHYSICAL CHEMISTRY-II

COURSE OUTCOMES:

- Knowledge on Third law of thermodynamics, Maxwell-Boltzmann distribution law and Sackur - Tetrode equation and their derivations.
- Understand the Free radical, ionic and Zeigler -Natta Polymerisation, Techniques and method for polymer weight determinations.
- Understand the Butler - Volmer equation and Ilkovic equation, Half wave potential, polarography.
- Understand the Branching Chain Reactions, Enzyme catalysis and Photochemical equilibrium
- Understand the free energy change in biochemical reactions, exergonic and endergonic reactions, DNA and RNA in living systems in biopolymer interactions.

UNIT-I:

Thermodynamics II: Third law and Statistical thermodynamics-Nernst Heat theorem - Third law of thermodynamics - Its limitations - Determination of absolute entropy - Concept of distriction - Thermodynamic probability and most probable distribution - Ensemble-ensemble averaging - Maxwell- Boltzmann distribution law - Partition function - Fermi-Dirac statistics - Bose Einstein statistics - Entropy and probability - Boltzmann-Plank equation - Calculation of thermodynamic properties in terms of partition function - Application of partition function - Chemical equilibrium and partition function - Translational, rotational and electronic partition function - Entropy of Monoatomic gases (Sackur - Tetrode equation).

UNIT-II:

Polymer Chemistry: Classification of polymers - Free radical, ionic and Zeigler -Natta Polymerisation - kinetics of free radical polymerisation - Techniques of polymerisation - Glass transition temperature - Factors influencing the glass transition temperature - Number average and Weight average, Molecular weights - molecular weights determination - End group analysis - Osmometry - Light scattering and ultra centrifugation methods.

UNIT-III:

Electro Chemistry II: Electrode potentials - Double layer at the interface - rate of charge transfer - Decomposition potential - Over potential - Tafel plots - Derivation of Butler - Volmer equation for one electron transfer - electro chemical potential. Electro catalysis - Fuel cells-Theory of polarography - Diffusion current - Ilkovic equation - Equation for half- wave potential – Applications of polarography - Amperometric titrations -Corrosion - Forms of corrosion - prevention methods.

UNIT-IV:

Chemical Kinetics: Branching Chain Reactions - Hydrogen-oxygen reaction - lower and upper explosion limits - Fast reactions - Study of kinetics by flow methods - Relaxation methods - Flash photolysis - Acid base catalysis - protolytic and prototropic mechanism - Enzyme catalysis.

Photo Chemistry: Quantum yield and its determination - Actinometry - Reactions with low and high quantum yields - Photo sensitisation - Exciplexes and Excimers - Photochemical equilibrium – Chemieluminescence - Kinetics of collisional quenching-Stern - Volmer equation - Photo Galvanic cells.

UNIT-V:

Biophysical Chemistry: Standard free energy change in biochemical reactions, exergonic and endergonic reactions, hydrolysis of ATP, thermodynamics of biopolymer solutions, chain configuration of bio polymers, calculation of average dimensions. Membrane equilibrium, ion transport through cell membrance, dialosis and its function. Structure and functions of proteins, enzymes, DNA and RNA in living systems, forces involved in bio polymer interactions, electrostatic forces, hydrophobic forces, molecular expansion and dispersion forces.

REFERENCE BOOKS:

1) Physical chemistry, G.K. Vemulapalli (Prentice Hall of India).
2) Physical chemistry, P.W. Atkins. ELBS
3) Chemical kinetics - K.J. Laidler, McGraw Hill Pub.
4) Text book of Physical Chemistry, Samuel Glasstone, Macmillan pub.
5) Statistical Thermodynamics - M.C. Gupta.
6) Polymer Science, Gowriker, Viswanadham, Sreedhar
7) Elements of Nuclear Science, H.J. Arniker, Wiley Eastern Limited.
8) Quantitative Analysis, A.I. Vogel, Addison Wesley Longmann Inc.
9) Physical Chemistry-G.W. Castellan, Narosa Publishing House, Prentice Hall
10) Physical Chemistry, W.J. Moore, Prentice Hall
11) Polymer Chemistry – Billmayer.
12) Fundamentals of Physical Chemistry, K K Rohatgi-Mukherjee. Wiley Eastern LimitedPublications.
13) Statistical Thermodynamics - M.Dole.
14) M.N. Hughes, The Inorganic chemistry of Biological Processes, John Wiley and Sons, New York2nd Edition, 1981.
15) A text book of Biochemistry, AV.S.S. Rama Rao.
16) Physical Chemistry by Atkenes.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	3	2	3			3		2			
2	3	2	3			2		2			
3	3	2	2			3		2			
4	3	2	3			2		2			
5	3	2	2			2		3			

***1-Low *2- Medium *3- Strong**

R22CH22: ORGANIC CHEMISTRY-II

COURSE OUTCOMES:

- Understand the mode of addition reactions involving addition by electrophile and nucleophiles over unsaturated bonds between carbons
- Understand and apply the substitution reaction mechanisms at aliphaticand aromatic substrates for various reactions leading to research.
- Knowledge on Aromatic Nucleophilic and Electrophilic substitution reactions and their rearrangements with mechanisms.
- Understand on eliminations and on how to protect various functional groups in Organic synthesis and can apply the same to novel molecules useful for research.
- Understand the mechanisms of studied named reactions and their applications in organic synthesis.

UNIT-I:

General Methods for Synthesis: Addition reactions involving electrophiles (Br_2, HBr, HOBr, and H_2O/H_2SO_4); nucleophilic additions (Michael addition, Mannich, and Grignard reactions); Addition to C- C multiple bonds-stereo chemistry of addition, formation and reactions of epoxides, syn and anti hydroxylation; hydrogenation (catalytic and Non catalytic).

UNIT-II:

Aliphatic Nucleophilic Substitutions: The SN_2, and SN_1: Mechanisms, energy profile diagram and stereochemistry; SNi, mixed SN_1 & SN_2, and SET mechanisms; Factors influencing nucleophilic substitution reactions: Effect of structure, nucleophile, solvent, and leaving group.

The neighbouring group mechanism: Neighbouring group participation by O, N, S, halogens, in nucleophilic substitution reactions..Concept of classical and Non-classical carbocations-Participation of Pi and Sigma bonds as neighbouring groups. Anchimeric assistance-steric requirement.

UNIT-III:

Aromatic Nucleophilic Substitutions: The SNAr, SN1 mechanisms and benzyne mechanism. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von-Ritcher, Sommelet-Hauser and Smiles rearrangements.

Aromatic Electrophillic Substitution reactions -Friedel Crafts Alkylation, Acylation, Halogenations.

UNIT-IV:

Elimination and Protecting Groups:

a) Types of elimination (E1, E1CB, E2) reactions, mechanisms, stereochemistry and orientation, Hofmann and Saytzeff's rules, Syn elimination versus anti elimination. Competitions between elimination and substitution.

b) Dehydration, dehydrogenation, decarboxylative elimination, pyrolytic elimination, molecularrearrangement during elimination.

c) *Importance of functional group protection in organic Synthesis:* Protecting agents for the protectionof functional groups- Hydroxyl group, Amino group, Carbonyl group and Carboxylic acid group.

UNIT-V:

Familiar Named Reactions: Benzoin, Perkin, Cannizaro, Dieckmann and Stobbe condensations; Hofmann, Schmidt, Lossen, Curtius, Clasien, Backmann and Fries rearrangements; Reformatsky, Favoursky, Wittig reaction, Baeyer Villiger reaction and Chichibabin reaction, Oppenaur oxidation, Clemmensen, Wolff-Kishner, Meerwein–Ponndorf–Veriey and Birch reductions..

REFERENCE BOOKS:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).
6) Stereo Chemistry of carbon compounds – E.L. Eliel.
7) Modern organic Reactions, H.O.House, Benjamin.
8) An introduction to chemistry of Heterocyclic compounds, R.M.Acheson.
9) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
10) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
11) Reaction Mechanism in organic chemistry, S.M.Mukherji and S.P.Singh, Macmillan.

OUTCOME MAPPING:

Course Outcomes (CO)	ProgramOutcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	3	2	3			2		3			
2	2	3	2			3		3			
3		3	3			3		3			
4		3	2			3		3			
5		3	3			3		3			

***1-Low *2- Medium *3- Strong**

R22CH23: ESSENTIAL LAB TECHNIQUES FOR INDUSTRY

COURSE OUTCOMES:

- Knowledge on adsorption and partition chromatography, Paper and TLC chromatography.
- Know about principle of HPLC, normal and reverse phases, HPLC method development.
- Understand the GC-principles and instrumentation, & exchange of ions taking place in IEC- Applications.
- Knowledge on AAS&ICP-OES-principles and instrumentation.
- Understand about the importance instrumentation of UV, IR, NMR, ESR, TEM, SEM techniques for structural analysis.

UNIT-I:

Chromatography–Adsorption and Partition

a) **Introduction to Chromatography:** Different types of Chromatography. Adsorption chromatography- adsorbents, solvents, solutes, apparatus. Column Chromatography- stationary phase, Mobile phase, packing of column, advantages and disadvantages.

b) **Thin Layer Chromatography:** Basic Principles. Common stationary phases, Methods of preparing TLC plates, Selection of mobile phase, Development of TLC plates, Visualization methods, R_f value. Application of TLC in monitoring organic reactions.

c) **Paper Chromatography:** Basic Principles. Ascending and descending types. Selection of mobile phase, Development of chromatograms, Visualization methods. Application of paper chromatography in the identification of sugars and amino acids. One and two dimensional paper paper chromatography.

UNIT-II:

High Performance Liquid Chromatography (HPLC): Basic Principles. Normal and reversed Phases. Selection of column and mobile phase. Instrumentation. detectors; RT values. Applications in the separation, identification and quantitative estimation of organic compounds. Concepts on HPLC method development.

UNIT-III:

Gas Chromatography: Basic Principles. Different types of GC techniques. Selection of columns and carrier gases. Instrumentation. detectors; RT values. Applications in the separation, identification and quantitative analysis of organic compounds.

Ion Exchange Chromatography: Basic Principles. Preparation of cross linked polystyrene resins. Different types of cation and anoin exchange resins. Application in the purification of carboxylic acidsand amines.

UNIT-IV:

AAS: Principle, instrumentation and applications

ICP-OES: Principle, instrumentation, applications and advantages over AAS.

UNIT-V:

UV, IR, NMR, ESR, TEM, SEM-Basic principles, instrumentation and advantages.

REFERENCE BOOKS:

1) Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman, HarcourtCollege Pub.
2) Separation Techniques by M. N. Sastri, Himalaya Publishing House (HPH), Mumbai.
3) Bio Physical Chemistry by A. Upadhyay, K. Upadhyay and N. Nath, (HPH), Mumbai.
4) A Hand Book of Instrumental Techniques for Analytical Chemistry- Ed-F. A. Settle, PrearsonEdn.,
5) Delhi. Introduction to Organic Laboratory Techniques-D. L. Pavia, G. M. Lampman, G. S. Krizand R. G. Engel, Saunders College Pub. (NY).
6) Instrumental methods of Chemical Analysis by B. K. Sharma, Goel Publish House, Meerut.
7) Instrumental methods of Chemical Analysis by H. Kaur, Pragati Prakasan, Meerut.

OUTCOME MAPPING:

Course Outcomes (CO)	ProgramOutcomes (POs)										
	1	2	3	4	5	6	7	8	9	10	
1	3	3	3			3		3			
2	3	2	3			2		2			
3	3	3	3			3		2			
4	2	3	2			3		3			
5	3	3	2	3				2			

***1-Low *2- Medium *3- Strong**

R22CH24A: INORGANIC CHEMISTRY-II

(ELECTIVE–A)

COURSE OUTCOMES:

- Knowledge about on various metal clusters and metal **π** complexes
- Understanding the reactions of organo metallic compounds and its applications.
- Understanding the reaction mechanism in transition metal complexes, anation reactions, and complementary reactions.
- Understand the orgel diagrams and electronic spectra of transition metal complexes.
- Magnetic properties and anomalous magnetic moments of transition complexes and structure and functions of hemoglobin, myoglobin, and vitamin B12, photochemical laws.

UNIT-I:

Metal Clusters Classification: LNCs and HNCs**,** Isoelectronic and Iso lobal relationships, electron counting rules: Wade's and Lauher's rules. M-M multiple bonding; Preparation, structure and bonding in di nuclear $[Re_2Cl_8]^{2-}$, tri nuclear $[Re_3Cl_9]$, tetra nuclear $[W_4OR_{16}]$ and hexa nuclear $[Mo_6Cl_8]^{4+}$, $[Nb_6Cl_{12}]^{2+}$ cluster molecules and ions.

Poly atomic Zintle ions and Chevrel phases. Applications of clusters

Metal π-Complexes Preparation, structure and bonding in Nitrosyl, Dinitrogen and Dioxygen complexes.

UNIT-II:

Organometallic Complexes of Transition Metals: Classification and electron counting rules. Metallocenes with four, five, six, seven and eight ($\square^4$ - $\square^8$) membered rings. Synthesis, structure and bonding of Ferrocene. Cyclopenta dienyl, Arene, Cyclohepta triene and Tropylium complexes of transition metals.

Reactions of organometallic compounds-oxidative addition, reductive elimination, insertion and elimination.

Applications of organometallic compounds-Catalytic hydrogenation, Hydroformylation and polymerization of olefin using Zeigler- Nutta catalyst.

UNIT-III:

Reaction Mechanism in Transition Metal Complexes: Kinetics of octahedral substitution, acid hydrolysis, base hydrolysis-conjugate base (CB) mechanism. Direct and indirect evidences in favour of CB mechanism.

Anation Reactions: Reactions without metal-ligand bond cleavage. Factors affecting the substitution reactions in octahedral complexes. Trans effect on substitution reactions in square planar complexes.

Mechanism of redox reactions, outer sphere mechanism, cross reactions and Marcus – Hush equation, inner sphere mechanism, complementary and non - complementary reactions.

UNIT-IV:

Electronic Spectra of Transition Metal Complexes: Electronic configurations of metal ions and Spectroscopic terms. Selection rules, Breakdown of selection rules, Slator – Condon repulsion parameters, Racah parameters, Term separation energies for d^n electronic configurations.

Correlation diagrams and Orgel diagrams. Tanabe-Sugano diagrams for configurations from d^1 to d^9octahedral and tetrahedral transition metal complexes of 3d series

Calculations of Dq, B and β parameters. Charge transfer spectra.

UNIT-V:

Magnetic Properties of Transition Complexes: Types of magnetism, anomalous magnetic moments - Orbital and spin contribution, spin - orbit coupling and magnetic moments. Chiroptical properties, Cotton effect and Faraday effect.

Biochemical Aspects of Iron and Cobalt: Binding, storage and transport of dioxygen by Hemoglobin and Myoglobin, Vitamin B_{12} and its importance.

Photo Inorganic Chemistry: Introduction, Photochemical laws, photo redox reactions and photo anation reactions. Photo chemical decomposition of water.

REFERENCE BOOKS:

1) Inorganic Chemistry, Huheey. Harper and Row.
2) Concise Inorganic Chemistry, J. D. Lee, ELBS.
3) Inorganic chemistry, K.F. Purcell and J.C. Kotz, Holt Saunders international
4) Organometallic chemistry, R.C. Mehrotra and A. Singh. New Age International.
5) Advanced Inorganic Chemistry, Cotton and Wilkinson, Wiley Eastern
6) Inorganic Reaction Mechanism, Basolo and Pearson, Wiley Eastern
7) Bioinorganic Chemistry, K. Hussan Reddy
8) Biological Aspects of inorganic chemistry, A. W. Addiso, W. R. Cullen, D. Dorphin and G. J. James.Weliey Interscience.
9) Photochemistry of coordination compounds, V.Balzaniand V.Carassiti. Academic Press.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	2	3	2			3		3			
2	3	2	3			2		3			
3	3	2	3			2		2			
4	2	2	3			2		3			
5	3	2	3			2		2			

*1-Low *2- Medium *3- Strong

R22CH24B: NANO SCIENCE AND TECHNOLOGY

(ELECTIVE–B)

COURSE OUTCOMES:

- Knowledge about on nanoscience, Types of nanostructures, Surface nanoscience and surface-active agents.
- Knowledge on synthesis and Characterization Techniques of Nanostructures.
- Understanding the Carbon nanotubes (CNT), structure of carbon nanotubes and Carbon-based nanomaterials.
- Knowledge on Applications of Nanostructured Materials and Carbon nanotubes for energy storages.
- Understanding Nanosensors, Micro and nano-sensors, biosensors, generation of biosensors.

UNIT -I:

Introduction to Nanoscience: Definition of Nano, emergence and challenges of nanoscience, influence of nano over micro/macro, Types of nanostructures: One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots structures, metal oxides, semiconductors and composites. Nanoscience and Interface: Intermolecular Forces, Van der Waals forces. Kessorn, Debye, and London Interactions. Surface nanoscience and surface-active agents.

UNIT-II:

Synthesis and Characterization of Nanostructures: Fabrication techniques: Self assembly, self replication, sol- gels, Langmuir-Blodgett thin films, Nanolithography, Bio inspired synthesis, and chemical vapor deposition. Characterization techniques: Electron microscopy, Scanning probe microscopy, Near field microscopy, Micro- and near field Raman spectroscopy, Surface enhanced Raman spectroscopy and X-Ray photo electron spectroscopy.

UNIT-III:

Chemistry of Nanostructures Carbon nanotubes (CNT): Structure of carbon nanotubes, synthesis and functionalization of Carbon nanotubes, electronic-vibrational- mechanical and optical properties of Carbon nanotubees; Graphene nanostructures. Carbon based nanomaterials in environment and biological systems. Biological aspects of Carbon Nanostructures, Fullerene and its derivatives. Environmental effects of nanostructures.

UNIT-IV:

Applications of Nanostructured Materials: Nanostructures in Ferroelectric materials and coatings, polymer based applications, Hydrophilic - hydrophobic surface-cleaning materials, nanostructures in energy conversion and storage for renewable energy, semiconductor materials, solar cells, fuel cells, Carbon nanotubes for energy storage and hydrogen storage, as nanoscale catalysts to save energy. Nanostructures in waste reduction and improved energy efficiency, in water purification, sensors for bio- medical applications and Carbon nano-adsorbents for environmental purification.

UNIT-V:

Nanotechnology in Sensor Devices: Nanosensors: Introduction to sensors, fundamentals and terminology of sensors, static and dynamic characteristics and characterization of sensors. Micro and nano-sensors, biosensors and micro fluids and organic and inorganic nanosensors. Nanotechnology based devices: nanomaterials, nanostructured films, nanoscale electronic and ionic transport devises. Sensor for bio-medical applications. Biosensors: generation of biosensors and nanomaterial based biosensors.

REFERENCE BOOKS:

1) Nanomaterials: Synthesis, properties and Applications, Edited by A.S.Adelstein.
2) Nanostructured carbon for advanced Applications, Edited by G.Benedek, Kluwer academicpublishers, 1996.
3) Chemistry of nanomaterials: Synthesis, properties and applications CNR Rao et.al.
4) Nanoparticles: From theory to applications G. Schmidt, Wiley Weinheim (2004).
5) Processing & properties of structural nanomaterials - Leon L. Shaw
6) Nanochemistry: A Chemical Approach to Nanomaterials, Royal Soc. of Chemistry, Cambridge,UK (2005).
7) Environmental Chemistry for a Sustainable World, Volume -1: Nanotechnology and
8) Health Risk Editors: Lichtfouse, Schwarzbauer, Robert
9) Advances in Nanotechnology and the Environment, Juyoung Kim, CRC Press, Taylor andFrancis Group.
10) Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH (2007).
11) Naostructures and Nanomaterials: Synthesis, properties and applications, G.Cao, ImperialCollege Press (2004).
12) The chemistry of nanomaterials: Synthesis, properties and applications, C.N.R.Rao, A.Muller,A.K.Cheetham (Eds), Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.
13) Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
14) Nanotubes and Nanowires-CNR Rao and A Govindaraj, RCS Publishing.
15) Carbon Nanomaterials for Environmental and Biological Applications, Bergmann and Machado,Springer.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	2	3	3	3		3		3			
2	3	2	3	2		2		3			
3	3	3	3	2		2		3			
4	3	3	3	1		3		3			
5	3	3	3	2		3		3			

***1-Low *2- Medium *3- Strong**

R22CH24C: MATERIAL SCIENCE

(ELECTIVE-C)

COURSE OUTCOMES:

- Knowledge on the basic concepts involved in Material science and material structures.
- Understand the various types of conducting materials.
- Knowledge on how to testing and characterizations are done for materials.
- Understand on aerospace materials used in Cryogenic applications.
- Understand the materials used in energy production and storage.

UNIT-I:

Material Science: Introduction, Condensed states of matter- crystalline and amorphous states. Ionic, covalent, metallic and molecular bindings- Bond angle, bond length and bond energy. Hybridisation - Delocalised chemical bonding. Basics in crystal morphology, Lattice energy - Madelung constant. Inert gas crystals - van der Waals interaction - Lennard Jones' potential. Simple crystal structures - Sodium Chloride, Cesium Chloride, Diamond and Zinc sulphide structures. Close packed structures - packing efficiency and density of materials.

UNIT-II:

Conducting Materials: Metals, Alloys, Semiconductors-Definition, electrical properties, optical properties, mechanical properties and thermal properties. Specific examples of metals-Copper, Aluminium, Iron, Gold, Silver. Uses of metals. Drawbacks of metals. Alloys-advantages of alloying. Examples-Brass, Bronze, Steel, Stainless steel, Gold alloys, silver alloys and their uses. Semiconductors: Elemental semiconductors- Silicon, Germanium. Doping-n-type and p-type semiconductors, p-n junctions. Qualitative ideas of devices- diodes to Integrated circuits (ICs).

UNIT-III:

Materials Testing and Characterization Vacuum Techniques: Vacuum pumps: Rotary, Vapour diffusion, Turbomolecular and Cryogenic pumps. Vacuum measurement: Thermal conductivity gauges and Pirani and thermocouple gauges. Ionisation gauges: Hot and cold cathode ionisation gauges. Non- Destructive Testing of Materials: X-Ray and Neutron Radiography. Mechanical Testing of Materials: Tensile, Compression and Hardness tests, B-V-R hardness numbers. Impact and Fatigue tests. Materials Characterisation: Electron Microscopy, Transmission Microscopy (TEM)-Scanning Microscopy (SEM) - Atomic Absorption, IR, Raman, Low Energy Electron Diffraction (LEED) and X-ray Photoelectron Spectroscopy (XPS).

UNIT-IV:

Aerospace Materials, Super Alloys and Smart Materials: Aerospace materials-Evaluation of materials for space environment. Materials for Cryogenic applications: Metals for low temperature applications, Austenitic stainless steel, Nitrogen containing steel, Al-Li alloys, Titanium alloys and cryoinsulation materials. Materials for space environment: Radiation shielding materials, Space suit materials and materials for life support system. Metallic materials, super alloys and Smart Materials: Iron based-nickel based–cobalt based super alloys-applications. Smart materials-shape memory effect (SME). Ti-Ni(SM) alloys, Cu based alloys and applications.

UNIT-V:

Materials in Energy Production: Global Energy Scene, Forms of energy, Conservation of energy, Solar Cells, Types of Solar cells. Solar Cell Fabrication Technology. Hydrogen energy-merits as a fuel- Hydrogen storage, sea as source of deuterium. Fuel cells-components, working and performance of fuel cells, Types of fuel cells-Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells and applications. Superconductors: Types - high Tc superconductors - applications of Superconductors.

REFERENCE BOOKS:

1) Elements of Materials Science and Engineering–Lawrence H van Vlack, Addision Wesley (1975).
2) Materials Science and Engineering, V. Raghavan, Prentice Hall India (1993).
3) The Structure and Properties of Materials, Rose, Shepard and Wulff, Vol.I-IV Wiley eastern,(1987).
4) X-Ray Crystallography, M .J Buerger, John Wiley (1942).
5) Introduction to Solids, A J Dekker, McMillan India (1981).
6) Electronic Processes in Materials, L. V Azaroff and J.J. Brophy. McGraw Hill (1963).
7) Materials Science and Technology–A comprehensive treatment, R.W Cahn, P Haasen & E JKramer.
8) Electronic and Magnetic Properties of Metals and Ceramics: Part I Materials Science andTechnology: A Comprehensive Treatment, Vol. 3, R. W. Cahn, P. Haasen, 1991, John Wiley.
9) High performance materials in Aerospace, H.M.Flower, I st ed, Chapman & Hall (1995).
10) Advanced Aerospace materials, B.Horst, B.Ilschner, K.C.Russel, Springer-verlag, Berlin (1992).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	3		3		2		
2	3	3	3	2		2		3		
3	3	3	3	2		3		3		
4	3	3	3	3		3		3		
5	3	3	3	2		3		2		

***1-Low *2- Medium *3- Strong**

PRACTICAL-I:

R22CH25: INORGANIC & PHYSICAL CHEMISTRY

A total Six (6) Experiments must be carryout taking minimum of '3' in each section

LIST OF EXPERIMETNS:

SECTION-I: INORGANIC CHEMISTRY

Semimicro analysis of six radical mixtures containing one interfering radical and one lessfamiliar cation each.

Interfering Anions : Oxalate, tartrate, phosphate, chromate.

Less familiar Cations : Thallium, molybdenum, thorium, zirconium, vanadium, uranium.

(Minimum three Mixtures)

SECTION-II: PHYSICAL CHEMISTRY

1) Potentiometric determination of Fe(II) with Cr(VI)
2) pH-metric determination of strong acid with strong base.
3) Conductometric titration of strong acid with strong base
4) Verification of Beers Law using potassium permanganate.

REFERENCE BOOKS:

1) Vogels Text Books of Qualitative analysis, Revised. J. asset, R.C. Denny, G.H. Jeffery and J.Mendhan. ELBS.
2) Synthesis and Characterisation of Inorganic Compounds, W.L.Jolly. Prentice Hall.
3) Practical Inorganic chemistry by G. Pass and H. Sutcliffe Chapman and Hall.
4) Practical Inorganic Chemistry by. K. Somasekhar Rao and K.N.K. Vani

PRACTICAL-II:

R22CH26: ORGANIC CHEMISTRY

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) **Identification Functional Groups in Organic Compounds:** Phenol, bases, organicacid, ketone, aldehyde, amide and carbohydrate with preparation of two solid derivatives.
    i) Identification of given two compounds with preparation of two solid derivatives and
    ii) Reporting of the melting points for derivatives.

2) **Purification of Derivatives**: The student has to do recryastallization to final derivatives(s) and submit the sample. If the sample is impure liquid must carryout distillation process.

PRACTICAL-III:

R22CH27: COMPREHENSIVE VIVA-VOCE

The students will be analyzed with questions covering 1st & 2nd semester topics.

R22CH28: COMMUNICATIVE ENGLISH

COURSE OUTCOMES:

- The course helps to improve easy and fluent communication skill among the students.
- This English Communication Skill based course mainly focuses on to improve the Linguistic Listening, Communicative Competence and Presentation Skills of the students.
- Activities in the English Communication Skill based course will simulate actual discourses that students will engage in their interaction with their peers, teachers or strangers in their day-to-day situations.
- To learn the employability skills and descriptions.
- To learn the extempore and presentations.

Unit-I: Communication Skills

a) Verbal: a) Types of Communication; b) Barriers to Communication.

b) Strategies for effective communication.

Nonverbal Skills –

a) Body Language-Voluntary and Involuntary;
b) Kinesics Facial Expressions;
c) Proxemics;
d) Oculesics;
e) Haptics and Chronemics.

Unit-II: Advanced Vocabulary

a) Synonyms & Antonyms; b) Phrasal verbs; c) Idioms; d) One word Substitutes.

Unit-III: Employability Skills & Descriptions

Employability Skills:

a) Interview Skills; b) Group Discussion c) Resume Writing.

Descriptions:

a) Process Description; b) Picture Description; c) Narration; d) Email etiquette.

Unit-IV: Role Play/Dialogue Writing

a) Introducing oneself & others;
b) Asking for & giving permissions;
c) Asking for and responding to give directions;
d) Seeking request;
e) Inviting and responding invitations;
f) Apologizing.

Unit-V: Presentation Skills

Extempore (JAM) Sessions; Paper Presentation.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	2	3	3	3		3	2	3	3	3
2	3	2	3	2		2	3	3	3	3
3	3	3	3	2		2	3	3	3	3
4	3	3	3	1		3	3	3	3	3
5	3	3	3	2		3	3	3	3	3

***1-Low *2- Medium *3- Strong**

THIRD SEMESTER

M.Sc. ANALYTICAL CHEMISTRY

SEMESTER-III

R22AC31: APPLIED INORGANIC ANALYSIS

COURSE OUTCOMES:

- Understand the methods of analysis of ores and minerals in industries.
- Knowledge on analysis of phosphate rock, feldspar, monazite.
- Understand the methods of analysis of various constituents and their determinations present in the ferrous alloys.
- Understand the methods of analysis of various constituents and their determinations present in the non-ferrous alloys
- Analysis of complex materials and types of various constituents and their determinations present in the cement and glasses.

UNIT-I:

Analysis of Limestone: Moisture, loss on ignition, insoluble matter (silica), determination of combinedoxides (R2O3), calcium, magnesium, carbon dioxide.

Analysis of Hematite - Moisture, volatile matter, silica, iron, oxide iron,

Analysis of Pyrolusite - Moisture, volatile matter, silica, manganese, combined oxidesAnalysis of Clay Materials: Moisture, volatile matter, silica, R_2O_3, Fe_2O_3.

UNIT-II:

Analysis of Phosphate Rock: Moisture, loss on ignition, SiO_2, allumina, Fe_2O_3, toal CaO, magnesium.

Analysis of Feldspar: Silica, sodium, potassium, sulphate.

Analysis of Monozite: Oxides of calcium, magnesium, iron, aluminum, sulphur, silica.Analysis of Arsenic ores, Barium ores, Chrome ores, Vanadium ores.

UNIT-III:

Analysis of Ferrous Alloys: Analysis of Steels - types of steels- digestion methods for different types of steels - determination of contents of carbon, silicon, sulphur, phosphorous, manganese, nickel magnesium, vanadium, molybdenum, nickel, aluminum, chromium and tungsten in steel samples.

UNIT-IV:

Analysis of Non - Ferrous Alloys: Brass, bronze and solder. Compositions of different alloys- digestion procedures of alloys - Procedures for the determination of contents like tin, copper, lead, zinc and iron, aluminum, manganese, antimony.

UNIT-V:

Analysis of Complex Materials: Analysis of cement - loss on ignition, insoluble residue, total silica, sesqui oxides, lime, magnesia, ferric oxide.

Analysis of Glasses: Determination of silica, sulphur, barium, arsinic, antimony, total R_2O_3, calcium, magnesium, total alkalies, aluminum, chloride, fluoride colouring agents in glass-chromium, cobalt, copper, total iron, manganese, nickel, titanium, lead, barium, sodium, potassium, cerium, zirconium, arsenic.

REFERENCE BOOKS:

1) F.J.Welcher-Standard methods of analysis
2) I.M.Kolthoff-Volumetric analysis V.A. Strenger Vols I to III,
3) A.I.Vogel - A text Book of quantitative Inorganic analysis - ELBS,
4) H.P.Walton- Principles and methods of chemical analysis-Prentice Hall,
5) Laitnen & Harris -Chemical Analysis,
6) C.W.Wilson and D.W.Wilson-Comprehensive analytical Chemistry,
7) F.D.Snell & F.M.Biffen-Commercial methods of analysis-D.B. Taraporavala & sons,
8) Manual of procedures for Chemical and instrumental analysis of Ores, Minerals and Ore Dressing Products Published by Indian Bureau of Mines, Ministry of Steel and Mines, Nagpur.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	2	3	2	2	3			2		
2	3	3	3					2		
3	3	2	2		3			1		
4	3	3	3		3	2		2		
5	2	2	2	2	2	2		1		

***1-Low *2- Medium *3- Strong**

R22AC32: ANALYSIS OF APPLIED INDUSTRIAL PRODUCTS

COURSE OUTCOMES:

- Knowledge on Pesticides analysis for food samples to asses measures and interpret data extracted from real life applications.
- Knowledge can establish numerical value in order to determine the various components present in an oil sample.
- Analyze the different solvent for the industrial purpose. Identify different chemical compound used as fertilizers and also can analyse those Fertilizers.
- Explores various methods and techniques to analyze different gas that are present in the fuels.

UNIT-I:

Pesticide analysis of Food Products: Purification of food samples,Gas chromatography for organophosphates in food, Thin layer chromatography for chlorinated pesticides in food products,Microscopic examination food.

UNIT-II:

Analysis of Oils: Saponification value, iodine value, acid value, ester value, bromine value, acetyl value

UNIT-III:

Analysis of industrial solvents like benzene, acetone, methanol and acetic acid,Determination of methoxyl and N-methyl groups.

UNIT-IV:

Analysis of Fertilizers: Urea, NPK fertilizer, super phosphate, Analysis of DDT, BHC, endrin, endosulfone, malathion, parathion,Analysis of starch, sugars, cellulose and paper.

UNIT-V:

Gas Analysis: Carbon dioxide, carbon monoxide, oxygen, hydrogen, saturated hydro carbon,unsaturated hydrocarbons, nitrogen, octane number, cetane number.

Analysis of Fuel Gases like: Water gas, producer gas, kerosene (oil) gas.

Ultimate Analysis: Carbon, hydrogen, nitrogen, oxygen, phosphorus and sulfur.

REFERENCE BOOKS:

1) F.J.Welcher - Standard methods of analysis,
2) A.I.Vogel - A text book of quantitative Inorganic analysis – ELBS.
3) H.H.Willard and H.Deal - Advanced quantitative analysis - Van Nostrand Co.
4) F.D.Snell & F.M.Biffen - Commercial methods of analysis - D.B.Taraporavala & sons.
5) J.J.Elving and I.M.Kolthoff - Chemical analysis - A series of monographs on analytical chemistry and its applications - Inter Science- Vol. I to VII.
6) G.Z.Weig - Analytical methods for pesticides, plant growth regulators and food additives – Vol.I to VII.
7) Analytical Agricultural Chemistry by S.L.Chopra & J.S.Kanwar - Kalyani Publishers.
8) Manual of soil, plant, water and fertilizer analysis, R.M. Upadhyay and N.L Sharma, KalyaniPublishers, New Delhi.
9) Analytical Chemistry, H. Kaur – A Pragathi Edition.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1		3	3			3		3		
2	2	3	2			3		2		
3		2	3	2		3		3		
4	3	3	3	2		3		3		
5	3	3	2			3		2		

***1-Low *2- Medium *3- Strong**

R22AC33A: OPTICAL THERMAL & RADIOCHEMICAL METHODS OF ANALYSIS

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand vibrational and raman spectroscopic techniques and instrumentations.
- Knowledge on principles of Nephelometer and Turbiditymeter and Flourimetry & Phosphorimetry- instrumentation.
- Knowledge about emission and flame spectroscopic methods.
- knowledge about principle & instrumental techniques of AAS, ICP-MS
- Understand about Thermal analysis techniques and radio chemical methods

UNIT-I:

Infrared Spectroscopy: Theory – Molecular Vibrations – Instrumentation- Limitations – Structuredetermination – Quantitative Analysis: Base line techniques.

Raman Spectroscopy: Theory – Properties of Raman lines – Differences between Raman & IR Spectra Rayleigh Scattering – Mechanism of Raman effect – Instrumentation – Applications.

UNIT-II:

Nephelometry & Turbidimetry: Theory – Instrumentation – Difference between Nephelometry & Turbidimetric titrations – Applications.

Flourimetry & Phosphorimetry: Theory – Flourescence & Phosphorescence – factors effecting Flourescence & Concentration – Limitations – Comparison of Flourimetry & Phosphorimetry – Applications.

UNIT-III:

Emission Spectroscopy: Principle – Theory – Instrumentation – Types responsible for Line Spectra – Merits & Demerits – Applications.

Flame Photometry: Principle – Theory – Instrumentation – Experimental Procedures – errors in Flame Photometry – Applications.

UNIT-IV:

Atomic Absorption Spectroscopy: Principle – Theory – Limitations – Relation between Atomic absorption& Flame emission – Instrumentation Estimation of cation & anions – Applications.

Inductively Coupled Spectrometer: Principles – Instrumentation – Advantages over Atomic Absorption Spectroscopy – Applications with specific examples like Chromium, Molybdenum, Zirconium and Aluminium.

UNIT-V:

Thermal Analysis Techniques: Thermogravimetric Analysis – Types of Thermal balances.
Differential Thermal Analysis: Differential scanning calorimetry-Thermometric Titrations.
Radio Chemical Methods: Objectives, introduction, principles and theoretical aspects, technique/ method, gas counter, scintillation counter, errors and correction, liquid scintillation counting, sample preparation, applications.

REFERENCE BOOKS:

1) B.K.Sharma - Instrumental methods of chemical analysis, Goel Publishers.
2) G.Chatwal and S.Anand --Instrumental methods of chemical analysis.
3) A.I.Vogel - A text Book of Quantitative Inorganic Analysis-ELBS.
4) H.H.Willard, LL Merrit and JA Dean -- Instrumental Methods of Analysis.
5) Peace-Instrumental Methods of Analysis.
6) J.W. Robbinson- Under graduate Instrumental Analysis.
7) G.W Eving- Instrumental Methods of Chemical Analysis.
8) D.A.Skoog, D.M.West and F.J.Holler -Fundamentals of Analytical Chemistry.
9) H.Kaur-Instrumental methods of chemical analysis, Pragathi Prakasan.
10) D.A.Skoog, F.J.Holler and Nieman-Instrumental Methods of Analysis.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1		3	3	2		2	3	2		
2	2	3	2	2		2	2	2		
3		3	2	3		2	3	2		
4	2	3	3	2		3	2	3		
5	3	3	2	2		3	2	2		

***1-Low *2- Medium *3- Strong**

R22AC33B: APPLICATIONS OF SYNTHETIC PRODUCTS

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand dyes and drug their industrial importance.
- Knowledge on synthetic drugs and their medicinal properties.
- Understand the cleansing action of soaps, manufacture of cosmetics and use of flavours and sweetness.
- Understand effects of pesticides and insecticides to the environment.
- Understand about explosive materials and preparation & use of polymers in industries.

UNIT-I:

Dyes: Colour and constitution, classification, dyeing method, and their industrial importance.

Drugs: Basic concepts, classification, sources, the requirement of an ideal drug.

UNIT-II:

Synthetic Drugs: Structure and medicinal properties.

Sulphanilamide: An example of sulpha drug - paracetamol, aspirin, oil of wintergreen; Mephensin. A muscle relaxant; Ibuprofen – an anti-inflammatory drug; L-dopa-cures Parkinson's disease;

UNIT-III:

Soaps and Detergents: Production and their cleansing action. Liquid crystals and their applications. Surfactants

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick and nailpolish, shampoos, hair dyes, and toothpastes.

Flavours: Natural flavouring materials and classification.

UNIT-IV:

Sweeteners: Natural and Synthetic sweeteners.

Pesticides: Introduction, Classification, Applications and their effect on the environment.

Insecticides: Introduction, Classification, Applications and their effect on the environment.

Explosives: Introduction, RDX, Gun Powder.

UNIT-V:

Polymers: Introduction, biodegradable and non-biodegradable polymers and their industrial importance, plastics (uses and effects on environment), natural and synthetic rubbers, polyamides, and polyesters like nylon, decron, terelyne. Thermoplastics–Poly carbonates, Poly acrylates in lensapplications, Polyurethanes, and conducting polymers.

REFERENCE BOOKS:

1) I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.742.
2) K. Albert, L Lehninger, D. L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ Publishers,1st Edition, New Delhi, 1993.
3) Harper's Biochemistry, Ed. R. Harper, 22nd Edition, Prentice Hall Press, New York, 1990.
4) Encyclopedia of Chemical Technology – Kirck – Othmer Series.
5) Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer & V.W. Rodfwell, 15th Edition,Maurzen Asian Edition, California, 1981.
6) Polymer Science, Gowarikar.
7) Industrial Chemistry, B.K. Sharma.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1		3	3	2		2	3	2		
2	2	3	2	2		2	2	2		
3		3	2	3		2	3	2		
4	2	3	3	2		3	2	3		
5	3	3	2	2		3	2	2		

***1-Low *2- Medium *3- Strong**

R22AC33C: BASICS OF BIOTECHNOLOGY

(ELECTIVE–C)

COURSE OUTCOMES:

- Understand cell biology, structure, theory biochemical methods for cell organelles and cell cycle.
- Knowledge on diversity of metabolic processes in microorganisms, plants and animals.
- Knowledge on Biology in the Computer age and Bioinformatics.
- Understand Biodegradation of recalcitrant compounds and Bioplastics and Biocompatible materials.
- Understand about food preservatives, Different food processing methods and Chemical preservation.

UNIT-I:

Biology of Cell (Cell Biology), Diversity of cell size and shape, Ultra structure, Cell theory, Cell isolation, Cell disruption, Centrifugation for separation of cell contents, Biochemical methods for the identification of Cell organelles (Marker enzytmes) Ultra structure, Composition and functions of organells in eukaryotes. Nucleus, Endoplasmicreticulam, Mitochondria, Chloroplast, Golgi complex, Ribosomes, Lysosomes and Microbodies (Peroxisomes and Glyoxysomes) Vacuoles, Gap junctions and Plasmodesmata and Cell cycle.

UNIT-II:

Basic concepts of metabolism (Biochemistry). Diversity of metabolic processes ; Autotrophs and heterotrophs; Glycolysis, Gluconeogenesis and Glycogen metabolism, cori cycle,Citric acid cycle, Electron transport system and oxidative phosphorylation, Pentose phosphate pathway.

UNIT-III:

Biology in the Computer age, information processing challenges in Biotechnology, Introduction and Scope of Bioinformatics, Biological Database Classification: Sequence, Structure and Integrated Databases.

UNIT-IV:

Bioremediation, Bioaugmentation, Biodegradation of recalcitrant compounds and the role of genetically engineered microbes and genetically modified organisms in the environmental management. Bioplastics and Biocompatible materials.

UNIT-V:

Food preservation – Different food processing methods, High temperature, Pasteurization, Sterilization, Cold storage, Chill temperature, Freezing, Drying,

Concentration, Chemical preservation, Radiation and novel methods like high pressure, microwave,dielectric methods.

REFERENCE BOOKS:

1) The Cell: A Molecular Approach, 4th edition, Geoffrey M. Cooper and Robert E. Hausman,2006, *ASM Press and Sinauer Associates, Inc.*
2) Cell and Molecular Biology: Concepts and Experiments, 4th edition, Gerald Karp, Wiley Publishers, New York
3) Nelson, David L., Cox, Michael M. Lehninger Principles of Biochemistry 4/e, 2005, W.H.Freeman, Madison avenue, New York.
4) Alexander, R. (1999) Compost markets grow with environmental applications, BioCycle, April,p. 48.
5) D. Rao, SciTech Publications, Chennai, India, 2009
6) Gorden, G.Brich, food science, pergamon press headington Hill hall, 1986.
7) John.A, Troller, Sanitation in food processing, Academic press, IN.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3		3		3
2	3	2	3	2		2		3		3
3	3	2	3	2		3		3		2
4	3	2	3			2		3		3
5	3	3	2			3		3		2

***1-Low *2- Medium *3- Strong**

R22AC34A: PRINCIPLES AND TECHNIQUES IN CLASSICAL ANALYSIS

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand acid-base titration and non-aqueous solvents
- Understand role of the various types of oxidants, reductants, and redox titrations.
- Understand the complexometric and precipitation titrations.
- Understand the gravimetric analysis and role of complexing precipitants.
- Understand enzymatic catalysed and uncatalyzed reactions.

UNIT-I:

Theory and Principles of Titrimetric Analysis:

Acid - Base Titrations: Titrimetric procedures involved in the neutralisation of acids and bases; Acid base indicators-indicator action-preparation of indicator solutions-mixed and universal indicators.

Precipitation Equilibria, Types of precipitates, Surface absorption, optimum conditions for precipitation.

Titration in Non-Aqueous Solvents: Choice of solvents for non-aqueous titrations. End point detection

Applications of non-aqueous titrations using glacial acetic acid as titre.

UNIT-II:

Redox Titrations: Theoretical principles - redox indicators - Indicator action.

Analytical chemistry of some selected oxidants / reductants, selection of suitable indicators for variousoxidant / reductant titration systems.

Oxidants: Mn(III), Mn(VII), Ce(IV), Cr(VI), V(V), Ti(III), Iodimetry and iodometry,

Reductants: Cr(II), V(II), Ti(III, Sn(II),

Use of Karl-Fisher reagent in the estimation of moisturecontent.

UNIT-III:

Complexometric Titrations: Theoretical principles involved in complexometric titrations - role of indicators, EDTA titrations, Silver cyanide titration, Direct titration, back titration, substitution titration, total hardness of water, fluoride ion as demasking agent- analysis of nickel alloy.

Precipitation Titrations: Theoretical principles involved in argentometric titrations-use of normal and adsorption indicators -Indicator action.

Gravimetric Analysis: Role of organic precipitants in Gravimetric Analysis.

Analytical Applications of organic precipitants in gravimetric analysis - Structural requirements of anorganic precipitant - Specificity, selectivity, sensitivity, masking.

Complexing precipitants like DMG, Oxine, Salicylaldoxime, α-Benzoinoxime. Ion associationprecipitants: Benzidene, Sodium tetra phenyl boron, arsonium salts.

UNIT-V:

Catalysed and Induced Reactions and Kinetic Methods of Analysis:

Kinetic aspects of the analytical use of chemical reactions-Kinetics of chemical reactions-Kineticeffects in oxidation reduction reactions

Application of Kinetic Methods: Catalytic reactions.

Uncatalysed Reactions: determination of components, determination of the rate with change ofconcentration, Types of kinetic methods: single point method, Differential method, Integral method, Rate determination by complex decomposition, by steady state condition, Kinetics of enzyme catalysedreactions- Factor effecting- activators, inhibitors, hydrogen ion concentration, temperature-Principles ofthe analytical use of enzyme reactions.

REFERENCE BOOKS:

1) I.M.Kolthoff - Volumetric analysis V.A. Strenger Volume I to III,
2) A.I.Vogel - A text Book of quantitative Inorganic analysis - ELBS,
3) H.P.Walton - Principles and methods of chemical analysis-Prentice Hall,
4) Laitnen-Chemical Analysis,
5) C.W.Wilson and D.W.Wilson-Comprehensive analytical Chemistry,
6) R.A.Day Jr and A.L.Underwood-Quantitative analysis-Prentice Hall,
7) K.B.Yarstimiskii - Kinetic Methods of Analysis,
8) D.A.Skoog, D.M.West and F.J.Holler - Fundamentals of Analytical Chemistry,
9) A Textbook of Analytical Chemistry. Y. Anjaneyulu - Published by Pharma Med Press.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			2		2		
2	3	3	3			2		3		
3	2	2	3			2		3		
4	3	2	3			2		3		
5	2	3	2			2		3		

***1-Low *2- Medium *3- Strong**

R22AC34B: FOOD CHEMISTRY & ANALYSIS

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand the types and properties, methods for determination of starch and lipids.
- Knowledge about the functions and importance to enzymes and vitamins in food.
- Knowledge on types of sugars, Fats and oils, Food and Drug interactions.
- Understand the structure, function, properties of minerals and vitamins.
- To get knowledge on proteins, amino acids and nucleic acids.

UNIT-I:

Starch Chemistry: Types of starches, properties of different starches. methods of extraction of starches and reducing sugars and non-reducing sugars determination. Crude fibre and fibre fractions determination.

Lipid Chemistry: Nature and types of fats, Plant, and animal foods. physical, chemical structures and properties of different fats and oils, Principles, and methods of determination of Saponification number, Iodine number, free fatty acid number, and richert-meisel number. Chemical changes in fatty acids. Chemical changes on Rancidity and heating, hydrogenation, inter-esterification, and acetylation, shortening power of fat.

UNIT-II:

Food enzymes: Types of enzymes in foods, functions, and their importance to food quality.

Methods of determination of total ash. Vitamins and Minerals - Ca. phosphorus. iron. Vitamin A, Beta carotene. Riboflavin and Vitamin C.

UNIT-III:

Sugars and Fats: Sugars, sugar crystals and Confections: Types of sugars and sugar syrups, Sugar cookery, Crystallization of sugars, Confectionery-Types, raw materials and their role, Indian confectionery.

Fats and oils: Sources. Composition, Absorption, Functional properties of fat, Rancidity.

Food and Drug interactions: Risk factors for food and drug interactions. Effect of food on drug therapy. Effect of drug on food and nutrition. Modifications of drug action by food and nutrition. Effectof drug on nutritional status.

UNIT-IV:

Minerals: An overview of structure, sources, functions (also their role as co factors in metabolism) deficiency states factors influencing bioavailability and requirements of Calcium, Phosphorus, Iron, Iodine, Zinc, Sodium, Potassium, Chloride and Fluorine Metabolism of Calcium and Phosphorus.

Vitamins: Sources. functions (also their role as cofactors in metabolism) deficiency states. factors influencing bioavailability and requirements'.

UNIT-V:

Proteins and Amino Acids: Sources, structure, functions, digestion, and absorption of proteins.

Classification of amino acids - peptides and proteins, Metabolism of amino acids - Amino Aciddecarboxylation, Tran's peptidation.

Formation and disposal of ammonia- Hepatic coma, creatine and Creatinine -biosynthesis.

Nucleic acid - DNA, RNA, Bases- Purines and Pyrimidines, synthesis of Nucleic Acids- Steps of replication-Initiation, Elongation and Termination. Protein biosynthesis.

REFERENCE BOOKS:

1) Clipton. E. Meloan. Food analysis 3rd edition (Theory & Practice).
2) Dennis. D, Muller., Food chemistry, a Laboratory Manual by inter science publication, JohnWilley & Sons Inc.
3) N. Shakuntula Manay & M. Shadaksharswamy (2001). Foods- Facts and Principles. S econdedition. New Age International Publishers, New Delhi.
4) Keith Wilson and John Walker (2000). Practical Biochemistry Principles and Techniques, 5thedition, Cambridge University Press.
5) Satyanarayana, U, 2001. Biochemistry, Calcutta: Books & Allied (P) Ltd, 8/I - Chintharnani DasLane.
6) Nath R.L. (1996). Text book of Medicinal Biochemistry, New age International (P) LimitedPublishers, New Delhi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3		2		
2	3	3	3			3		3		
3	2	2	3			3		3		
4	3	2	3			3		3		
5	2	3	2			3		3		

***1-Low *2- Medium *3- Strong**

R22AC34C: GREEN CHEMISTRY

(ELECTIVE–C)

COURSE OUTCOMES:

- Knowledge on the principles and importance of Green chemistry.
- Understand the use of biocatalysts in chemical reactions.
- Knowledge about the solvent free techniques in chemical reactions.
- Understand the synthesis and applications of ionic liquids.
- Understand the Ultrasound and Microwave assisted green synthesis.

UNIT-I:

Fundamentals and significance of Green Chemistry:

Discussion of the current state of chemistry and the environment and the definition of Green chemistry. Assessment of the impact of chemistry in the environment and definition of risk hazard. An introduction to the tools of green chemistry and its fundamental principles. Principles of Green Chemistry: Prevention of waste / by-products, Hazardous products- Designing of safer chemicals- Selection of appropriate solvents and starting materials- Use of protecting groups and catalysis- Designing of biodegradable products.

UNIT-II:

Catalysis for Green Chemistry:

Use of biocatalysts- Biochemical Oxidation, Biochemical Reduction, Enzyme Catalyzed Hydrolytic Process, Modified biocatalysis- transition metal catalysis- Reformatsky reaction, Wurtz reaction, Pinacol coupling, Simmons-Smith reaction, Mukaiyama reaction, Heak reaction, Ullmann's coupling.

UNIT-III:

Solvent Free Reactions:

Solvent free techniques- Reactions on solid mineral supports, Phase Transfer Catalysis- C-alkylation, N-alkylation, S-alkylation, Darzen's reaction, Wittig reaction. Green synthesis- Oxidation, Reduction, Hydroboration, Bouveault reaction, Strecker reaction, Green synthesis- Biginelli reaction, Aza-Michael reaction, Suzuki reaction, Stille reaction, Sonogashira reaction.

UNIT-IV:

Ionic liquids:

Definition- Types of Ionic Liquids-Synthesis of Ionic Liquids- Selection of ionic liquids-physical properties- Application in organic synthesis- alkylation, allylation, oxidation, reduction, polymerization,hydrogenation, hydroformylation, alkoxycarbonylation, carbon-carbon bond forming reactions, alkene metathesis. **P**hase transfer catalysis in green synthesis: Introduction, mechanism of phase transfer catalyst reactions, types and advantages of phase transfer catalyst reactions.

UNIT-V:

Ultrasound and Microwave Assisted Green Synthesis:

Introduction, instrumentation and the phenomenon of cavitation. Chemical reactions: Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions. Microwave: Introduction, concept, reaction vessel/ medium, specific effects, atom efficiency (% atom utilization) and advantages and limitations. Chemical reactions: N-alkylation and alkylation of active methylene compounds and Diels –Alder reactions. Reactions in water and reactions in organic solvents. Solvent free reactions and deprotection of esters.

REFERENCE BOOKS:

1) Green Chemistry theory and Practice, P. T. Anastas and J. C. Warner Oxford Univ. Press.,Oxford (1988).
2) Green Chemistry and Introductory text, Mike Lancaster, II Edition 39.
3) New Trends in Green Chemistry, V.K. Ahluwalia, M. Kidwai.
4) Green Chemistry: Environment Friendly Alternatives, Rashmi Sanghi, M M Srivastava, Narosa,New Delhi (2003).
5) Green Solvents for Organic Synthesis, V.K. Ahluwalia, Rajender S. Varma.
6) Green Analytical Chemistry, Mihkel Koel and Mihkel Kaljuran.
7) Green Chemistry – an introduction text, Royal Society of Chemistry, UK(2002).
8) Phase Transfer Catalysis in Organic Synthesis, W. B. Weber, G. W. Gokel, Springer (1977).
9) Phase Transfer Catalysis, E. V. Dehmlov, S. S. Dehmlov, 2nd Edn., Verlagchemie, Wienhein,(1983).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	2	2	3	
2	3	3	3			3	2	3	2	
3	3	3	3		3	3	2	3	2	
4	3	3	3			3	2	3	2	
5	2	3	2			3	2	3	3	

***1-Low *2- Medium *3- Strong**

PRACTICAL-I:

R22AC35: CLASSICAL METHODS OF ANALYSIS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) Analysis of iron ore.
2) Analysis of pyrolusite.
3) Analysis of synthetic mixture copper and nickel.
4) Analysis of synthetic mixture of iron and zinc.
5) Analysis of cement.
6) Analysis of total hardness in waters.
7) Analysis of chloride in water samples.

PRACTICAL-II:

R22AC36: INSTRUMENTAL METHODS OF ANALYSIS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) Determination of alkalinity in industrial or environmental samples using pH metric procedures.
2) Assay of commercial acids by pH metric titrations using suitable base.
3) Conductometric titrations with individual acids and mixtures of acids.
4) Potentiometric titration of Fe(II) with Cr(VI).
5) Estimation of mixture of Mn(VII) and V(V) with Fe(II) using potentiometric techniques.
6) Mixture analysis of Ce(IV) and V(V) with Fe(II) by a potentiometric method.
7) Estimation of potassium thiocyanate with silver nitrate by potentiometric method.

M.Sc. INORGANIC CHEMISTRY

SEMESTER-III

R22IC31: ADVANCES IN INORGANIC CHEMISTRY

COURSE OUTCOMES:

- Knowledge on how to draw the MOT diagrams and well versed with the properties and utility of polymers of inorganic molecules.
- Understand the usage of OMC for different purposes like Catalyst and inorganic reaction mechanisms.
- Understand the special properties of the inorganic ring compounds and their synthesis.
- Knowledge on inorganic cages and metal clusters and inorganic polymers.
- Utility of inorganic polymers and catalysis of organo metallic compounds**.**

UNIT-I:

Molecular Orbital Theory: experimental evidence for covalence in coordinate bond of metal complexes-sigma and pi bonding orbitals in octahedral complexes-energy level diagrams- Measurement of pi-bonding effects- influence of pi-overlap on delta-Qualitative treatment of square planar and tetrahedral complexes on M.O. theory.

Concept of resonance Coordination Polymers: linear, two dimensional and three dimensional polymers, Chelate effects-Macro cyclic complexes of alkali: metals, crown ethers and cryptate forming ligands.

UNIT-II:

Inorganic Reaction Mechanisms: Homogeneous catalytic hydrogenation-metal ion catalysis of organic reactions-hydrolysis, transamination, aldol condensation, decarboxylation, carboxylation, Synthetic oxygen carriers., Reactions of coordinated ligands-Template reactions, photo chemistry of complex ions- photo chemical decomposition of Co(III) and Cr(III) complexes-photolysis of metal tri oxalates-photo absorption and isomerisation in complexesphoto oxidation in solution.

Organo Metallic Chemistry: Acetylene and olefin complexes of transition metals-preparation, properties and reactions-structure and bonding. Metallocenes-Synthesis and reactions of ferrocene- structure and bonding. Some examples of arene complexes, Carbonylate anions - carbonyl hydrides-structure and bonding in metal carbonyls.

UNIT-III:

Novel Inorganic Compounds: Acyclic & cyclic systems from the periodic table - Inorganic homo & heterocycles saturated and unsaturated ring systems. p-electron precise and rich rings. Synthesis, structure and reactivity. Metallacycles-Chemistry of individual rings.

UNIT-IV:

Cages & clusters of Elements, structural variety. properties and implications of borides, carbides, silicides, nitrides, phosphides, oxides and sulphides of transition elements, multiple bonds and cluster variety of transition metals. Higher boranes, carboranes and metalloboranes. Inorganic polymers, definition, variety and merits. P, Si, S, N, & 0 based polymers. Polyphosphazenes, polythiazenes, poly siloxanes and poly silanes.

UNIT-V:

Catalysis by organometallic compounds-oxidative addition, insertion/ migration reactions, hydroformylation, olefin isomerisation and polymerisation reaction catalysis reaction of synthetic gas-synthetic gasoline-Zeiglar - Natta catalysis in polymerization, Dinitrogen complexes Nitrogen fixation.

REFERENCE BOOKS:

1) J.L.Huheey: Inorganic Chemistry - Principles, structure and reactions-Harper.
2) F.A.Cotton and G.W.Wilkinson: Advanced Inorganic Chemistry-Wiley Eastern.
3) F.Basolo and R.G. Pearson: Mechanism of Inorganic Reactions-Wiley-Eastern,
4) D.Banerjea: Coordination Chemistry - Tata Mcgraw-Hill, New Delhi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	2	3	4	5	6	7	8	9	10
1	3		3	2		3	2			
2	3	3	3	2		3	3			
3	2	2	2			3	3			
4	3	2	3			2	2			
5	3	3	3			2	3			

***1-Low *2- Medium *3- Strong**

R22IC32: PHYSICAL INORGANIC CHEMISTRY

COURSE OUTCOMES:

- Knowledge about thermochemistry, enthalpy, entropy of hydration, electrolytes emf and its relation to free energy.
- Knowledge on solid- solid reactions, theory, preparation and its properties.
- Know about HSAB and various concepts for acids and bases.
- Understand the differences between aqueous and non-aqueous solvents, titrations.
- Knowing about Inorganic polymers, cages and boranes.

UNIT-I

Inorganic Energetics: General Principles of thermochemistry – thermodynamics - enthalpy, entropy and free energy concepts-interpretation of entropy- temperature dependence of entropy and enthalpy-trends in entropies. Equilibrium-effect of temperature on equilibrium. Lattice energies – Born - Mayer equation - Born Haber Cycle-applications. Bond energies – Hydration - structural treatment - enthalpy and entropy of hydration. Solution of electrolytes - electro chemical cells - emf and its relation to free energy and equilibrium constants. Thermodynamic approach to the use of high temperature techniques in inorganic synthesis.

UNIT-II

Solid State Chemistry: Structure and bonding in metals-V.B. and band theories-interstitial compounds-Hume-Rothery rulessemiconductors-photo and thermal semi conductors; solid-solid reactions.

Preparative Methods: Solid state reaction, precipitative reactions, sol-gel route, precursor method, Ion exchange reactions, intercalation / deintercalation reactions. Glasses and thin film preparation. Thermal analysis, microscopy as tools of characterization.

Electrical Properties: Development of free electron theory to band theory of solids - metals and their properties; semiconductors - extrinsic and intrinsic, Hall effect; Insulators - Dielectric, Ferroelectric, Pyroelectric and Peizoelectric properties and the relationship between them. New Materials - Zeolites, Fullerenes.

UNIT-III:

Acids and Bases: Arrhenius, Bronsted lowry, Lewis Luxflood, solvent systems, Usanovich concepts generalized acid- base concept-HSAB theory-symbiosis-measures of acid-base strengths- trends in acidities Bond energies and bond lengths in acid-base compounds.

UNIT-IV:

Non-Aqueous Solvent Chemistry: Classification of solvents-reactions in liquid ammonia-solution of metal in ammonia-reactions of solvated electron-sulphurdioxide and acetic acid as non aqueous solvents molten solids as non aqueous systems.

Non-Aqueous Solvents: General properties and classification of solvents. Self-ionization and leveling effect. Reactions in nonaqueous solvents: Solute-solvent interaction. Reactions in liquid NH3. Solutions of metals in liquid ammonia. Reactions in liquid SO_2, liquid HF, liquid halogens and interhalogens, and liquid dinitrogen tetroxide. Titrations in nonaqueous solvents.

UNIT-V:

Inorganic Polymers, Inorganic Chains: Heterocatenation-intercalation chemistry-inorganic rings borazines-phosphozenes-cyclo and linear phosphozines- homocyclic and heterocyclic inorganic ring systems-cagesboron cage compounds-boranes-and carboranes-metal clusters- binuclear and trinuclear clusters-bonding.

REFERENCE BOOKS:

1) J.L.Huheey:Inorganic Chemistry-Principles ,structure and reactions-Harper,
2) W.E.Addison: Structural Principles of Inorganic Compounds-Longmans,
3) R.S.Drago: Physical Methods in Inorganic Chemistry-Reinhold,
4) K.B.Harvey and G.B.Porter: Physical Inorganic Chemistry- Addison-Weslay,
5) J.B.Ander and A.J.Sonnessa : Principles of Chemistry-Macmillan,
6) A.Barnard: Theoretical Basis of Inorganic Chemistry- Tata-Mcgraw Hill.,
7) H.Sisler, “Chemistry of Nonaqueous Solvent”.
8) N.B.Hannay, “Solid State Chemistry”, Prentice Hall.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	2	3	4	5	6	7	8	9	10
1	3	2	3			3	3			
2	3	3	3			3				
3	3	3	2			3	2			
4	3	3	3			3	3			
5	3	3	3			2	3			

***1-Low *2- Medium *3- Strong**

R22IC33A: INSTRUMENTAL METHODS IN INORGANIC ANALYSIS

(ELECTIVE–A)

COURSE OUTCOMES:

- Apply green concept for solvent free reactions and used in sample treatment and instrument analysis.
- Knowledge on how to analyse the spectrums to determine the type of functional group by using Infrared Spectroscopy, and Raman Spectroscopy.
- Analyze to operate the different equipment i.e. hands on experience by using Nephelometry & Turbidimetry and Flourimetry & Phosphorimetry.
- Understand the hands on experience to do the analysis at high temp by using flame photometry.
- Analysis for the analytes at micro or even at nano level**.**

UNIT-I: Green Analytical Chemistry:

Green Analytical Chemistry: Concepts and trends.

"Greening" Sample Treatment: Reduced and Solvent-Free Sample preparation methodologies,alternative solvents, energy saving procedures.

Green Instrumental Analysis: Assessment of analytical methods for "Greenness". Greening flowinjection analysis, chemical sensors, liquid green chromatography.

UNIT-II:

Infrared Spectroscopy: Theory – Molecular Vibrations – Instrumentation – Limitations – Structure determination – Quantitative Analysis – Base line techniques.

Raman Spectroscopy: Theory – Properties of Raman lines – Differences between Raman & IRSpectra – Rayleigh Scattering – Mechanism of Raman effect – Instrumentation – Applications

UNIT-III:

Nephelometry & Turbidimetry: Theory – Instrumentation – Differences between Nephelometry & Turbidimetric titrations – Applications.

Flourimetry & Phosphorimetry: Theory – Flourescence & Phosphorescence – factors effecting Flourescence & Concentration – Limitations – Comparison of Flourimetry & Phosphorimetry – Applications.

UNIT-IV:

Flame Photometry: Principle – Theory – Instrumentation – Experimental Procedures – Errors in Flame Photometry – Applications.

UNIT-V:

Atomic Absorption Spectroscopy: Principle – Theory – Limitations – Relation between Atomic Absorption & Flame emission – Instrumentation- Estimation of cation & anions – Applications. **Inductively Coupled Spectrometer:** Principles – Instrumentation – Advantages over Atomic Absorption Spectroscopy – Applications with specific examples like Chromium, Molybdenum, Zirconium and Aluminium.

REFERENCE BOOKS:

1) A.I.Vogel: A text book of quantitative Inorganic Analysis-3rd Edition-ELBS,
2) J.W.Robbinson: Under-graduate Instrumental Analysis,
3) R.A.Day and A.L.Underwood: Quantitative Analysis-,
4) G.W.Eving: Instrumentation Methods of Chemical Analysis-McGraw-Hill.,
5) Willard, Merrit and Dean: Instrumental Methods of Analysis - D.Van Nostrand,
6) J.A.Barnard and R.Chayan: Modern Methods of Chemical Analysis,
7) G.H.Morrison and H.Frieser: Solvent Extraction in Analytical Chemistry-John Wiley.,
8) S.M.Khopkar: Basic Concepts of Analytical Chemistry,
9) H.A.Laintenen and W.E.Harri: Chemical Analysis,
10) B.K.Sharma - Instrumental methods of chemical analysis, Goel Publishers,
11) G.Chatwal and S.Anand - Instrumental methods of chemical analysis,
12) J.J.Lingane – Electro analytical Chemistry- Inter Science,
13) Peace, Instrumental Methods of Analysis,
14) D.A. Skoog, D.M.West and F.J.Holler-Fundamentals of Analytical Chemistry,
15) H.Kaur- Instrumental methods of chemical analysis, Pragathi Prakasan,
16) D.A.Skoog, F.J.Holler and Nieman-- Instrumental Methods of Analysis.
17) Green Analytical Chemistry: Theory & Practice, Miguel De La Guardia, Sergio Armenta,Elsevier.
18) Green Analytical Chemistry: Mihkel Koel, Mihkel Kaliurand, RSC Publishing.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	3			
2	3	3	3			3				
3	3	3	2			3	2			
4	3	3	3			3	3			
5	3	3	3			2	3			

***1-Low *2- Medium *3- Strong**

R22IC33B:TRANSITION METAL ORGANO METALLICS IN CATALYSIS

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand the basic principles involved in the synthesis, structure and bonding of TMOMCs.
- Knowledge on the process of catalysis and catalytic activity of TMOMCc.
- Knowledge about unique TMOMCs formed with organic ligands.
- Understand the most important catalytic applications of TMOMCs in chemical reactions.
- Knowledge about the role of TMOMCs in asymmetric catalysis.

UNIT-I:

Transition Metal Organometallic Compounds (**TM-OMCs**): Introduction, classification, synthesis, bonding,structure and reactivity. Organometallics in homogenous catalysis. 18-electron and 16-electron rules, Isolobal analogy, σ - bonded and π - bonded organometallics. Complexes of σ–donor ligands: Transition metal alkenyls, alkynyls, carbenes and carbines. Complxes of π– aceptor ligands: Transition metal dioxygen and dinitrogen, nitrosyl, tertiary phosphines and arsines. Transition metal compounds with M-H bonds. Stability of transition metal organometallic compounds.

UNIT-II:

TM-OMCs in Catalysis: Introduction, basic principles, activity and selectivity in catalysis; homogeneous vs. heterogeneous catalysis; importance of homogeneous catalysis in the synthesis of high value chemicals. Characteristics of central metal ions and influence of attached ligands on catalytic activity. Iimportant properties of ligands, and nucleophilic and electrophilic attack on coordinated ligands. Reactions of Transition metal organometallics as catalysts: oxidative addition,reductive elimination, insertion, elimination reactions and β-hydride elimination reactions. Metal ion catalyzed reactions involving Ag(I), Cu (II) and Os(VIII). Catalytic cycles.

UNIT-III:

Synthetic and structural aspects of Transition metal organometallics: Synthesis, properties, structure and bonding of transition metal carbonyl, Carbonylate anion, and carbonyl hydride complexes. Synthesis, properties and structure and bonding of acetylene and olefin complexes of transition metals. Metallocenes with four, five, six, seven and eight ($\square^4$ - $\square^8$) membered rings. Cyclopenta dienyl, Arene, Cyclohepta triene and Tropylium complexes of transition metals. Synthesis, properties, structure and bonding of nitrosyl and dinitrogen complexes of transition metals.

UNIT-IV:

Applications of TMOMCs as Catalysts: Fischer–Tropsch synthesis, olefin hydrogenation, Asymmetric hydrogenation (Enantio-slective hydrogenation), Hydroformylation, Monsanto acetic acid process, Alkenes - Polymerization, Isomerization, dimerization, oligomerization, hydrocynation and metathesis reactions: Carbonylation reaction, Synthetic gas-synthetic gasoline using Rh(I), Co, Pd(II), Ti(IV) complexes and dinitrogen complexes of Ru(II) , Os(II), Co(I) and Mo(0) for nitrogen fixation. Dioxygen complexes of Ir(I) and Rh(I) as oxygen carriers . Oxo complexes as homogeneous oxidation catalysts.

UNIT-V:

TM-OMCs in asymmetric catalytic reactions Asymmetric Catalysis: General features of chiral ligands and complexes; Mechanisms and Catalytic cycles in hydrogenation, isomerization, epoxidation and catalytic reactions of C-C bond formation. Platinum catalyst, Asymmetric palladium catalyst and Rhodium Catalysts for asymmetric ketone reduction. Metallocene catalysts: structure, special features and advantages of metallocene catalysts; mechanism of polymerization and stereocontrol by metallocene catalysts, the role of phosphine ligands in regio selective formation of linear aldehydes and Markovnikov and anti-Markovnikov additions.

REFERENCE BOOKS:

1) Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, 6th Ed. (1999) John Wiley.
2) Inorganic Chemistry: Principles of structure and Reactivity, J.E. Huheey, Keiter and Keiter, 4th Ed,(2006).
3) Organometallic Chemistry of Transition Metals, R. H. Crabtree, John Wiley. 4th Ed, (2005).
4) Organometallics, Ch. Elschenbroich and A. Salzer, VCH. 3rd Ed (2006)
5) Principles and Applications of Organotransition metal Chemistry, J.P. Collman, L.S. Hegedus, J.R.Norton and R.G. Finke, Univ. Sci. Books, Mill Valley. California. 1996
6) Organotransition Metal Chemistry, Anthony F.Hill, Royal Society of Chemistry, TutorialChemistry Text, 2002.
7) Organotransition Metal Chemistry: Applications to Organic Synthesis, S.G.Davies, Pergamon,1982.
8) Homogeneous Catalysis: The Applications and Chemistry of Catalysis by Soluble Transition MetalComplexes, G.W. Parshall and S.D. Ittel, Wiley, New York 1992.
9) Applied Homogeneous Catalysis with Organometallic Compounds, Vols. 1 & 2, edited by B.Cornils and W.A. Herrmann, VCH, Weinheim, New York, 1996.
10) Homogeneous Catalysis: Mechanisms and Industrial Applications, S. Bhaduri and D. Mukesh,Wiley, New York, 2000.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	3	2		
2	2	3	3			3	1	3		
3	3	2	2			3	2	3		
4	2	3	3			3	3	3		
5	3	3	2			2	3	3		

***1-Low *2- Medium *3- Strong**

R22AC33C: GREEN CHEMISTRY

(ELECTIVE–C)

COURSE OUTCOMES:

- Knowledge on the principles and importance of Green chemistry.
- Understand the use of biocatalysts in chemical reactions.
- Knowledge about the solvent free techniques in chemical reactions.
- Understand the synthesis and applications of ionic liquids.
- Understand the Ultrasound and Microwave assisted green synthesis.

UNIT-I:

Fundamentals and significance of Green Chemistry:

Discussion of the current state of chemistry and the environment and the definition of Green chemistry. Assessment of the impact of chemistry in the environment and definition of risk hazard. An introduction to the tools of green chemistry and its fundamental principles. Principles of Green Chemistry: Prevention of waste / by-products, Hazardous products- Designing of safer chemicals- Selection of appropriate solvents and starting materials- Use of protecting groups and catalysis- Designing of biodegradable products.

UNIT-II:

Catalysis for Green Chemistry:

Use of biocatalysts- Biochemical Oxidation, Biochemical Reduction, Enzyme Catalyzed Hydrolytic Process, Modified biocatalysis- transition metal catalysis- Reformatsky reaction, Wurtz reaction, Pinacol coupling, Simmons-Smith reaction, Mukaiyama reaction, Heak reaction, Ullmann's coupling.

UNIT-III:

Solvent Free Reactions:

Solvent free techniques- Reactions on solid mineral supports, Phase Transfer Catalysis- C-alkylation, N- alkylation, S-alkylation, Darzen's reaction, Wittig reaction. Green synthesis- Oxidation, Reduction, Hydroboration, Bouveault reaction, Strecker reaction, Green synthesis- Biginelli reaction, Aza-Michael reaction, Suzuki reaction, Stille reaction, Sonogashira reaction.

UNIT-IV:

Ionic liquids:

Definition- Types of Ionic Liquids-Synthesis of Ionic Liquids- Selection of ionic liquids- physical properties- Application in organic synthesis- alkylation, allylation, oxidation, reduction, polymerization, hydrogenation, hydroformylation, alkoxycarbonylation, carbon-carbon bond forming reactions, alkene metathesis. **P**hase transfer catalysis in green synthesis: Introduction, mechanism of phase transfer catalyst reactions, types and advantages of phase transfer catalyst reactions.

UNIT-V:

Ultrasound and Microwave Assisted Green Synthesis:

Introduction, instrumentation and the phenomenon of cavitation. Chemical reactions: Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions. Microwave: Introduction, concept, reaction vessel/ medium, specific effects, atom efficiency (% atom utilization) and advantages and limitations. Chemical reactions: N-alkylation and alkylation of active methylene compounds and Diels –Alder reactions. Reactions in water and reactions in organic solvents. Solvent free reactions and deprotection of esters.

REFERENCE BOOKS:

1) Green Chemistry theory and Practice, P. T. Anastas and J. C. Warner Oxford Univ. Press.,Oxford (1988).
2) Green Chemistry and Introductory text, Mike Lancaster, II Edition 39.
3) New Trends in Green Chemistry, V.K. Ahluwalia, M. Kidwai.
4) Green Chemistry: Environment Friendly Alternatives, Rashmi Sanghi, M M Srivastava, Narosa,New Delhi (2003).
5) Green Solvents for Organic Synthesis, V.K. Ahluwalia, Rajender S. Varma.
6) Green Analytical Chemistry, Mihkel Koel and Mihkel Kaljuran.
7) Green Chemistry – an introduction text, Royal Society of Chemistry, UK(2002).
8) Phase Transfer Catalysis in Organic Synthesis, W. B. Weber, G. W. Gokel, Springer (1977).
9) Phase Transfer Catalysis, E. V. Dehmlov, S. S. Dehmlov, 2nd Edn., Verlagchemie, Wienhein,(1983).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	2	2	3	
2	3	3	3			3	2	3	2	
3	3	3	3		3	3	2	3	2	
4	3	3	3			3	2	3	2	
5	2	3	2			3	2	3	3	

***1-Low *2- Medium *3- Strong**

R22IC34A: BIOINORGANIC CHEMISTRY

(ELECTIVE–A)

COURSE OUTCOMES:

- Knowledge on elements in living system, metallo porphyrines and Hemoglobin transportation.
- Know about Enzymes, coenzymes structure and functions.
- Importance on nitrogenase, metal ions by complex formation.
- Transportation and storage of metal ions by complex formation and the detoxification of nitrogen in vitro and in vivo.
- Understand the metal ion toxicity, antibiotics and related complexes.

UNIT-I:

Introduction, role of essential and non essential elements in living systems, Importance of elements with particular reference to: calcium, sodium and potassium, Metalloporphyrines-structures & functions of the following: Chlorophyll and its activity-role of Mg in photosynthesis;

UNIT-II:

Haemoglobin: Structure and mechanism of transportation of oxygen-mioglobin Other biological dioxygen carriers like: Hemerythrin, and hemocyanine

UNIT-III:

Enzymes-Importance and Introduction: Enzyme related proteins of cobalt(II), copper, molybdenum, Vitamin B12 & B12 - coenzymes, Enzymes - Structure and function: Redox reactions-oxidation of ascorbic acid by Cu(II) enzymes - peroxydases and catalases - cytochromes.

UNIT-IV:

Reduction of nitrogen by nitrogenase, Carboxylation and decarboxylation reactions-phosphorylation -exchange of functional groups - blocking of functional groups - transportation andstorage of metal ions by complex formation

UNIT-V:

Metal Ion Toxicity - Metal ion detoxification-nitrogen fixation in vitro and vivo-bio chemistry of metals-ADP and ATP Inorganic Chemistry of biological systems- antibiotics and related complexes.

REFERENCE BOOKS:

1) J.E.Huheey, E.A.Keiter and R.L.Keiter, Inorganic Chemistry
2) D.Banerjea - Fundamental principles of Inorganic Chemistry -S.Chand
3) D.Banerjea - Coordination Chemistry -Tata McGraw Hill,New Delhi
4) Gurudeepraj - Advanced Inorganic Chemistry – Vol. 2, Goel Publishing House, Meerut
5) E.I. Ochiai - Bio-Inorganic Chemistry-An Introduction-Allyn & Bacon, Lonmdon
6) K.Hussain Reddy - Bioinorganic Chemistry - New Age International Publs.
7) Bertini, Gray, Lippard & Valentine -- Bioinorganic Chemistry-Viva-Low priced.
8) Lippard & Berg - Principles of Bioinorganic Chemistry- Panima Publs Co.
9) A review of physiological chemistry by H.A.Harper, V.W. Rodwell and P.A. Mayes-LangeMedical Publications, California.
10) Bhagi and G.R. Chatwal- Bioinorganic Chemistry- Himalaya Publishing House, New Delhi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3	1		3		3		
2	3	3	3			3	2	3		
3	3	3	3	1		3	2	3		
4	3	3	3	2		3	2	3		
5	3	3	3	2		3	2	2		

***1-Low *2- Medium *3- Strong**

R22IC34B: APPLICATIONS OF SYNTHETIC PRODUCTS

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand dyes and drug their industrial importance.
- Knowledge on synthetic drugs and their medicinal properties.
- Understand the cleansing action of soaps, manufacture of cosmetics and use of flavours and sweetness.
- Understand effects of pesticides and insecticides to the environment.
- Understand about explosive materials and preparation & use of polymers in industries.

UNIT-I:

Dyes: Colour and constitution, classification, dyeing method, and their industrial importance.

Drugs: Basic concepts, classification, sources, the requirement of an ideal drug.

UNIT-II:

Synthetic Drugs: Structure and medicinal properties.

Sulphanilamide: An example of sulpha drug - paracetamol, aspirin, oil of wintergreen; Mephensin.

A muscle relaxant; Ibuprofen – an anti-inflammatory drug; L-dopa-cures Parkinson's disease;

UNIT-III

Soaps and Detergents: Production and their cleansing action.Liquid crystals and their applications. Surfactants

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick andnail polish, shampoos, hair dyes, and toothpastes.

Flavours: Natural flavouring materials and classification.

UNIT-IV

Sweeteners: Natural and Synthetic sweeteners.

Pesticides: Introduction, Classification, Applications and their effect on the environment.

Insecticides: Introduction, Classification, Applications and their effect on the environment.

Explosives: Introduction, RDX, Gun Powder.

UNIT-V

Polymers: Introduction, biodegradable and non-biodegradable polymers and their industrial importance, plastics (uses and effects on environment), natural and synthetic rubbers, polyamides, and polyesters like nylon, decron, terelyne. Thermoplastics–Poly carbonates, Poly acrylates in lens applications, Polyurethanes, and conducting polymers.

REFERENCE BOOKS:

1) I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.742.
2) K. Albert, L Lehninger, D. L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ Publishers, 1st Edition, New Delhi, 1993.
3) Harper's Biochemistry, Ed. R. Harper, 22nd Edition, Prentice Hall Press, New York, 1990.
4) Encyclopedia of Chemical Technology – Kirck – Othmer Series.
5) Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer & V.W. Rodfwell, 15thEdition, Maurzen Asian Edition, California, 1981.
6) Polymer Science, Gowarikar.
7) Industrial Chemistry, B.K. Sharma.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	3	3	3	2		3		3			
2	3	3	3			3		2			
3	3	3	3	2		3		3			
4	3	2	3			2		3			
5	3	3	2	2		3	2	3			

***1-Low *2- Medium *3- Strong**

R22IC34C: BASICS OF BIOTECHNOLOGY

(ELECTIVE–C)

COURSE OUTCOMES:

- Understand cell biology, structure, theory biochemical methods for cell organelles and cell cycle.
- Knowledge on diversity of metabolic processes in microorganisms, plants and animals.
- Knowledge on Biology in the Computer age and Bioinformatics.
- Understand Biodegradation of recalcitrant compounds and Bioplastics and Biocompatible materials.
- Understand about food preservatives, Different food processing methods and Chemical preservation.

UNIT-I:

Biology of Cell (Cell Biology), Diversity of cell size and shape, Ultra structure, Cell theory, Cell isolation, Cell disruption, Centrifugation for separation of cell contents, Biochemical methods for the identification of Cell organelles (Marker enzytmes) Ultra structure, Composition and functions of organells in eukaryotes. Nucleus, Endoplasmicreticulam, Mitochondria, Chloroplast, Golgi complex, Ribosomes, Lysosomes and Microbodies (Peroxisomes and Glyoxysomes) Vacuoles, Gap junctions and Plasmodesmata and Cell cycle.

UNIT-II:

Basic concepts of metabolism (Biochemistry). Diversity of metabolic processes ; Autotrophs and heterotrophs; Glycolysis, Gluconeogenesis and Glycogen metabolism, cori cycle,Citric acid cycle, Electron transport system and oxidative phosphorylation, Pentose phosphate pathway.

UNIT-III:

Biology in the Computer age, information processing challenges in Biotechnology, Introduction and Scope of Bioinformatics, Biological Database Classification: Sequence, Structure and Integrated Databases.

UNIT-IV:

Bioremediation, Bioaugmentation, Biodegradation of recalcitrant compounds and the role of genetically engineered microbes and genetically modified organisms in the environmental management. Bioplastics and Biocompatible materials.

UNIT-V:

Food preservation – Different food processing methods, High temperature, Pasteurization, Sterilization, Cold storage, Chill temperature, Freezing, Drying,

Concentration, Chemical preservation, Radiation and novel methods like high pressure, microwave, dielectric methods.

REFERENCE BOOKS:

1) The Cell: A Molecular Approach, 4th edition, Geoffrey M. Cooper and Robert E. Hausman,2006, *ASM Press and Sinauer Associates, Inc.*
2) Cell and Molecular Biology: Concepts and Experiments, 4th edition, Gerald Karp, Wiley Publishers, New York
3) Nelson, David L., Cox, Michael M. Lehninger Principles of Biochemistry 4/e, 2005, W.H.Freeman, Madison avenue, New York.
4) Alexander, R. (1999) Compost markets grow with environmental applications, BioCycle, April,p. 48.
5) D. Rao, SciTech Publications, Chennai, India, 2009
6) Gorden, G.Brich, food science, pergamon press headington Hill hall, 1986.
7) John.A, Troller, Sanitation in food processing, Academic press, IN.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3		3		3
2	3	2	3	2		2		3		3
3	3	2	3	2		3		3		2
4	3	2	3			2		3		3
5	3	3	2			3		3		2

***1-Low *2- Medium *3- Strong**

PRACTICAL–I:

R22IC35: CLASSICAL METHODS OF ANALYSIS-I

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) Analysis of iron ore.
2) Estimation of pyrolusite.
3) Analysis of synthetic mixture copper and nickel.
4) Analysis of synthetic mixture of iron and zinc.
5) Analysis of cement.
6) Analysis of total hardness in waters.
7) Analysis of chloride in water samples.

PRACTICAL-II:

R22IC36: INSTRUMENTAL METHODS OF ANALYSIS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) Determination of alkalinity in industrial or environmental samples using pH metric procedures.
2) Assay of commercial acids by pH metric titrations using suitable base.
3) Conductometric titrations with individual acids and mixtures of acids.
4) Potentiometric titration of Fe(II) with Cr(VI).
5) Estimation of mixture of Mn(VII) and V(V) with Fe(II) using potentiometric techniques.
6) Mixture analysis of Ce(IV) and V(V) with Fe(II) by a potentiometric method.
7) Estimation of potassium thiocyanate with silver nitrate by potentiometric method.

M.Sc. ORGANIC CHEMISTRY

SEMESTER-III

R22OC31: ORGANIC SPECTROSCOPY-I

COURSE OUTCOMES:

- Knowledge on UV-visible spectroscopy and woodward fieser rules, Optical rotatory dispersion and octant rule.
- Apply IR frequencies for structural determination. Understand NMR spectra, chemical shift and cooling constant values for Interpretation of proton spectra.
- Apply the combined and individual spectral patterns for solving of unknown compound structure determination.
- It can provide a platform to get the awareness towards UV, FTIR, ^{1}H NMR and ESR Spectrometry which aims to apply this knowledge towards research.

UNIT-I:

UV-Visible Spectroscopy:

a) **UV Spectroscopy**: Energy transitions – Simple chromophores – UV absorption of Alkenes –polyenes unsaturated cyclic systems – Carbonyl compounds, α,β-unsaturated carbonyl systems - Woodward Fieser rules – aromatic systems – solvent effects – geometrical isomerism – acid and base effects – typical examples – calculation of λ_{max} values using Woodward - Fieser rules.

b) **ORD:** Theory of optical rotatory dispersion, α-Axial haloketone rule and octant rule – Application of these rules in the determination of absolute configuration of cyclohexanones, decalones and cholestanones.

c) **Circular Dichroism:** Principle – positive and negative cotton effects – Absolute configuration.

UNIT-II:

Infrared Spectroscopy (FT-IR): Fundamental modes of vibrations – Stretching and bending vibrations – overtones, combination bands and Fermi resonance, factors influencing vibrational frequencies, hydrogen bonding – fingerprint region and its importance – Study of typical group frequencies for – CH, -OH, -NH, -CO-NH_2, -CC, -CHO, -CO and aromatic systems.

Application in structural determination –Simple problems.

UNIT-III:

^{1}H NMR Spectroscopy:

a) Magnetic properties of Nuclei, Nuclear resonance, Fourier Transformation and its importance in NMR. Equivalent and non-equivalent protons, The chemical shift and its importance, calculation of chemical shift, factors affecting the chemical shifts such as

electronegativity and anisotropy, effect of deuteration, Signal integration, Spin-spin coupling: vicinal (Karplus relationships), germinal and long range. Coupling constants (*J*) and factors affecting coupling constants. Shielding and deshielding mechanisms in acetylene carbonyl and Benzene, anisotropy-Spin-Spin Interactions related to first order and higher order spectra (AB, A_2; AB_2, ABX, ABC, AMX)-temperature dependence spectra, Hydrogen bonding. Nuclear Overhauser effect (NOE).

b) Applications: Interpretation of NMR spectrum of a given compound leading to identification- typical examples of PMR spectroscopy.

UNIT-IV:

Electron Spin Resonance Spectroscopy (ESR):

a) Basic Principles, Comparison of NMR & ESR. Determination of 'g' value, Factors affecting the 'g' value. Isotropic and Anisotropic constants. Splitting, hyperfine splitting coupling constants. Line width, Zero field splitting, and Kramer degeneracy. Crystal field splitting, Crystal field effects.

b) **Applications:** Detection of free radicals; ESR spectra of

(a) Methyl radical ($CH_3^{\cdot}$), (b) Benzene anion ($C_6H_6^{-}$).

UNIT-V:

Common Problem on UV-Vis, FT-IR, and ^{1}H NMR:

a) Problems involving individual spectral methods-UV, IR, and PMR

b) Problems involving combined any two of UV, IR, and PMR

c) Problems involving all three UV, IR, and PMR spectral data.

REFERENCE BOOKS:

1) Spectrometric identification of organic compounds by R.N. Silverstein & G.C. Bassier(John Willey).

2) Spectroscopic methods in Organic Chemistry by Williams and Fleming (Mcgraw Hill).

3) "Organic Photochemistry" by R.O. Kan (Mc Graw Hill).

4) "Advanced Organic Chemistry Reaction Mechanisms and Structure" by J March (McGraw Hill & Kogshusha).

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3	2	3		
2	3	3	3			3		3		
3	3	3	3	2		3	2	3		
4	3	3	3	2		3	2	3		
5	3	3	3	2	2	3	2	3		

***1-Low *2- Medium *3- Strong**

R22OC32: ORGANIC SYNTHESIS & REACTION MECHANISMS-I

COURSE OUTCOMES:

- Understand the fundamental tools required for the determination of reaction mechanisms.
- Knowledge on free radicals and their reactions, addition, substitution, decomposition reactions of free radicals.
- Apply the reagents and approaches for various synthetic reactions involving Oxidations and reductions.
- Understand for Reducing agents for various organic molecules and its synthetic utility.
- Knowledge on asymmetric synthesis provides a platform for carryout various stereochemical reactions wherever necessary to apply towards research.

UNIT-I:

Methods for Reaction Mechanism by Kinetic & Non-Kinetic studies

Kinetic studies: Kinetics of reaction, Energy profile diagram, Intermediate versus transition state, Reaction rate and rate limiting step.

Non-Kinetic studies Identification of products, testing possible intermediates, trapping of intermediates, Cross over experiments, Isotopic labeling.

UNIT-II:

Free Radicals

Free radicals and their reactions-Introduction to radical reactions, Addition of halogens, Hydrogen halides. Substitution reactions- Halogenation, Aromatic substitution, Sandmayer reaction, Autooxidation, Decomposition of dialkyl and diacyl peroxides.

UNIT-III:

Oxidations

Introduction: Different Oxidative processes.

Hydrocarbon: Alkenes, aromatic rings saturated C-H groups (activated and unactivated), Alcohols, diols, aldehydes, Ketones, Carboxylic acids, Amines, hydrazines, sulphides. Oxidations with ruthenium tetroxide iodobenzene diaccetate and Tl(III) nitrate, Lead tetra acetate, SeO_2, MnO_2 Ag_2CO_3, peracids.

Oxidation of C=C perhydroxylation using $KMnO_4$, OsO_4, peracids.

UNIT-IV:

Reductions

Introduction: Reductive process Hydrocarbons: Alkanes, alkenes, alkynes, and aromatic rings Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Nitro, nitroso, azo and oxime group Hydrogenolysis. Catalytic hydrogenations, Reduction by dissolving metals, Reduction with metal and acid. Reduction with metal in liquid ammonia (Birch reduction).

Reduction by hydride transfer reagents Aluminium alkoxide, LiAlH4, NaBH4, Diisobutyl aluminium hydrides–Sodium cyano borohydride, tryalkyl borohydirdes-Reduction with diimide.

UNIT-V:

Asymmetric Synthesis-I

Terminology: Topocity in molecules Homotopic, stereo Heterotopic (enantiotopic and diastereotopic) groups and faces- symmetry, substitution and addition criteria. Prochirality nomenclature: Pro-R, Pro-S, Re, and Si.

Selectivity in synthesis: Stereo specific reactions (substrate stereoselectivity). Conditions Stereo selective reactions (product stereoselectivity): Enantio selectivity and diastereoselectivity.

Analytical Methods: % Enantiomer excess, optical purity, % diastereomeric excess.

REFERENCE BOOKS:

1) Mechanism and structure in Organic Chemistry "E.S.Could Henry – Holt and Co,Newyork.
2) Advances in Organic Reaction mechanism and structure J. March (McGrew Hill).
3) Aguide Book to Mechanism in Organic Chemistry" by P.Sykes.
4) Synthetic approaches in organic chemistry by R.K.Bansal (Narosa Publications).
5) Some modern methods of synthesis by Carruthers (Cambridge).
6) Asymmetric synthesis by Nogradi.
7) Asymmetric organic reactions by it) Morrison and HS Moschcr.
8) Stereo differentiating reactions by Izumi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3	3	2	3	2	3		
2	3	2	3	2		3	2	3		
3	3	3	3	2		3	2	3		
4	3	3	3	2		3	2	3		
5	3	3	3	2		3	2	3		

***1-Low *2- Medium *3- Strong**

R22OC33A: ALKALOIDS, TERPENOIDS, QUINONES & PHENOTHIAZINES

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand the definitions and importance of various alkaloids and their synthesis
- Understand the structure elucidation and also know the synthetic processes application and synthetic methods of studied alkaloids
- Understand indole alkaloids and their structural elucidation with their synthesis.
- Knowledge on Basic ideas of isoprene rule, terpenoids classification, their natural sources, synthesis.
- Understand the structure characterization and synthesis of quinones and Phenothiazines.

UNIT-I:

Alkaloids-I: Definition, General methods of identification of alkaloids - nomenclature – occurrence – isolation - chemical tests for identification-general methods of structural elucidation-degradation–classification based on nitrogen heterocyclic ring-role of alkaloids in plants.

a) Structure and synthesis of Atropine, Caffeine.
b) Quinoline alkaloids: Chemistry and synthesis of Quinine, Cinchonine, and their stereochemistry.

UNIT-II:

Alkaloids-II:

a) Isoquinoline-Morphine Group Alkaloids: Papaverine, Hydrastine, narcotine, canadine, Coclawrine, Morphine, Codeine, emetine, Apomorphine, Glaucine.
b) Stereochemistry of emetine, and morphine alkaloids.
c) Biogenesis of alkaloids.

UNIT-III:

Alkaloids-III:

a) Indole alkaloids: Reserpine, strychnine, brucine, lysergic acid, erogotamine.
b) Structure, stereochemistry, synthesis and biosynthesis of Ephedrine, Conine and nicotine.

UNIT-IV:

Terpenoids: Classificaiton, sources, isolation, synthesis and stereochemistry with special reference to zingiberene, santonin, eudesmol, abietic acid, Biosynthesis of terpenoids.

Quinones and Phenothiazines:

Quinones: Identification of quinones, Lapachol. Chrysophenol and Physcion-chemistryand synthesis.

Phenothiazines: Classification, pharmacological properties of phenothaizines, general methods of synthesis of phenothiazines with reference to Promazine, Prochlorperazine and Thioriazine.

REFERENCE BOOKS:

1) Alkaloids by K.W. Bentley Vols. I & II.
2) Text Book of Organic Chemistry I.L. Finar Vol. II 3.An introduction of alkaloids by G.A. Swain.
3) Naturally occurring quinines – R. H. Johnson Vol. I & II, Academic Press, London.
4) Chemistry and physiology of alkaloids by Manske Vol. I & II, VII.
5) Medicinal Chemistry by A. Burger.
6) Isoquinoline Alkaloids by M.Shamma.
7) Heterocylclic Chemistry by JA Joule etal., Chapman – Hall.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1		2	3	1		3		3		
2		3	3	2		3		3		
3	3	2	3	1		3		3		
4	3	3	3	2		3		3		
5	3	2	3	2		3		2		

***1-Low *2- Medium *3- Strong**

R22OC33B: CHEMISTRY OF AEROSPACE MATERIALS

(ELECTIVE–B)

COURSE OUTCOMES:

- Knowledge on the various classes of materials used in aerospace.
- Understand the materials used and their property requirements for different parts of spacecraft.
- Understand for the study on composition- structure-processing-property correlation in aerospace materials toenable them to design new materials with improved property.
- Understand the metallic materials for cryogenic applications.
- Knowledge on the evaluation of materials for space environment and space worthiness.

UNIT-I:

Carbon Based Materials: Carbon fiber, carbon-carbon composites, carbon aerogels and foams, **Ceramic Materials:** Polymer derived ceramics- synthesis, processing of pre-ceramic polymers, ceramic fibers, Ceramic matrix composites, Thermal barrier coatings, Ablative materials, Silica tiles, Ceramic aerogels, Porous ceramics and ceramic foams, Ultrahigh temperature ceramics- TiB_2, ZrB_2, HfB_2 and their composites, Materials with zero thermal expansion-glass ceramics- preparation and application.

UNIT-II:

Metallic Materials: Super alloys, Titanium alloys, Intermetallics and metal matrix composites, Functionally graded materials -production, properties and application.

UNIT-III:

High Temperature Polymers: Aromatic liquid crystalline polyesters, Phenolics, Polyimide, Poly ether ether ketones- synthesis, processing and applications.

UNIT-IV:

Materials for Cryogenic Applications: Metals for low temperature applications, Austenitic stainless steel, Nitrogen containing steel, Aluminium, Aluminium-lithium alloys, Titanium alloys, Cryo insulation materials, Polymers and adhesive for cryo temperature applications.

UNIT-V:

Materials for Space Environment: Radiation shielding materials, Atomic oxygen resistant materials, Space suit materials and materials for life support systems, Evaluation of materials for space environment and space worthiness.

REFERENCE BOOKS:

1) G. Savage, Carbon-Carbon Composites, 1st ed., Chapman and Hall, 1993.
2) M. Scheffler, P. Colombo, Cellular Ceramics, Structure, Manufacturing, properties andApplications, 1st ed., Wiley-VCH, 2006.
3) W.D. Kingery, H.K. Bowen, D.R. Uhlmann, Introduction to Ceramics, 2nd ed., WileyInterscience, 1976.
4) J.S. Reed, Principles of Ceramic Processing, 2nd ed., Wiley-Interscience, 1995.
5) H.M. Flower, High Performance Materials in Aerospace, 1st ed., Chapman & Hall, 1995.
6) B.Horst, B. Ilschner, K.C. Russel, Advanced Aerospace Materials, Springer-Verlag, Berlin, 1992.
7) F. Mohammad, Speciality Polymers: Materials and Applications, I.K. International publishing House Pvt. Ltd, 2007.
8) W. Krenkel, R. Naslain, H. Schneider, (Eds.) High Temperature Ceramic Matrix composites, 1st ed., Wiley-VCH, 2006.8 13
9) T.W. Clyne, P.J. Withers, E.A. Davis, I.M. Ward, Introduction to Metal Matrix Composites, Cambridge Solid State Science Series, 1st ed., Cambridge University Press, 1993.
10) R.R. Luise, Applications of High Temperature Polymers, CRC press, 1st ed., 1996.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3	1		3		3		
2	3	3	3	2		3		3		
3	3	3	3	1		3		3		
4	3	3	3	2		3	3	3		
5	3	3	3	2		3	3	2		

***1-Low *2- Medium *3- Strong**

R22OC33C: DRUG DISCOVERY, DESIGN AND DEVELOPMENT

(ELECTIVE–C)

COURSE OUTCOMES:

- Knowledge about the definition of basic principles of pharmacology.
- Understand the discovery of optimization of existing drugs as leads.
- Knowledge the structure activity / relationship in various drugs.
- Knowledge on the introduction of QSAR & properties.
- Learn about the structure, uses & mechanisms of action of common drugs.

UNIT-I: Basic Principles of Pharmacology

Definitions: Disease, drug, bioassay, pharmacokinetics and pharmacodynamics, stages involvedin drug discovery, formulation, drug dosing, routes of drug administration,

Pharmacokinetics: Absorption, distribution, metabolism and excretion of drugs (ADME), drugdelivery.

Pharmacodynamics: Nature of drug - receptor interactions, theories of drug action: occupancytheory, rate theory, induced-fit theory, macromolecular perturbation theory.

Drug synergism and antagonism, drug toxicity, clinical trials.

UNIT-II: Lead Discovery and Optimization

Lead Discovery: Existing drugs as leads (me too drugs), pharmacophore. Principles of design ofagonists e.g. salbutamol, antagonists e.g. cimetidine and enzyme inhibitors e.g. captopril. Drugdiscovery without lead. Serendipity-penicillin and librium as examples.

Lead Optimization: Bioisosterism, variation of alkyl substituents, chain homologation and branching, variation of aromatic substituents, extension of structure, ring expansion and ring contraction, ring variation, variation and position of hetero atoms, ring fusion, simplification of the lead, rigidification of lead, conformational blockers, discovery of oxamnquine.

UNIT-III: SAR

Structure Activity Relationship (SAR): SAR in sulfa drugs, benzodiazepines, and taxol analogs, principles of prodrug design.

UNIT-IV: QSAR Studies

Quantitative Structure Activity relationship (QSAR): Introduction to QSAR, physicochemical properties. lipophilicity: partition coefficient (P) and the lipophilicity substituent constant (π), electronic effects: Hammett constant (σ), steric effects: Traft's constant (Es), Hanscth analysis, Craig's plot, Topliss scheme, free Wilson approach, Lipenski rule of five.

UNIT-V: Common Drugs

Structure, uses, mechanism of action of antibacterial agents: sulfamethoxazole, penicillin G, antiviral agents: acyclovir, indinavir, anticancer agents: mechlorethamine, methotrexate, antifungal agents: fluconazole, griseofulvin, gastrointestrinal agents: ranitidine, omeprazole, metoclopramide, cardiovascular agents: amrinone, procainamide, captopril, propranolol, mehyl dopa, anticoagulants: warfarin, central nervous system agents: paracetamol, betamethasone, chlorpromazine, levodopa, diazepam, phenytion, procaine.

REFERENCE BOOKS:

1) Medicinal Chemistry and Pharmaceutical Chemistry, H. Singh and Kaur.
2) An Introduction to Medicinal Chemistry, 4th Ed., G. L. Patrik.
3) Fundamentals of Medicinal Chemistry, Gareth Thomas.
4) Biochemical Approach to Medicinal Chemistry, Thomas Nogrady.
5) Principles of Medicinal Chemistry, William Foye.
6) Medicinal Chemistry, Ashutosh Kar.
7) Medicinal Chemistry, R. R. Nadendla.
8) Berger's Medicinal Chemistry, Vols. 1-5, Manfred E. Wolf.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	1	3		
2	3	3	3			3	1	3		
3	3	2	3			3		3		
4	3	2	3			3	3	3		
5	3	2	3			3	3	2		

***1-Low *2- Medium *3- Strong**

R22OC34A: CHEMISTRY OF NATURAL PRODUCTS

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand the classification and general methods of synthesis of various flavonoids.
- Understand the synthesis of fat and water soluble vitamins.
- Knowledge on the classification of hormones, and synthesis of some steroidal and non-steroidal harmones.
- Understand functions, structures and synthesis aminoacids, proteins, enzymes, cofactors and prostaglandins.
- Understand different types of naturally occurring insecticides and their specific and commercial importance.

UNIT-I:

Flavonoids and Prostagladins

Flavonoids: Classificaiton, sources, isolation, general methods of synthesis of flavones, flavanones, flavonols. Chemistry and synthesis with special reference to quercetin and kampferol.

Prostaglandins: Prostaglandins with special reference to PGE and PGF.

UNIT-II:

Vitamins

Fat Soluble Vitamins: Chemistry, Synthesis & biosynthesis of vitamin A_1, vitamin E (α, β, γ, δ-tocopherols) and vitamin K

Water soluble Vitamins: Chemistry, Synthesis, and biosynthesis of B_1 and C.

UNIT-III:

Steroidal Hormones

Chemistry & synthesis of equilenine, oestrone, progesterone, androsterone, testosterone, cortisone.

Non-Steroid Hormones: Chemistry & synthesis of thyroxin, epinephrine, and oxytocin.

UNIT-IV

Amino Acids: Classification of amino acids. Specific methods of preparations –Malonic ester synthesis and Erlenmeyer azlactone synthesis. Isoelectric point.

Proteins: General nature of proteins – annealing, Biuret reaction, Ninhydrin test. Classification of proteins. Merrifield solid phase peptide synthesis. Primary, secondary, tertiary, and quaternarystructure of proteins.

a) Enzymes: classification, kinetics, and mechanism of enzyme action
b) Coenzymes and cofactors: NAD FAD folic acid citric acid cycle.

UNIT-V

Insecticides

Naturally Occurring Insecticides: Introduction, general properties, sources, isolation, synthesis, and stereochemistry of Pyrethrin I and II; Jasmolin I & II; Structure activity relationship (SAR) studies and biosynthesis of pyrethrins.

Rotenoids: Chemistry and synthesis of rotenone.

Isobutylamines: Chemistry and synthesis of anacyclin, and spilanthol .

Minor Insecticides of Plant Origin: Pachyrrhizin and custard-apple.

REFERENCE BOOKS:

1) Steroids by Fieser and Fieser,
2) The Vitamins by S.F. Dykes,
3) The Natural Pigments by K.W. Bentley,
4) Biological Chemistry by Holum,
5) Organic Chemistry Vol.II by I.L.Finar,
6) Naturally occurring insecticides by M. Jacobson and D.G. Crosby, Marcel- Decker Inc, New York.
7) General Organic and Biochemi stry by F.A. Bettelheim and Jerry March, Saunders College, Publishing.
8) The terpenoids by Simonsen,
9) The steroids by Shoppee,
10) Chemistry of Carbon compounds by Rodd.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	2	2	3			3		3		
2	3	3	3			3		3		
3	3	2	3			3		3		
4	3	3	3			3		3		
5	3	2	3			3		3		

***1-Low *2- Medium *3- Strong**

R22OC34B: CHEMISTRY OF HIGH ENERGY MATERIALS

(ELECTIVE–B)

COURSE OUTCOMES:

- Knowledge about the definitions of high energy materials.
- Understand about the basis of energetic materials.
- Knowledge about the theoretical basis of thermodynamics.
- Understand about the importance of various novel energetic materials.
- Knowledge on the handling & synthesis of energetic materials.

UNIT -I:

High Energy materials: Introduction, Definitions, Combustion, Deflagration, Detonation, Fire and Combustion, Deflagration and Detonation.

UNIT-II:

Classification of Energetic Materials: Primary Explosives, High (Secondary) Explosives, Propellant Charges, Rocket Propellants, Chemical Thermal Propulsion (CTP), Pyrotechnics, Detonators, Initiators, Delay Compositions and Heat-Generating Pyrotechnics, Light-Generating Pyrotechnics, Decoy Flares, Smoke Munitions, Near-Infrared (NIR) Compositions.

UNIT-III:

Detonation, Detonation Velocity and Detonation Pressure,

Thermodynamics: Theoretical Basis, Computational Methods, Thermodynamics, Detonation Parameters, Combustion Parameters, Example: Theoretical Evaluation of New Solid Rocket Propellants 101 4.2.5 Example: EXPLO5 Calculation of the Gun Propellant Properties of Single,Double and Triple Base Propellants.

UNIT-IV:

Design of Novel Energetic Materials: Classification, Polynitrogen Compounds, High-Nitrogen Compounds, Tetrazole and Dinitramide Chemistry, Tetrazole, Tetrazine and Trinitroethyl Chemistry, Ionic Liquids, Dinitroguanidine Derivatives, Co-Crystallization, Future Energetics.

UNIT-V:

Synthesis of Energetic Materials: Molecular Building Blocks, Nitration Reactions, Processing, Safe Handling of Energetic Materials in the Laboratory, General, Protective Equipment, Laboratory, Equipment. Energetic Materials of the Future.

REFERENCE BOOKS:

1) G.Majano, S. Mintova, T.Bein, T.M.Klapotke, Advanced Materials.
2) R.M.Doherty, Novel Energetic Materials and Applications.
3) H.D.B. Jenkins, Chemical Thermodynamics at a Glance, Black well, Oxford.
4) J.P. Agarwal, R.D. Hodgson Organic Chemistry of Explosives.
5) Prof. Dr. Thomas Kal Potke Energetic Materials-LMU Munich. (https://www.hedm.cup.uni-muenchen.de/personen/professors/klapoetke/index.html)
6) https://www.uidaho.edu/sci/chem/people/faculty/jshreeve

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3		2	3		3		1
2	3	3	3		2	3		3		2
3	3	3	3		2	3		3		2
4	3	3	3		2	3		3		2
5	3	2	3		2	3		3		

***1-Low *2- Medium *3- Strong**

R22OC34C: APPLICATIONS OF SYNTHETIC PRODUCTS

(ELECTIVE–C)

COURSE OUTCOMES:

- Understand dyes and drug their industrial importance.
- Knowledge on synthetic drugs and their medicinal properties.
- Understand the cleansing action of soaps, manufacture of cosmetics and use of flavours and sweetness.
- Understand effects of pesticides and insecticides to the environment.
- Understand about explosive materials and preparation & use of polymers in industries.

UNIT-I:

Dyes: Colour and constitution, classification, dyeing method, and their industrial importance.

Drugs: Basic concepts, classification, sources, the requirement of an ideal drug.

UNIT-II:

Synthetic Drugs: Structure and medicinal properties.

Sulphanilamide: An example of sulpha drug-paracetamol, aspirin, oil of wintergreen; Mephensin.

A muscle relaxant; Ibuprofen-an anti-inflammatory drug; L-dopa-cures Parkinson's disease;

UNIT-III:

Soaps and Detergents: Production and their cleansing action.Liquid crystals and their applications. Surfactants

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick andnail polish, shampoos, hair dyes, and toothpastes.

Flavours: Natural flavouring materials and classification.

UNIT-IV:

Sweeteners: Natural and Synthetic sweeteners.

Pesticides: Introduction, Classification, Applications and their effect on the environment.
Insecticides: Introduction, Classification, Applications and their effect on the environment.
Explosives: Introduction, RDX, Gun Powder.

UNIT-V:

Polymers: Introduction, biodegradable and non-biodegradable polymers and their industrial importance, plastics (uses and effects on environment), natural and synthetic rubbers, polyamides, and polyesters like nylon, decron, terelyne. Thermoplastics–Poly carbonates, Poly acrylates in lens applications, Polyurethanes, and conducting polymers.

REFERENCE BOOKS:

1) I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.742.
2) K. Albert, L Lehninger, D. L. Nelson, M.M. Cox, Principles of Biochemistry, CBZPublishers, 1st Edition, New Delhi, 1993.
3) Harper's Biochemistry, Ed. R. Harper, 22nd Edition, Prentice Hall Press, New York,1990.
4) Encyclopedia of Chemical Technology – Kirck – Othmer Series.
5) Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer & V.W. Rodfwell, 15thEdition, Maurzen Asian Edition, California, 1981.
6) Polymer Science, Gowarikar.
7) Industrial Chemistry, B.K. Sharma.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3		3		
2	3	3	3			3		2		
3	3	3	3	2		3		3		
4	3	2	3			2		3		
5	3	3	2	2		3	2	3		

***1-Low *2- Medium *3- Strong**

PRACTICAL–I:

R22OC35: MULTISTAGE ORGANIC SYNTHESIS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

Expt-1: Synthesis of paracetomol from benzene

Step 1: Benzene to Nitrobenzene (Nitration)

Step 2: Nitrobenzene to N-phenyl hydroxylamine (reduction)

Step 3: N-phenyl hydroxyl amine to *p*-aminophenol (Rearrangement) Step 4: *p*-amino phenol to *p*-hydroxy acetanilide/paracetomol(acetylation)

Expt-2: Synthesis of *o*-chlorobenzoic acid from phthalic acid

Step 1: Phthalic acid to phthalic anhydride (Dehydration)

Step 2: Phthalic anhydride –phthalic amide (Amide formation)

Step 3: Phthalmide-Anthranilic acid (Hoffman's Bromamide reaction)

Step 4: Anthranilic acid -*ortho*-chloro benzoic acid

Expt-3: Synthesis of sulpha drug from aniline

Step 1: Aniline to acetanilide

Step 2: Acetanilide to *p*-acetamide benzene sulphonyl chloride (sulphonation)

Step 3: *p*-acetamide benzenesulphonylchloride to *p*-acetamide benzenesulphonamide (s-amination)

Step 4: *p*-acetamide benzene sulphonamide to *p*-amino benzenesulphonamide(hydrolysis)

Expt-4: *m*-Chloro-nitrobenzene from nitrobenzene

Step 1: Nitro benzene to *m*-dinitro benzene (nitration)

Step 2: *m*-dinitrobenzene to *m*-nitro aniline (partial reduction)

Step 3: *m*-nitro aniline to *m*- nitrodiazoniumchloride (diazotization)

Step 4: *m*-nitrodiazoniumchloride to *m*-Chloro-nitrobenzene (sandmayers reaction)

Expt-5: Synthesis of *p*-bromo benzanilide from benzophenone

Step 1: Benzophenone to benzopenone oxime (Addition)

Step 2: Benzophenone oxime to benzanilide (Beckman's rearrangement)

Step 3: Benzanilide to *p*-bromobenzanilide) (bromination)

Expt-6: Synthesis of Methyl orange from aniline

Step 1: Aniline to sulphonic acid (sulphonation)

Step 2: sulphonic acid to Diazonium chloride (diazotization)

Step 3: Diazonium chloride to methyl orange (coupling reaction)

Expt-7: Synthesis of Acridone from Anthranilic acid

Step 1: Anthraninilc acid to o-chlorobenzoic acid (Diazotosation followed by sand mayer's reaction)

Step 2: o-chlorobenzoic acid to N-phenyl anthranilic acid (Substitution)

Step 3: N-phenyl anthranilic acid to acridone (Cyclisation)

Note: All the students must submit the TLC for all the stages of preparation and a photo copymust be pasted in records.

REFERENCE BOOKS:

1) Practical Organic Chemistry A.I.Vogel (Longmans).
2) Text Book of practical organic Chemistry F.G.Mann & B.C. Sanders.
3) A Manual of Practical Organic Chemistry Day Sitaramam & Govindachari.
4) Organic Experiments L.F.Fieser.
5) Practical Organic Chemistry H.T.Openshaw.
6) Systematic Identification of Organic Compounds, P.L.Shriner, R.C.Fuson & D.Y.Curtin.
7) Identification of Organic Compounds N.D.Cheronis & J.B.Entrilkin.
8) Advanced Organic Synthesis by R.S.Monson Academic Press.

Note: For University Practical Examination the Duration is a 9 hours.

PRACTICAL–II:

R22OC36: ORGANIC ESTIMATIONS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

Part I: One theory question either relating to spectral characterization or any practical oras wish by the examiner.

Part II: The following Estimations/Isolations

Expt. 1: Estimation of hydroxyl group by acetylation or pthalation method

Expt. 2: Estimation of phenol (Bromination method)

Expt. 3: Estimation of aniline (Bromination method)

Expt. 4: Estimation of carbonyl groups (Hydrazone formation method)

Expt. 5: Estimation of sugars-glucose and sucrose by using Fehlings solution

Expt. 6: Determination of iodine value of oil or fat

Expt. 7: Determination of saponification value of oil or fat

Expt. 8: Estimation of vitamin 'C' in lime juice.

Expt. 9: Isolation of caffeine from tea/coffee sample.

Part-III: Record Submission

Note: For University Practical Examination the Duration is a 6 hours.

FOURTH SEMESTER

M.Sc. ANALYTICAL CHEMISTRY

SEMESTER-IV

R22AC41: ADVANCED METHODS OF ANALYSIS

COURSE OUTCOMES:

- Knowledge on the use the mass spectrum of a compound to find the molecular mass & to help identify the structure of a compound.
- Understand the principles of different X-ray spectroscopic method's and application.
- Knowledge on aware of the fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy
- Apply the use NMR spectra to determine the structures of compounds, given other information such as a molecular formula.
- Understand Principles and Applications of Mossbauer spectroscopy.

UNIT-I:

Mass Spectrometry: Principle - Theory - Instrumentation - Interpretation of spectra of metal compounds-identification of compounds of metal compounds from fragmentation pattern.

Types of Ions produced in mass spectrometer - Nitrogen rule, thermodynamic studies-molecularstructure Analytical aspects of the mass spectrometry, applications.

UNIT-II:

X- RAY Spectroscopy: Principles - Theory, X-ray diffraction – Instrumentation - X-ray fluorescence - applications-identification of substances by the powder diffraction method-applications.

UNIT-III:

Electron Paramagnetic Resonance Spectroscopy (EPR):

Principle-Theory-Instrumentation -hyperfine interactions-determination of 'g' value - endor and eldor, applications - Study of free radicals, Determination of Manganese, Determination of Vanadium.

UNIT-IV:

Mossbauer Spectroscopy: Principle, Instrumentation and Mossbauer Spectra, Applications.

UNIT-V:

Nuclear Magnetic Resonance Spectroscopy (NMR): Principles-theory-instrumentation-differences between NMR and EPR-chemical shift-spin-spin coupling effect of chemical exchange on spin-spin interactions-spin decoupling-limitations of NMR-cause of chemical shift and shielding-applications- qualitative and quantitative analysis-kinetic studies.

REFERENCE BOOKS:

1) Becky - Ionization mass spectrometry.
2) Physical methods of Analytical Chemistry Vol. I - III,
3) J.Roilly and W.N.Ray -Physical Chemical Methods.
4) Advances in Analytical Chemistry and Instrumentation. Vol. I – IV.
5) T.H.Gouw- Guide to modern methods of instrumental analysis,
6) A.I.Vogel - A text Book of Quantitative Inorganic Analysis-ELBS.
7) P.Delahay -New instrumental methods in Analytical Chemistry.
8) H.H.Willard, LL Merrit and JA Dean -- Instrumental Methods of Analysis.
9) Banwell- Fundamentals of molecular spectroscopy.
10) D.M.Willium and I.Fleming - Spectroscopic methods of Inorganic Chemistry.
11) J.Charalambous - Mass spectrometry of metal compounds.
12) J.W.Robbinson- Under graduate Instrumental Analysis.
13) D.A.Skoog, F.J.Holler and Neman-- Instrumental Methods of Analysis.
14) Instrumental Methods of Chemical Analysis: Analytical Chemistry.
15) Gurdeep R.Chatwal and Sham K. Anand, 5th edn.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2	2	3	2	3	2	
2	3	3	3			3		3		
3	3	3	3			3	2	3		
4	3	3	3	2		3	2	3	2	
5	3	3	3	2		3	2	2	2	

***1-Low *2- Medium *3- Strong**

R22AC42: ANALYSIS OF DRUGS, FOODS, DAIRY PRODUCTS & BIOCHEMICAL ANALYSIS

COURSE OUTCOMES:

- Understand core skills to interpret in real life applications for pharmaceutical drugs.
- Knowledge about pharmaceutical preparation of various sedative drugs and some other drugs.
- Applying this knowledge they can analyze and utilize various drugs.
- Understand various methods and techniques to asses and identify matter for milk and preservatives.
- How to detect the core analytes that are existing in the sample for blood analysis.

UNIT-I:

Analysis of the following Drugs and Pharmaceuticals Preparations: (Knowledge of molecular formula, structure and analysis) Analysis of analgesics and antipyretics like aspirin and paracetamol Analysis of antimalerials like choloroquine. Analysis of drugs in the treatment of infections and infestations: Amoxycillin., chloramphenicol, metronidazole, penicillin, tetracycline. Anti tuberculous drug- isoniazid.

UNIT-II:

Analysis of the following Drugs and Pharmaceuticals Preparations: (Knowledge of molecular formula, structure and analysis) Analysis of antihistamine drugs and sedatives like: allegra, zyrtec(citirizine), alprazolam, trazodone, lorazepem.

UNIT-III:

Analysis of anti epileptic and anti convulsant drugs like phenobarbital and phenacemide. Analysis of drugs used in case of cardiovascular drugs:atenolol, norvasc (amlodipine), Analysis of Lipitor (atorvastatin) a drug for the preventin of productin of cholesterol.

Analysis of diuretics like: furosemide (Lasix), triamterene Analysis of prevacid (lansoprazole) a drug used for the prevention of production of acids in stomach.

UNIT-IV:

Analysis of Milk and Milk Products: Acidity, total solids, fat, total nitrogen, protenines, lactose, phosphate activity, casein, chloride Analysis of food materials.

Preservatives: Sodium carbonate, sodium benzoate sorbic acid Flavoring agents - Vanilla, diacetyl, isoamyl acetate, limonene, ethylpropionate, allyl hexanoate and Adulterants in rice and wheat, wheat flour, sago, coconut oil, coffee powder, tea powder, milk.

UNIT-V:

Clinical Analysis of Blood: Composition of blood, clinical analysis, trace elements in the body.Estimation of blood cholesterol, glucose, enzymes, RBC & WBC, Blood gas analyser.

REFERENCE BOOKS:

1) F.J.Welcher-Standard methods of analysis,
2) A.I.Vogel-A text book of quantitative Inorganic analysis-ELBS,
3) F.D.Snell & F.M.Biffen-Commercial methods of analysis-D.B.Taraporavala & sons,
4) J.J.Elving and I.M.Kolthoff- Chemical analysis - A series of monographs on
5) Analytical chemistry and its applications -- Inter Science- Vol I to VII.,
6) Aanalytical Agricultrual Chemistry by S.L.Chopra & J.S.Kanwar - Kalyani Publishers
7) Quantitative analysis of drugs in pharmaceutical formulations by P.D.Sethi, CBS Publishers andDistributors, New Delhi.
8) G.Ingram- Methods of organic elemental micro analysis- Chapman and Hall.
9) H.Wincciam and Bobbles (Henry J)-Instrumental methods of analysis of food additives.,
10) H.Edward-The Chemical analysis of foods; Practical treatise on the examination of food stuffsand the detection of adulterants,
11) The quantitative analysis of drugs- D.C.Garratt-Chapman & Hall,
12) A text book of pharmaceutical analysis by K.A.Connors-Wiley- International, Comprehensivemedicinal chemistry-Ed Corwin Hansch Vol 5, Pergamon Press.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3			3		3		
2	3	3	3			3		3		
3	3	3	3			3	2	3		
4	3	3	3			3	3	3	2	
5	3	3	3			3	2	2	2	

***1-Low *2- Medium *3- Strong**

R22AC43A: SEPARATION TECHNIQUES AND ELECTRO ANALYTICALTECHNIQUES

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand Solvent Extraction and Ion Exchange separation methods for compounds.
- Know about basics and fundamental concepts of chromatography.
- Understand the basic principles, procedure, instrumentation, and applications of Column, Paper and TLC chromatographic techniques.
- Understand the basic principles, procedure, instrumentation, and applications of HPLC, GC, SFC chromatographic techniques.
- Understand separation and quantification of ions of a substance through Electrogravimetry and Coulometry.

UNIT-I:

Separation Techniques in Chemical Analysis:

Solvent Extraction: Introduction, principle, techniques, factors affecting solvent extraction, quantitative treatment of solvent extraction Equilibria - chelate and ion association systems-synergism, ION EXCHANGE: Introduction, action of ion exchange resins, separation of inorganic mixtures,applications.

UNIT-II:

Chromatography-I: Basics of chromatography, methods of development-Elution development, Gradient elution development. Principles of chromatography, adsorption, partition coefficient. Terms: retention time and volume, resolution, Separation Factor. Dynamics of chromatography- High Equivalent Theoretical Plate (HETP), Van Deempter equation. Introduction, equipment and applications of Column, paper chromatography and Thin layerchromatography.

UNIT-III:

Chromatography -II:

Introduction, instrumentation and applications: HPLC and Gas chromatography. Size Exclusion Chromatography – Principles of gel – filtration Chromatography, Instrumentation, retention behavior, resolution, selection of gel type, applications, Ion exclusion – Principle and applications. Supercritical fluid chromatography (SFC) – Instrumentation of SFC, stationary and mobile phases used in SFC, Detectors, Advantages of SFC. Technique and applications of SFC.

UNIT-IV:

Electrogravimetry:

Theory of electro analysis–Polarisation–Over voltage–Principles involved in electrogravimetric analysis–current–voltage curves – separation of metals by electrolysis – constant current – controlled potential electrolysis.

Coulometry: Coulometry at controlled potential – separation of Nickel and Cobalt – coulometres – types of coulometric analysis – constant current coulometry of coulometric titrations.

UNIT-V:

Voltametry, Polarography and Amperometric Titrations: Voltametry – Principle of Polarography – dropping mercury electrode; working; factors effecting the limiting current;residual current, migration current – diffusion current – kinetic current – polarographic maximum – Half wave potential – Organic Polarography, Rapid Scan polarography – cyclic voltammetry qualitative and quantitative polarographic analysis – Amperometric titrations – its advantages and disadvantages – Bi Amperometric titrations – Chrono potentiometry.

REFERENCE BOOKS:

1) B.K.Sharma - Instrumental methods of chemical analysis, Goel Publishers,
2) G.Chatwal and S.Anand -Instrumental methods of chemical analysis,
3) J.J.Lingane- Electroanalytical Chemistry - Inter Science,
4) A.I.Vogel - A text Book of Quantitative Inorganic Analysis-ELBS,
5) H.H.Willard, LL Merrit and JA Dean - Instrumental Methods of Analysis,
6) Peace-Instrumental Methods of Analysis,
7) J.W. Robbinson- Under graduate Instrumental Analysis,
8) R.A.Day and A.L. Underwood- Quantitative Analysis,
9) G.W Eving- Instrumental Methods of Chemical Analysis,
10) D.A.Skoog, D.M.West and F.J.Holler--Fundamentals of Analytical Chemistry,
11) H.Kaur- Instrumental methods of chemical analysis, Pragathi Prakasan,
12) D.A.Skoog, F.J.Holler and Neman-- Instrumental Methods of Analysis,
13) G.H.Morrison and H.Frieser- Solvent extraction in Analytical Chemistry,
14) Chemical Separation methods- JA Dean, D.Vannostrand Company, New York,
15) Physical and Chemical Methods of Separation by E.W.Berg, MC Graw Hill Book Company,New York.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3			3		3		
2	3	3	3			3	2	3	1	
3	3	3	3			2	1	3	1	
4	3	3	3			3	2	3	1	
5	3	3	3			3	2	3	1	

***1-Low *2- Medium *3- Strong**

R22AC43B: ANALYTICAL CHEMISTRY OF OILS & FATS

(ELECTIVE–B)

COURSE OUTCOMES:

- Knowledge about Elementary methods of analysis of Oils, Fats & Fatty acids.
- Knowledge on Separation Techniques in Fatty acids.
- Understand about chromatography techniques of Oils & Fats.
- Knowledge about principles and spectroscopy techniques of Oils & fats.
- Knowledge about the analysis of special quality control methods for Oils and Fats.

UNIT-I:

Elementary methods of analysis of oil seeds, Oils, Fats & Fatty acids including BIS methods, Identification of Oils & Fats: Methods for detection of adulteration in Oils & Fats, Method's for evaluation of stability of Oils & Fats. BIS & AG mark specifications for Oils and Fats.

UNIT-II:

Techniques of separations of Fatty acids Esterification, Low temp, Crystallization, Urea adduct, counter current Distribution.

UNIT-III:

Chromatographic methods of separation for Oils and Fats with special reference to TLC & GLC techniques.

UNIT-IV:

Principles and uses of modern Physico chemical analysis techniques such as UV, IR, NMR, MS etc. in Oils and Fats, their products analysis.

UNIT-V:

Dilatometric measurement and its significance. Wet bulb temp & Measurement of humidity, special quality control methods for Oils and Fats like detection of Nickel etc.

REFERENCE BOOKS:

1) Analytical methods in Oils & Fats by cocks.
2) Laborary Hand book for chromatographic methods by O.Milkes.
3) Treatise on Fats, Fatty Acids, Oleo chemicals by O.P.Narula.
4) Instrumentation by Eckmen.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3	2		3	2	3	2	
2	3	2	2	2		3	2	3	1	
3	3	2	3	2		2	1	3	1	
4	3	2	3	1		3	2	3	1	
5	3	3	3			3	2	3	1	

***1-Low *2- Medium *3- Strong**

R22AC43C: QUALITY CONTROL & QUALITY ASSURANCE IN PHARMA INDUSTRY

(ELECTIVE–C)

COURSE OUTCOMES:

- Knowledge about the basics of quality audit like SOP, ICH, ISO etc.
- Understand the various documentation processes and handling of materials.
- Understand the organizational responsibilities and personal responsibilities in the pharmasector.
- Knowledge acquire basic knowledge about the regulatory aspects and quality control.
- Knowledge about the Basic concepts of Quality Assurance

UNIT-I:

Pharmaceuticals Concept of drug, lead compound and lead modification, prodrugs and soft drugs. Importance of quality control, drugs and pharmaceuticals, sources of impurities in pharmaceutical chemicals, analytical quality control in finished/final products, common methods of assay.

UNIT-II:

Quality Audit, Documentation Quality audit. Standard operating procedure (SOP); international conference harmonization (ICH); ISO-9000; ISO-14000, WHO specifications, USFDA guidelines and ICMR. Documentation and Handling: Manufacturing documents, Master Formula, batch formula, Record, Distribution of records, Handling of returned goods, Recovered materials and Reprocessing.

UNIT-III:

Organization and Personnel Responsibilities Training, Hygiene, Premises: Location, Design, Plant layout, Construction, Maintenance and Sanitations. Environmental control, sterile areas, control of contamination.

UNIT-IV:

Regulatory Aspects and Quality Control Regulatory aspects. Validation f Personnel, Equipment and cleaning methods, regulatory aspects of pharmaceutics. Quality Control. In-process quality Control on various dosage forms, Sterile and non-sterile operations.

UNIT-V:

Basic concepts of Quality Assurance Basic concepts, principles or prescription, Needs, requirementsand expectations, characteristics of quality, Achieving, sustaining and improving quality, Quality dimensions and costs of quality. Elements of quality Assurance, Quality Management System, Quality management concepts and principles: ISO 9001:2000, QMS Case studies on ISO 9001: 2000 in chemical industries.

REFERENCE BOOKS:

1) R. Pannerselvam, Production and Operations Management, Prentice Hall India Learning Pvt. Ltd3rd Ed., 2012.
2) M. Savsar, Quality Assurance and Management, InTech-Croatia, 2012, ISBN 978-953-51-0378-3.
3) D.C. Montgomery, Statistical Quality Control, John Wiley & Sons, 5th Ed., 2005.
4) M. K. Starr, Production and Operations Management, Biztantra, Delhi, 2004.
5) D.H. Shah, QA Manual, Business Horizons, 2000.
6) D.H. Besterfield, C. Besterfield-Michna, G.H. Besterfield, M. Besterfield Sacre, Total QualityManagement, Pearson Education, Inc., 3rd Ed., 2003.
7) P. Konieczka, J. Namiesnik, Quality Assurance and Quality Control in the Analytical ChemicalLaboratory: A Practical Approach, 1st Ed., CRC press 2009.
8) D. Hoyle, ISO 9000 Quality Systems Handbook, 5th Ed., Butterworth Heinemann-Elsevier, NewYork, 2006.
9) E. Prichard, V. Barwick, Quality Assurance in Analytical Chemistry, John Wiley & Sons, 2007.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3	2		3	3	3	2	1
2	3	2	2	2		3	3	3	1	2
3	3	2	3	2		2	3	3	1	2
4	3	2	3	2		3	3	3	1	2
5	3	3	3	3		3	3	3	1	2

***1-Low *2- Medium *3- Strong**

R22AC44A: ENVIRONMENTAL CHEMISTRY AND ANALYSIS

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand the soil development and various nutrients present in the soil.
- Understanding the water quality parameters and various pollutants causing water pollution.
- Understand effects of specific pollutants.
- Understand waste water treatment methods.
- Understanding the methods for analysis of soil, air and water samples.

UNIT-I:

Significance of basic segments of Environment: Nomenclature in the study of Environmental Chemistry. Soil Chemistry & Pollution Studies: Principles of weathering - effect of temperature, water, air, plants and animals on weathering., Soil formation / development-factors affecting soil development physical properties of soil; soil colloids-ion exchange properties. Soil fertility, productivity - Soil nutrients-micro and macro.

UNIT-II:

Study of Water Pollution and Monitoring and Treatment Methods of Water Pollutants: Hydrosphere-water resources-hydrological cycle-unique properties of water- water quality parameters., Pollution from Domestic water, industrial, agricultural, solid waste, shipping, radioactive waste & thermal pollution.

UNIT-III:

Effect of specific pollutants like mercury, lead, arsenic, selenium, nitrates, oil., Effects of soaps, detergents, pesticides, hydrocarbon with regard to water pollution., Techniques of water treatment- Primary, secondary and tertiary methods-use of coagulants-flash distillation-solar stills, ion exchange reverse osmosis, electro dialysis.

UNIT-IV:

Study of Air Pollution and Monitoring and Treatment Methods in case of Air Pollution: Atmospheric sources and emission of air pollutants-carbon monoxide-sulphur, oxides-oxides of nitrogen, organic pollutants and photo chemical smog-particulates-acid rain and radioactive substances. Continuous monitoring of air pollutants - Principles, Monitoring instruments, monitoring of sulphur dioxide, hydrogen sulphide, oxides of nitrogen, oxides of carbon, hydrocarbons, ozone and suspended particulate matter and radioactive substances.

UNIT-V:

Environmental Chemical Analysis:

Analysis of Soil: Sampling, determination of moisture, total nitrogen, phosphorus, silicon, lime, humus,nitrogen, alkali salts.

Analysis of Water Samples: Dissolved oxygen, Chemical oxygen demand, Biological oxygen demand,Phosphates, nitrogen compounds.

Analysis of metallic constituents,

Analysis of Air Samples: Carbon mono oxide, carbon dioxide, sulphur dioxide, hydrogen sulphide,oxides of nitrogen, ammonia, ozone, hydrocarbons and aromatic hydrocarbons.

REFERENCE BOOKS:

1) Environmental Chemistry by A.K.De, Wiley Eastern Limited, New Delhi
2) A Text Book of Environmental Chemistry by O.D.Tyagia and M.Mehra-Anmol Publicaitons,
3) Environmental Pollution Control and Engineering by C.S.Rao , Wiley Eastern Limited,
4) Environmental Chemistry by P.S. Sindhu -New Age International Publishers
5) A Text Book of Environmental Chemistry and Pollution Control by S.S.Dara, S.Chand & Co.,
6) Environmental Pollution Analysis by S.M. Khopkar, Wiley Eastern Limited, New Delhi
7) Analytical Agricultural Chemistry by S.L.Chopra & J.S.Kanwar - Kalyani Publishers
8) Manual of soil, plant, water and fertilizer analysis, R.M. Upadhyay and N.L 5harma, KalyaniPublishers, New Delhi.
9) Environmental Chemistry by B.K.Sharma - Goel Publishing House, Meerut.
10) Soil Chemical Analysis by M.L. Jackson, Prentice-Hall India Pvt. Ltd., New Delhi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	3	3	2	
2	3	3	3			3	2	3	2	
3	3	5	3			2	2	3	2	
4	3	3	3			2	3	3	1	
5	3	3	2			3	3	3	1	

***1-Low *2- Medium *3- Strong**

R22AC44B: FORENSIC SCIENCE IN SOLVING CRIME

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand definition and difference between Forensic Science and Criminalists.
- Knowledge on major contributors to the development of Forensic Science.
- Understand the Importance of physical evidence.
- Knowledge on Forensic Technology solving crimes with advanced technology
- Understand the steps typically required to maintain appropriate health and safety standards at the crime scene.

UNIT-I:

Introduction to Forensic Science: Need and functions of Forensic science. Historical aspects of Forensic science. Development of Forensic Science Laboratories. Definitions and concepts in Forensic science. Basic principles of Forensic science. Scope of Forensic science. Governing principals of Forensic Science. Forensic Science in Indian scenario. Admissibility in Indian Courts. Frye standard andDaubert standard.

UNIT-II:

Divisions of Forensic Science

Branches of Forensic science and their importance. Hierarchical set up of various Government ForensicScience Laboratories.

Forensic Evidences: Concise of Forensic Physical, Biological, Chemical and Psychological evidences,Medico-Legal Cases. Legal and Scientific problems. Forensic intelligence and Interviews.

UNIT-III:

Crime Scene

Types of crime scenes. Safety measures at crime scenes. Role of First Responding Officer. Coordinationbetween police personnel and Forensic scientists at crime scenes. The evaluation of 5Ws (who? what? when? where? why?) and 1H (how?)

UNIT-IV:

Police and Forensic Science

Relationship between police and forensic expert, Role of Police at the Crime scene, scientific help at crime scene, Importance of Chain of custody, handling of various types of crime scenes by police, forensic teaching of police personals, forensic case documentation by Police, Technological Advance and Police, Mobile device forensics, Role of Media, Human Rights Commission & Criminal Justice System.

UNIT-V:

Administration and Organizational Setup:

DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTS, NCRB, BPR&D, Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic Science, American Board of Forensic Odontology, Bureau of Alcohol Tobacco and Firearms, Interpol and FBI, Australian Academy of Forensic Sciences. Forensic Science in India: Teaching Courses and Research fields in Forensic Science, Scope and jobs in Forensic Science.

REFERENCE BOOKS:

1) Max. M. Houck, Forensic Science: Modern Methods of Solving Crime.
2) U.S. Attroney's Bulletion: Forensic Science & Forensic Evidence.
3) Ross M. Gardeneer and Tom Bevel: Practical Crime scene analysis and reconstruction.
4) Dr. Karanam Satyanarayana: Step by step in police investigation and ground realities, Ist edition.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	2	2	3			3		3		
2		2	3	3		3		3		
3	3	2	3	2		3		2		
4	3	3	1	1		3		3		
5	2	3	3			3		3		

***1-Low *2- Medium *3- Strong**

R22AC44C: ENGINEERING CHEMISTRY

(ELECTIVE–C)

COURSE OUTCOMES:

- Knowledge on Chemistry of engineering materials and their applications.
- Understand the Principles of polymer chemistry and engineering applications of polymers.
- Knowledge on Principles of electro chemistry, electrochemical cells, Reference electrodes,
- Solar and fuel cells,Energy Storage Devices.
- Understand the mechanism of corrosion and Principles of corrosion control.
- Knowledge on analytical techniques and their importance.

UNIT-I: Engineering Materials

Refractories: Classification – Acidic, Basic and Neutral refractories; Properties: refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling; Preparation, Properties and applications of alumina, magnesite and zirconia bricks,

Composites: Introduction Constituents of Composites, types- Fibre reinforced Particulate and Layered composites and their applications.

Lubricants: Mechanism of lubrication, Liquid lubricants - properties: viscosity index, flash and fire points, cloud and pour points, oiliness; Solid lubricants - graphite and molybdenum sulphide.

UNIT-II: Polymer Chemistry:

Introduction, polymerization: types – addition and condensation polymerization; Mechanism of free radical addition polymerization with suitable example; Polymer Tacticity and Ziegler Natta polymerization (mechanism).

Plastics: Classification (Thermoplastic and thermosetting); Preparation, properties and uses of PVC, Teflon, Bakelite, Nylon-6,6.

Rubbers: Natural rubber, drawbacks of raw rubber, Vulcanization of rubber; Synthetic rubbers: Buna- S, Buna-N and Poly urethane.

UNIT-III: Electro Chemistry:

Electrode potential, Determination of single electrode potential; Nernst equation (problems); Electrochemical series – significance; Electro chemical cells, Reversible and irreversible cells, Reference electrodes – Standard Hydrogen electrode, Calomel electrode, Ion selective electrode (glass electrode) – measurement of pH;

Solar cells: Introduction, Solar Panels, Applications; Fuel Cells: Hydrogen – Oxygen Fuel Cell; Batteries: Lead – acid, NiCad and Lithium Batteries.

UNIT-IV: Corrosion and Corrosion Control:

Corrosion: Types of corrosion - Chemical or dry corrosion, Pilling – Bedworth rule; Electrochemical orwet corrosion; Galvanic corrosion, pitting, stress and differential aeration corrosion; factors influencing corrosion;

Corrosion control – sacrificial anodic method and impressed current cathodic methods, corrosion inhibitors; Protective coatings: Metallic coatings – electro plating (Au) and electroless plating (Ni). Paints – constituents and functions.

UNIT-V: Analytical Techniques:

Beer-Lambert's law; **Colorimetry**: principle, instrumentation (with block diagram) and Estimation of iron, **Flame photometry**: principle, instrumentation (with block diagram) and estimation of sodium; **A**tomic **A**bsorption **S**pectroscopy: principle, instrumentation (with block diagram) and estimation of nickel.

Conductometric titrations (Acid-Base) and Potentiometric titrations (Redox titrations–Fe^{2+} *vs* dichromate).

REFERENCE BOOKS:

1) P.C. Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi 15thedition (2010).
2) S.S. Dara & Mukkanti K. "A text book of engineering chemistry" S. Chand & Co. Ltd., NewDelhi (2006).
3) B. Sivasankar "Engineering Chemistry" Tata McGraw Hills co., New Delhi (2008).
4) Dr. B. K. Sharma, Instrumental methods of analysis, Krishna Prakashan Media, 2000.
5) Text Book of Engineering Chemistry by C.P. Murthy, C.V. Agarwal, A. Naidu B.S. Publications, Hyderabad (2006).
6) Engineering Chemistry by K. Maheswaramma, Pearson publishers 2015.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3	2	3		
2	3	3	2	3		3	1	3		
3	3	3	3	2		3	2	2		
4	3	3	2	1		3	2	3		
5	2	3	3	2		3	1	3		

***1-Low *2- Medium *3- Strong**

PRACTICAL-I:

R22AC45: CLASSICAL & INSTRUMENTAL METHODS OF ANALYSIS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) Estimation of total iron with different procedures using various reductants.
2) Analysis of zinc in zinc containing alloy using EDTA.
3) Analysis of nickel by EDTA.
4) Estimation of glucose.
5) Analysis of oil for the determination of saponification value, acid value and iodine value.
6) Estimation of chloride and iodide in a mixture by potentiometric method.
7) Determination of Fe(III) colorimetrically using potassium thiocyanate.
8) Estimation of amount of manganese by colorimetric procedure.

PRACTICAL-II:

R22AC46: PROJECT WORK / SPECTRAL PROBLEMS

TITLE SELECTION: 1) PROJECT WORK / 2) SPECTRAL PROBLEMS

1) **Project Work:** For University students- Project Work / Internship is compulsory and have to submita dissertation containing Back ground of the work, Experimental, Results and Discussion and Summary.

   ***In respect of Affiliated Colleges*-**Project work is optional for only colleges having doctorate degree faculty and students may opt for project work and others have to select *Spectral Problems paper*.

2) **Spectral Problems:** For students who selected spectral problems will be given spectra of two different compounds for structural elucidation along with Viva-voce. (A minimum of 10 representative examples should be studied in regular practical hours).

PRACTICAL-III:

R22AC47: COMPREHENSIVE VIVA-VOCE

1) The students will be analyzed with questions covering 3rd & 4th semester topics.

M.Sc. INORGANIC CHEMISTRY

SEMESTER-IV

R22IC41: PHOTO INORGANIC CHEMISTRY

COURSE OUTCOMES:

- Knowledge regarding photo chemical excitation process.
- Learn about the different photochemical processes like flourosence.
- Understand about the utility of sensitizers.
- Knowledge about the transitions, zero – zero spectroscopy.
- Application of redox process in estimating the life times.

UNIT-I:

Basics of Photochemistry: Absorption, excitation, photochemical laws, quantum yield, electronically excited states-life times- measurements of the times. Flash photolysis, stopped flow techniques. Energy dissipation by radiative and non radiative processes, absorption spectra, Frank- Condon principle, photo chemical stages- primary and secondary processes.

Properties of Excited States: Structure, dipole moment, acid-base strengths, reactivity. Photochemical kinetics - calculation of rates of radiative processes. Bio molecular deactivation- queching.

UNIT-II:

Excited States of Metal Complexes: Comparison with organic compounds, electronically excited states of metal complexes, charge-transfer spectra, charge transfer excitations, methods for obtaining charge – transfer spectra.

UNIT-III:

Metal Complex Sensitizers: Metal complex sensitizer, electron relay, metal colloid systems, semiconductor supported metal or oxide systems, water photolysis, nitrogen fixation and carbon dioxide reduction.

UNIT-IV:

Ligand Field Photochemistry: Photo substitution, photo oxidation and photo reduction, liability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero – zero spectroscopic energy, development of equations for redox potentials of the excited states – Energy transfer under conditions of weak interaction and strong interaction – excipliex formation, conditions for the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates.

UNIT-V:

Redox Reactions by Excited Metal Complexes: (2, 2'- bipyridine and 1,10-phenonthroline complexes). Illustration of reducing and oxidising character of Ruthenium 2+ (bipyridal complex, comparison with Fe(bipy)3, role of spin – orbit coupling – life time of these complexes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants into high energy products, chemical energy into light.

REFERENCE BOOKS:

1) Concepts of inorganic photochemistry – A.W. Adamson and P.D. Fleischauer, Wiley,
2) Inorganic photo Chemistry – J.Chem. Educ., Vol 60 No 10, 1983,
3) Progress in Inorganic Chemistry, Vol. 30, ed. S.J.Lippard, Wiley,
4) Coordination Chem. Revs , 1981, Vol. 39, 121, 131 ; 1975 ,15-321, 1990 , 97, 313
5) Photo chemistry of coordination compounds, V.Balzari and V.Carassiti, Academic Press,
6) Elements of Inorganic Chemistry, G.J.Ferraudi, Wiley.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3	2		2		2		
2	2	2	3	2		2		2		
3		3	2	1		3				
4	3	2	2			2				
5	3	3	3			3		2		

***1-Low *2- Medium *3- Strong**

R22IC42: PHYSICAL METHODS IN STRUCTURAL STUDIES

COURSE OUTCOMES:

- Knowledge versed with the SEM, TEM, X-ray diffraction analysis**.**
- Understand the difference between electron probe technique and ion prob technique.
- Knowledge on read and analyzing the spectra to understand the chemical bonds**.**
- Understand the resonance, splitting like concepts in determining the complex structures.
- Acquire the knowledge of fragmentation of complexes.

UNIT-I:

Electron Probe Techniques:

Scanning Electron Microscopy (SEM): Principle, Instrumentation, Applications. Electron ProbeX-Ray Analysis (EPXMA) – Principle, Instrumentation, Applications.

Auger Electron Spectorscopy (AES) - Principle, Instrumentation, Applications.

UNIT-II:

Ion Probe Techniques:

Rutherford Backscattering Spectrometry (RBS): Principle, Instrumentation, Applications. Secondary Ion Mass Spectrometry (SIMS) – Fundamental aspects of sputtering – Principle, Instrumentation (Static & dynamic), Applications.

Scanning Probe Microscopy Techniques: Scanning Tunneling Microscopy - Principle, Instrumentation, Applications. Atomic Force Microscopy – Principle, Instrumentation, Applications.

UNIT-III:

IR and Raman Spectroscopy: Theory - difference between IR and Raman spectra-basic instrumentation and general experimental techniques - typical applications in inorganic chemistry for structure elucidation, group frequencies of organic, inorganic and organo metallic systems, factors affecting the group frequencies, study of hydrogen bonding effects, vibrational spectra of ionic, coordination and metal carbonyl compounds.

UNIT-IV:

NMR Spectroscopy: Principle-basic instrumentation-chemical shifts-spin-spin coupling-typical applications in structure determination of inorganic compounds and complexes.

Introduction to 31P and 19F NMR.

ESR Spectroscopy: Principle-basic instrumentation-presentation of spectra - hyper fine splitting- illustrations for structural and reaction mechanistic studies in inorganic chemistry. ESR spectra of organic free radicals and ion radicals, transition metal complexes, applications.

UNIT-V:

MASS Spectrometry: Principle - theory-instrumentation-Applications.

X-RAY Diffraction Methods: X-Ray Photoelectron Spectroscopy – Principle – Instrumentation -Applications.

X-RAY Fluorescence, X-RAY Diffraction Method, Applications.

REFERENCE BOOKS:

1) J.L.Huheey:Inorganic Chemistry-Principles ,structure and reactions – Harper,
2) W.E.Addison: Structural Principles of Inorganic Compounds - Longmans,
3) R.S.Drago: Physical Methods in Inorganic Chemistry - Reinhold
4) K.B.Harvey and G.B.Porter: Physical Inorganic Chemistry - Addison-Weslay,
5) J.B.Ander and A.J.Sonnessa: Principles of Chemistry - Macmillan,
6) A.Barnard: Theoretical Basis of Inorganic Chemistry - Tata-McgrawHill.,
7) R. M. Silverstein, G. C. Bassler and T. C. Morrill: Spectrometric Identification of OrganicCompounds, Wiley.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	3		3	3		2	
2	3	3	3	2		2		2		
3	3	3	2	1		3		2		
4	3	3	3			3				
5	3	3	3			3		2		

***1-Low *2- Medium *3- Strong**

R22IC43A: INSTRUMENTAL METHODS IN INORGANIC ANALYSIS (ELECTIVE–A)

COURSE OUTCOMES:

- Apply green concept for solvent free reactions and used in sample treatment and instrument analysis.
- Knowledge on how to analyse the spectrums to determine the type of functional group by using Infrared Spectroscopy, and Raman Spectroscopy.
- Analyze to operate the different equipment i.e. hands on experience by using Nephelometry & Turbidimetry and Flourimetry & Phosphorimetry.
- Understand the hands on experience to do the analysis at high temp by using flame photometry.
- Analysis for the analytes at micro or even at nano level**.**

UNIT-I:

Electrogravimetry: Theory of electro analysis – Polarisation – Over voltage – Principles involvedin electro gravimetric analysis – current – voltage curves – separation of metals by electrolysis – constant current – controlled potential electrolysis.

Coulometry: Coulometry at controlled potential – separation of Nickel and Cobalt – coulometres–types of coulometric analysis – constant current coulometry - coulometric titrations.

UNIT-II:

Voltametry, Polarography and Amperometric Titrations:

Voltametry – Principle of Polarography – dropping mercury electrode; working; factors effecting the limiting current; residual current, migration current – diffusion current – kinetic current – polarographic maximum – Half wave potential – Organic Polarography, Rapid Scan polarography

-cyclic voltametry – qualitative and quantitative polarographic analysis – Amperometric titrations-its advantages and disadvantages – Bi-Amperometric titrations – Chrono potentiometry

UNIT–III:

Separation Methods: Solvent Extraction: General considerations - distribution ratio-percent extraction effectiveness of extraction classification of metal extraction systems-factors which effect chelate formation-process of extraction-quantitative treatment.

Techniques of Extraction: Choice of solvent-batch extraction-continuous extraction-back washing and stripping-treatment of emulsions.

Ion Exchange Methods in Chemical Analysis: Chemical structure of ion exchange resins, ion exchange Equilibria, selectivity, ion exchange capacity-application of ion-exchangers.,

UNIT-IV:

Chromatographic Techniques: (Principles-elementary theory and simple applications) General introduction- Column chromatography-chromatographic techniques and nomenclature -adsorption chromatography-partition chromatography-paper chromatography, Gel Chromatography.

UNIT-V:

Thin Layer Chromatography: Ion exchange chromatography Gas chromatography - Gas liquidchromatography (GLC) High Pressure Liquid Chromatography (HPLC) – Applications.

REFERENCE BOOKS:

1) A.I.Vogel: A text book of quantitative Inorganic Analysis-3rd Edition-ELBS,
2) J.W.Robbinson: Under-graduate Instrumental Analysis,
3) G.W.Eving: Instrumentation Methods of Chemical Analysis-McGraw-Hill.,
4) Willard, Merrit and Dean: Instrumental Methods of Analysis - D.Van Nostrand,
5) J.A.Barnard and R.Chayan: Modern Methods of Chemical Analysis,
6) G.H.Morrison and H.Frieser: Solvent Extraction in Analytical Chemistry-John Wiley.,
7) B.K.Sharma - Instrumental methods of chemical analysis, Goel Publishers,
8) G.Chatwal and S.Anand - Instrumental methods of chemical analysis,,
9) J.J.Lingane- Electroanalytical Chemistry- Inter Science,
10) D.A.Skoog, D.M.West and F.J.Holler - Fundamentals of Analytical Chemistry,
11) H.Kaur - Instrumental methods of chemical analysis, Pragathi Prakasan,
12) D.A.Skoog, F.J.Holler and Nieman- Instrumental Methods of Analysis.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	3		3	3	3	2	
2	3	3	3	3		2	1	2	1	
3	3	3	2	3		3	1	2	1	
4	3	3	3	2		3	1	2	1	
5	3	3	3	2		3	1	2	1	

***1-Low *2- Medium *3- Strong**

R22IC43B: INDUSTRIAL INORGANIC CHEMISTRY

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand the importance of Inorganic chemicals in chemical industry.
- Knowledge about role played by various inorganic compounds.
- Understand the Inorganic chemicals in Fertilizer industry.
- Knowledge on the applications of Inorganic fibres and inorganic fillers.
- Understand the hazardous chemicals and safety measures.

UNIT-I:

Inorganic Compounds and Industry: Importance of the chemical industry in India and abroad. Primary inorganic materials**:** Water, Hydrogen, Hydrogen peroxide and inorganic peroxo compounds, Nitrogen and nitrogen compounds, Phosphorous and phosphorous compounds, Sulphur and sulphur compounds and Halogens, halogen compounds and iodine and iodine compounds. Bulk and commodities chemicals: metals and their compounds: Metallic lithium and its compounds; Metallic sodium and sodium borates; Potassium and its compounds, KOH and K_2CO_3. Alkaline earth metals and its compounds: Beryllium and magnesium, Calcium, strontium and barium; Manganese and its compounds. Performance /function based fine and specialty chemicals

UNIT-II:

Fertiliser Industry: Introduction, Essential plant Nutrients, primary and secondary Nutrients, Micro- and Macro- nutrients. Classification of Fertilizers: Straight Fertilizers, Compound/Complex fertilizers, Nitrogenous fertilizers, Phosphatic fertilizers, and Potassic fertilizers. Nitrogenous fertilizers: Ammonium sulphate, Ammonium nitrate, Calcium ammonium nitrate, Calcium nitrate, Ammonium chloride and Urea. Phosphatic fertilizers: Ground rock phosphate, Single superphosphate and Triple superphosphate. Potassic fertilizers: Potassium chloride, Potassium sulphate and Potassium nitrate. Complex fertilizers: Ammonium phosphate sulphate, Ammonium phosphates, Mono- and Di-Ammonium phosphate, Nitrophosphates, Urea and NPK Complexfertilizers.

UNIT-III:

Core Inorganic Compounds in Industry Organo-Silicon Compounds:

Antifoamers, adhesives, coatings and in herbicides and fungicides. Inorganic solids: CsCl, NaCl, ZnS, NiAs, perovskite, spinels, corundum, beta tungsten and graphite. Zeolites and catalysts for water purification and softening. Inorganic fibers: glass fiber, amorphous fiber or rock wool, carbon fiber, alumina fiber and potassium titanate fiber. Construction materials: Enamel and ceramics. Carbon modifications: diamond, graphite, carbonization and graphitization, Glassy and foamed carbon and carbon black. Fillers - synthetic and natural fillers and their applications. Metallic hard materials.

UNIT-IV:

Inorganic Chemicals in Corrosion Protection: Fundamentals of corrosion. Corrosion related damage and types of corrosions. Corrosion problems and passivity. Methods of prevention and control: Protective coatings, inhibitors, cathodic and anodic protection and material selection and design improvement. Metal finishing and processing: Metal finishing and technological importance, process of electrodeposition of Copper and Nickel and Corrosion protection pigments. Inorganic pigments: TiO2, lithopone, ZnS, ZnO and Fe_2O_3; Luminescent pigments and magnetic pigments.

UNIT-V:

Industrial Hazards and Safety: Classification of hazardous chemicals, storage, transportation, handling, risk assessments, checklists, hazardous chemical surveys, safety program and safety reviews. Flammable material handling and fire fighting equipment, control measures for toxic chemicals, safety in laboratories, plants and in the transportation and storage of toxic chemicals. remote control systems, tear gas, chemical weapons and ocean dumping of chemical weapons. Chemical Explosives and safety measures. Hazardous waste management, bioconversion of waste materials to Industrial products. Industrial hygiene: air and biological monitoring, occupational diseases and personal protective equipment.

REFERENCE BOOKS:

1) Industrial Inorganic Chemistry by K H Buechel, H -H Moretto, P Woditsch; Wiley-VCH 2nd Ed.
2) Inorganic Chemistry: An Industrial and Environmental Perspective by T W Swaddle, AP 1997.
3) Industrial Chemistry, B.N. Chakrabarty, Oxford & IBH Publishing Co, New Delhi (1981).
4) Industrial Chemistry, B.K. Sharma Goel Publishing House, Meerut.
5) Introduction to Industrial Chemistry, Howard, W.L., Wiley-Interscience (1986).
6) Chemistry of Water Treatment, S.D. Faust and O.M. Aly, Butterworths (1983).
7) Principles of Industrial Chemistry, C. A. Clausen and G. Matts.
8) Safety and Hazards management in Chemical industries, Vyas M. N. Atlantic Publication (2013).
9) Safety evaluation of environmental chemicals, Dikshith T.S.S, New Age International, (1996)
10) Fertilizers, Organic Manures and Biofertilizers–A Product Quality Guide for Major & Micronutrients, HLS Tandon, Fertilizer Development and Consultation Organisation, New Delhi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	2	3	4	5	6	7	8	9	10
1	2	3	3	3		3	3	3	2	
2	2	3	3	3		2	2	2	2	
3	3	2	2	3		3	2	2	2	
4	3	3	3	3		3	2	2	2	
5	3	3	3	3		3	2	2	2	

***1-Low *2- Medium *3- Strong**

R22IC43C: QUALITY CONTROL & QUALITY ASSURANCE IN PHARMAINDUSTRY

(ELECTIVE–C)

COURSE OUTCOMES:

- Understand the basics of quality audit like SOP, ICH, ISO etc.
- Understand the various documentation processes and handling of materials.
- Understand the organizational responsibilities and personal responsibilities in the pharma sector.
- Knowledge about the regulatory aspects and quality control.
- Know about the Basic concepts of Quality Assurance.

UNIT-I:

Pharmaceuticals Concept of drug, lead compound and lead modification, prodrugs and soft drugs. Importance of quality control, drugs and pharmaceuticals, sources of impurities in pharmaceutical chemicals, analytical quality control in finished/final products, common methodsof assay.

UNIT-II:

Quality Audit, Documentation Quality audit. Standard operating procedure (SOP); international conference harmonization (ICH); ISO-9000; ISO-14000, WHO specifications, USFDA guidelines and ICMR. Documentation and Handling : Manufacturing documents, Master Formula, batch formula, Record, Distribution of records, Handling of returned goods, Recovered materials and Reprocessing.

UNIT-III:

Organization and Personnel Responsibilities Training, Hygiene, Premises: Location, Design, Plant layout, Construction, Maintenance and Sanitations. Environmental control, sterile areas, control of contamination.

UNIT-IV:

Regulatory Aspects and Quality Control Regulatory aspects. Validation of Personnel, Equipment and cleaning methods, regulatory aspects of pharmaceutics. Quality Control. In-processquality Control on various dosage forms, Sterile and non-sterile operations.

UNIT-V:

Basic concepts of Quality Assurance Basic concepts, principles or prescription, Needs, requirements and expectations, characteristics of quality, Achieving, sustaining and improving quality, Quality dimensions and costs of quality. Elements of quality Assurance, Quality Management System, Quality management concepts and principles: ISO 9001:2000, QMS Case studies on ISO 9001: 2000 in chemical industries.

REFERENCE BOOKS:

1) R. Pannerselvam, Production and Operations Management, Prentice Hall India LearningPvt. Ltd 3rd Ed., 2012.
2) M. Savsar, Quality Assurance and Management, InTech-Croatia, 2012, ISBN 978-953-51-0378-3.
3) D.C. Montgomery, Statistical Quality Control, John Wiley & Sons, 5th Ed., 2005.
4) M. K. Starr, Production and Operations Management, Biztantra, Delhi, 2004.
5) D.H. Shah, QA Manual, Business Horizons, 2000.
6) D.H. Besterfield, C. Besterfield-Michna, G.H. Besterfield, M. Besterfield Sacre, TotalQuality Management, Pearson Education, Inc., 3rd Ed., 2003.
7) P. Konieczka, J. Namiesnik, Quality Assurance and Quality Control in the AnalyticalChemical Laboratory: A Practical Approach, 1st Ed., CRC press 2009.
8) D. Hoyle, ISO 9000 Quality Systems Handbook, 5th Ed., Butterworth Heinemann-Elsevier,New York, 2006.
9) E. Prichard, V. Barwick, Quality Assurance in Analytical Chemistry, John Wiley & Sons,2007.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2	3	3	3		2	2
2	3	2	2	2	2	3	3	1	2	2
3	3	3	3	2	3	3	3	3	2	2
4	3	2	2	2	2	3		2	2	2
5	3	3	3	2	3	2		2	1	2

***1-Low *2- Medium *3- Strong**

R22IC44A: ENVIRONMENTAL CHEMISTRY

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand the soil development and various nutrients present in the soil.
- Understanding the water quality parameters and various pollutants causing water pollution.
- Understand effects of specific pollutants.
- Understand waste water treatment methods.
- Understanding the methods for analysis of soil, air and water samples.

UNIT-I:

Significance of basic segments of environment - Nomenclature in the study of environmental chemistry, Soil chemistry & pollution studies: Principles of weathering - effect of temperature, water, air, plants and animals on weathering, Soil formation / development - factors affecting soil development - physical properties of soil; soil colloids-ion exchange properties., Soil fertility, productivity- Soil micro and macro nutrients.

UNIT-II:

Air Pollution: General classification of atmospheric regions and significance - Chemical reactionstaking place in atmosphere Structure and properties-study of temperature inversion phenomenon. Depletion of stratospheric ozone and its effect on environment. Atmospheric sources and emission of air pollutants with special reference to particulate and radioactive substances. Analysis of carbon mono oxide-sulphur dioxide-hydrogen sulphide, hydrocarbons, aromatic hydrocarbons.

UNIT-III:

Hydrosphere and Water Pollution: Hydrosphere-water resources-hydrological cycle-unique properties of water- water quality parameters-domestic water pollution-industrial, agricultural, solid waste, thermal, shipping water pollution and radioactive waste pollution.

UNIT-IV:

Effect of specific pollutants like mercury, lead, arsenic, selenium, nitrates, oil., Effects of soaps, detergents, pesticides, hydrocarbon with regard to water pollution., Determination of D.O., COD, BOD, phosphates, nitrogen compounds.

UNIT-V:

Monitoring And Treatment Methods in case of Air Pollution, Water Pollution & Control: Continuous monitoring of air pollutants and control - Principles, Monitoring instruments, monitoring of sulphur dioxide, hydrogen sulphide, oxides of nitrogen, oxides of carbon, hydrocarbons, ozone, suspended particulate matter and radioactive substances., Techniques of water treatment - Primary, secondary and tertiary methods-use of coagulants-flash distillation-solarstills, ion exchange, reverse osmosis, electro analysis, electro dialysis.

REFERENCE BOOKS:

1) Standard methods of Examination of Water and Waste Water,
2) H.D. Forth and L.M. Turk-Fundamentals of Soil Science: Wiley-Eastern Pvt. Ltd.,
3) J. Drever-The Geochemistry of Natural Waters-Prentice Hall Inc.,
4) N.F. Voznaya-Chemistry of water and microbiology-Mir Publishers,
5) F.I. Belan-Water Treatment-Mir Publishers,
6) J.A. Daji-Text Book of Soil Science-Media Promoters and Publishers,
7) AK. De-Environmental Chemistry-Wiley Eastern Ltd.,,
8) B.K. Sharma-Environmental Chemistry - Pragathi Prakasan,
9) L.M. Thomson, F.R. Troch-Soils and Soil fertility- Tata Mc Graw Hill,
10) V.V. Metelev, A.I.Kanaev and N.G. Dzasokhova-Water Toxicology-Amorin Publish Co.,
11) N.C. Brady and Beckmann-Nature and Properties of Soils-Eurasia Publishing Co.,
12) S.S. Dara - A Text Book of Environmental Chemistry and Pollution Control,
13) O.D. Thyagi and M.Mehra - A text Book of Environmental Chemistry – Anamol,
14) S.M. Khopkar – Environmental Pollution Analysis.
15) Soil Chemical Analysis by M.L. Jackson, Prentice-Hall India Pvt. Ltd., New Delhi.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3			3	3	3	2	
2	3	3	3			3	2	3	2	
3	3	5	3			2	2	3	2	
4	3	3	3			2	3	3	1	
5	3	3	2			3	3	3	1	

***1-Low *2- Medium *3- Strong**

R22IC44B: FORENSIC SCIENCE IN SOLVING CRIME (ELECTIVE–B)

COURSE OUTCOMES:

- Understand definition and difference between Forensic Science and Criminalists.
- Knowledge on major contributors to the development of Forensic Science.
- Understand the Importance of physical evidence.
- Knowledge on Forensic Technology solving crimes with advanced technology
- Understand the steps typically required to maintain appropriate health and safety standards at the crime scene.

UNIT-I:

Introduction to Forensic Science: Need and functions of Forensic science. Historical aspects of Forensic science. Development of Forensic Science Laboratories. Definitions and concepts in Forensic science. Basic principles of Forensic science. Scope of Forensic science. Governing principals of Forensic Science. Forensic Science in Indian scenario. Admissibility in Indian Courts.Frye standard and Daubert standard.

UNIT-II:

Divisions of Forensic Science

Branches of Forensic science and their importance. Hierarchical set up of various Government Forensic Science Laboratories.

Forensic Evidences: Concise of Forensic Physical, Biological, Chemical and Psychological evidences, Medico-Legal Cases. Legal and Scientific problems. Forensic intelligence and Interviews.

UNIT-III:

Crime Scene

Types of crime scenes. Safety measures at crime scenes. Role of First Responding Officer. Coordination between police personnel and Forensic scientists at crime scenes. The evaluation of 5Ws (who? what? when? where? why?) and 1H (how?)

UNIT-IV:

Police and Forensic Science

Relationship between police and forensic expert, Role of Police at the Crime scene, scientific help at crime scene, Importance of Chain of custody, handling of various types of crime scenes by police, forensic teaching of police personals, forensic case documentation by Police, Technological Advance and Police, Mobile device forensics, Role of Media, Human Rights Commission & Criminal Justice System.

UNIT-V:

Administration and Organizational Setup:

DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTS, NCRB, BPR&D, Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic Science, American Board of Forensic Odontology, Bureau of Alcohol Tobacco and Firearms, Interpol and FBI, Australian Academy of Forensic Sciences. Forensic Science in India: Teaching Courses and Research fields in Forensic Science, Scope and jobs in Forensic Science.

REFERENCE BOOKS:

1) Max. M. Houck, Forensic Science: Modern Methods of Solving Crime.
2) U.S. Attroney's Bulletion: Forensic Science & Forensic Evidence.
3) Ross M. Gardeneer and Tom Bevel: Practical Crime scene analysis and reconstruction.
4) Dr. Karanam Satyanarayana: Step by step in police investigation and ground realities, Istedition.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	2	2	3			3		3		
2		2	3	3		3		3		
3	3	2	3	2		3		2		
4	3	3	1	1		3		3		
5	2	3	3			3		3		

***1-Low *2- Medium *3- Strong**

R22IC44C: ENGINEERING CHEMISTRY

(ELECTIVE–C)

COURSE OUTCOMES:

- Knowledge on Chemistry of engineering materials and their applications.
- Understand the Principles of polymer chemistry and engineering applications of polymers.
- Knowledge on Principles of electro chemistry, electrochemical cells, Reference electrodes, Solar and fuel cells,Energy Storage Devices.
- Understand the mechanism of corrosion and Principles of corrosion control.
- Knowledge on analytical techniques and their importance.

UNIT-I: Engineering Materials

Refractories: Classification – Acidic, Basic and Neutral refractories; Properties: refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling; Preparation, Properties and applications of alumina, magnesite and zirconia bricks,

Composites: Introduction Constituents of Composites, types- Fibre reinforced Particulate and Layered composites and their applications.

Lubricants: Mechanism of lubrication, Liquid lubricants - properties: viscosity index, flash and fire points, cloud and pour points, oiliness; Solid lubricants - graphite and molybdenum sulphide.

UNIT-II: Polymer Chemistry

Introduction, polymerization: types – addition and condensation polymerization; Mechanism of free radical addition polymerization with suitable example; Polymer Tacticity and Ziegler Natta polymerization (mechanism).

Plastics: Classification (Thermoplastic and thermosetting); Preparation, properties and uses of PVC, Teflon, Bakelite, Nylon-6,6.

Rubbers: Natural rubber**,** drawbacks of raw rubber**,** Vulcanization of rubber; Synthetic rubbers: Buna-S, Buna-N and Poly urethane.

UNIT-III: Electro Chemistry

Electrode potential, Determination of single electrode potential; Nernst equation (problems); Electrochemical series – significance; Electro chemical cells, Reversible and irreversible cells, Reference electrodes – Standard Hydrogen electrode, Calomel electrode, Ion selective electrode (glass electrode) – measurement of pH;

Solar cells: Introduction, Solar Panels, Applications;**Fuel Cells**: Hydrogen – Oxygen Fuel Cell; **Batteries**: Lead – acid, NiCad and Lithium Batteries.

UNIT-IV: Corrosion and Corrosion Control

Corrosion: Types of corrosion - Chemical or dry corrosion, Pilling – Bedworth rule; Electrochemical or wet corrosion; Galvanic corrosion, pitting, stress and differential aeration corrosion; factors influencing corrosion;

Corrosion Control – Sacrificial anodic method and impressed current cathodic methods, corrosion inhibitors; Protective coatings: Metallic coatings – electro plating (Au) and electroless plating (Ni). Paints – constituents and functions.

UNIT-V: Analytical Techniques

Beer-Lambert's law; **Colorimetry**: principle, instrumentation (with block diagram) and Estimation of iron, **Flame photometry**: principle, instrumentation (with block diagram) and estimation of sodium; **A**tomic **A**bsorption **S**pectroscopy: principle, instrumentation (with block diagram) and estimation of nickel.

Conductometric titrations (Acid-Base) and Potentiometric titrations (Redox titrations – Fe^{2+} *vs* dichromate).

REFERENCE BOOKS:

1) P.C. Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi 15^{th} edition(2010).
2) S.S. Dara & Mukkanti K. "A text book of engineering chemistry" S. Chand & Co. Ltd., New Delhi(2006).
3) B. Sivasankar "Engineering Chemistry" Tata McGraw Hills co., New Delhi (2008).
4) Dr. B. K. Sharma, Instrumental methods of analysis, Krishna Prakashan Media, 2000.
5) Text Book of Engineering Chemistry by C.P. Murthy, C.V. Agarwal, A. Naidu B.S. Publications,Hyderabad (2006).
6) Engineering Chemistry by K. Maheswaramma, Pearson publishers 2015.

OUTCOME MAPPING:

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1	3	3	3	2		3	2	3		
2	3	3	2	3		3	1	3		
3	3	3	3	2		3	2	2		
4	3	3	2	1		3	2	3		
5	2	3	3	2		3	1	3		

***1-Low *2- Medium *3- Strong**

PRACTICAL-I:

R22IC45: CLASSICAL & INSTRUMENTAL METHODS OF ANALYSIS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

1) Estimation of total iron with different procedures using various reductants.
2) Analysis of zinc in zinc containing alloy using EDTA.
3) Analysis of nickel by EDTA.
4) Estimation of glucose.
5) Analysis of oil for the determination of saponification value, acid value and iodine value.
6) Estimation of chloride and iodide in a mixture by potentiometric method.
7) Determination of Fe(III) colorimetrically using potassium thiocyanate.
8) Estimation of amount of manganese by colorimetric procedure.

PRACTICAL-II:

R22IC46: PROJECT WORK / SPECTRAL PROBLEMS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

Title Selection: 1) Project Work / 2) Spectral Problems

1) **Project Work:** For University students- Project Work / Internship is compulsory and have to submit a dissertation containing Back ground of the work, Experimental, Results and Discussion and Summary.

   In respect of Affiliated Colleges-Project work is optional for only colleges having doctorate degree faculty and students may opt for project work and others have to select *Spectral Problems paper*.

2) **Spectral Problems:** For students who selected spectral problems will be given spectra of two different compounds for structural elucidation along with Viva-voce. (A minimum of 10 representative examples should be studied in regular practical hours).

PRACTICAL-III:

R22IC47: COMPREHENSIVE VIVA-VOCE

1) The students will be analyzed with questions covering 3rd & 4th semester topics.

M.Sc. ORGANIC CHEMISTRY

SEMESTER-IV

R22OC41: ORGANIC SPECTROSCOPY-II

COURSE OUTCOMES:

- Understand the fundamentals of ^{13}C NMR techniques and apply the spectroscopy knowledge for the structural elucidation organic compounds.
- Knowledge on the instrumentation of Mass, types of fragmentation, investigate the structural information of molecules Mass spectroscopic techniques.
- Understand the spectral problems involving 2D NMR techniques.
- Apply the spectroscopy knowledge for the structural elucidation of natural products.
- Knowledge on Spectral Problems involving all spectral data UV-Vis. ^{1}H NMR, ^{13}C NMR, Mass spectrometry & 2D NMR techniques.

UNIT-I:

^{13}C NMR Spectroscopy:

Types of 13C NMR spectra, Undecoupled, proton- decoupled, single frequency off-resonance decoupled (SFORD) and selectively decoupled spectra. Signal enhancement by Nuclear OVER HAUSER effect. ^{13}C chemical shifts, factors affecting the chemical shifts. Noise decoupled and off-resonance spectra of simple Compounds. Calculation of chemical shifts of alkanes, alkenes, alkynes, and aromatic compounds. Typical examples of CMR spectroscopy –problems.

UNIT-II:

Mass Spectroscopy:

Introduction, Principles of Ionization Methods: EI, CI, FDI, PDI, LDI, FAB, TSI and ESI, Types of mass analyzers; Types of fragments-odd electron and even electron containing neutral and charged species (even electron rule), nitrogen rule, molecular-ion peak, base peak, metastable ion, isotopic abundance. High Resolution-MS (HRMS), index of hydrogen deficiency (IHD). Fragmentation of typical organic compounds-hydrocarbons, aromatics, alcohols, alkyl halides, ethers, Carbonyls, carboxylic acids, esters, amines, amides, nitro compounds. General methods of mass spectral fragmentation-β-cleavage, Mclafferty rearrangement, retro Diels-Alder fragmentation and ortho effect. Factors affecting fragmentation-Mass spectra related problems.

UNIT-III:

2D NMR Techniques:

Principles of 2D NMR, classification of 2D-experiments, 2D-J-resolved spectroscopy. Correlation spectroscopy (COSY), HOMO COSY (^{1}H-^{1}H COSY), COSY of *m*-dinitrobenzene, isopentyl acetate, Hetero COSY (1H, ^{13}C COSY) Hetero COSY of isopentyl

acetate and 4- methyl-2-pentanol, HMQC, HMQC of codeine, long range ^{1}H, ^{13}C COSY (HMBC), HMBC of codeine and NOESY, NOESY of 9-benzylanthracene, 2-D INADEQUATE experiments.

UNIT-IV:

Spectral Characteristics of Natural Products involving all Spectral Data: Use of spectroscopic methods UV, IR, ^{1}H and ^{13}C NMR and Mass spectra in the structure elucidation ofnatural products. Illustration with suitable compounds like Apigenin (Flavone), Kaempferol (flavonol), Umbelliferone (coumarin), Camphor (Terpenoid), Lawsone (Naphthoquinone), Papaverine (Alkaloid), and Equilenine (steroid).

UNIT-V:

Spectral Problems:

Applications of ^{13}C NMR spectroscopy: Stereochemistry, and reaction mechanisms. Applications of ^{1}H NMR spectroscopy: Stereochemistry-Geometrical and optical isomerism. Spectral Problems involving all spectral data UV-Vis. ^{1}H NMR, ^{13}C NMR, Mass spectrometry &2D NMR techniques.

REFERENCE BOOKS:

1) Spectrometric identification of organic compounds by R.N.Silverstein & G.C.Bassier (John Willey)
2) Spectroscopic methods in Organic Chemistry by Williams and Fleming (McGraw Hill).
3) Organic photochemistry by R.O.Kan (Mc Graw Hill)
4) Advanced organic Chemistry Reaction Mechanisms and Structure by J March (Mc Graw Hill & Kogshusha).
5) Carbon-13 NMR Spectroscopy by J.B. Stothers.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	3	2	3	3	3	3	
2	3	3	3	3	2	3	1	3	3	
3	3	3	3	3	2	3	1	2	2	
4	3	3	3	2	2	3	1	3	2	
5	3	3	3	2	1	2	1	3	2	

***1-Low *2- Medium *3- Strong**

R22OC42: ORGANIC SYNTHESIS & REACTION MECHANISMS-II

COURSE OUTCOMES:

- Understand the fundamental tools required for the determination of reaction mechanisms.
- Knowledge on free radicals and their reactions, addition, substitution, decomposition reactions of free radicals.
- Apply the reagents and approaches for various synthetic reactions involving Oxidations and reductions.
- Understand for Reducing agents for various organic molecules and its synthetic utility.
- Knowledge on asymmetric synthesis provides a platform for carryout various stereochemical reactions wherever necessary to apply towards research.

UNIT-I:

Formation of C-C Single & Double Bonds and Diels–Aider & Related Reactions:

Formation of C-C single bonds–enamines and related reactions.

Formation of C-C double bonds–Corey-winter olefination, Peterson olefination, Julia olefination, McMurry coupling, witting reaction of Phosphorus ylides–stereoselective synthesis of tri and tetra- substituted alkenes.

Diels–Aider and related reactions – diene-dienophile, intramolecular Diels –Alder reactions, Stereochemistry and mechanism Retro Diels – Alder reaction –1, 3-dipolar reactions.

UNIT-II:

Synthetic Strategies or Retro Synthetic Analysis: Terminology- Target Molecule(TM), synthon, synthetic equivalent, functional group interconversion (FGI), and representation of disconnection of bonds. Linear and convergent synthesis. One group and two group disconnections in simple molecules- Alcohols, Olefins, aryl ketones, α,β-Unsaturated compounds. 1,3 dicarbonyl compounds. synthesis involving chemoselectivity, regioselectivity, reversal of polarity and cyclizations.

UNIT-III:

Photochemistry: Photochemistry of olefins–conjugated olefins–Aromatic compounds-isomerisation–additions. Photochemistry of carbonyl compounds–Norrish type I and II reactions–Paterno–Buchi Reaction. Photo reduction, Photochemical rearrangements–Photo Fries rearrangement, Di-π-methane rearrangement.

UNIT-IV:

Pericyclic Reactions: Definition, classification, MO theory, Electronic configuration in ground and first excited states of aliphatic conjugated polyene system (upto 4 double bonds).

Electrocyclic Reactions: Mechanism, stereochemistry, PMO, FMO, correlation diagram, Woodward Hoffman rules. **Cycloaddition Reactions**: FMO and correlation diagram methods- (2+2) and (4+2) cycloaddition reactions, stereochemistry. Woodward Hoffman rules.

Sigmatropic Rearrangement: classification, Mechanism by FMO method, Woodward Hoffmanrules. Cope, claisen and Aza-cope rearrangements.

UNIT-V:

Asymmetric Synthesis-II: Substrate Controlled Asymmetric Synthesis: Nucleophilic additions to chiral carbonyl compounds. 1, 2- asymmetric induction, Cram's rule, and Felkin-Anhmodel. i) Chiral auxiliary controlled asymmetric synthesis: Į-Alkylation of chiral Enolates, aza enolates, 1,4-Asymmetric induction and Prelog's rule. Use of chiral auxiliaries in DielsAlder and Aldol reactions. ii) Chiral reagent controlled asymmetric synthesis: Asymmetric reductions using BINAL-H.; Asymmetric Hydroboration using $(IPC)_2$ BH and $IPCBH_2$.

REFERENCE BOOKS:

1) Some Modern methods of synthesis By Caruthers (Cambridge)
2) Organic synthesis by Robert & Ireland (Printce Hall of India)
3) Designing Organic Synthesis B staurt Warron, John Wiley & Sons
4) "Pericyclic reactions a mechanistic study" S.M. Mukheji
5) Synthetic approaches in Organic Chemistry " R.K. Bansal Narosa Publications
6) Advances in Organic Chemistry – Reaction mechanism and structure" by J. March (Mc GrawHill).
7) 'Organic Photo chemistry and Pericyclic reactions' M.G. Arora Anmol Publications Pvt. Ltd.
8) Fundamentals of photochemistry by K.K. Rohatgi–Mukharjee Now Age international publishers.
9) Photochemistry by C W S Wells.
10) Organic Photochemistry by Turro.
11) Molecular Photo chemistry by Gilbert & Baggo.
12) Organic Photo chemistry by D Coyle.
13) Asymmetric synthesis by Nogradi.
14) Asymmetric organic reactions, J. D. Morrison and H. S. Moschcr.
15) Principles of Asymmetric synthesis, R. E. Gawley and J. Aube, 2nd Ed., Elsevier, 2012.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3	2			
2	3	2	2	1		3	2	1		
3	3	3	3	1		3		3		
4	3	2	2	1		3		2		
5	3	3	3	2		2		2		

***1-Low *2- Medium *3- Strong**

R22OC43A: ADVANCED ORGANIC CHEMISTRY

(ELECTIVE–A)

COURSE OUTCOMES:

- Understand novel named reactions and applications in modern organic synthesis.
- Understand the importance and principles of green chemistry, microwave assisted reactions and know applying the green synthesis to organic reactions.
- Knowledge on current importance of Nanochemistry in various fields and their synthetic methods (Solid and Gase phase).
- Knowledge of using organoboranes and organosilanes in organic synthesis.
- Understand requirements of guest and host and formation of building blocks of supramolecular chemistry.

UNIT-I

Advanced named Reactions in Organic Synthesis:

Baylis-Hillmon reaction, RCM Olefin metathesis, Grubb's catalyst, Mitsunobu reaction, Suzuki Coupling, Heck Coupling, Stille Coupling, Sonagashia, Coupling, Negishi Coupling, Hiyama Coupling, Buchwold – Hartwig Reaction, Click Reaction.

UNIT-II

Nano Chemistry

Introduction, Carbon Nanotubes: structure of single and multi wall carbon nanotubes, synthesis-solid and gaseous carbon source-based production techniques, synthesis with controlled orientation. Growth mechanism of carbon nanotubes-catalyst free growth, catalyst activated growth, nano buds, nanotorus properties-general, adsorption, electronic & optical, Mechanical and reactivity. Defects, Toxicity Applications.

UNIT-III:

Green Synthesis:

Introduction, Principles, Green solvents- supercritical fluids, water, ionic liquids and PEGs as green solvents for organic reactions. Examples of green reactions-synthesis of Ibuprofen, Clean Fischer-Indole synthesis comparison of the above with conventional methods.

Microwave Organic Synthesis: Introduction, Applications: Microwave-assisted reactions in water (oxidation of toluene to benzoic acid, oxidation of alcohols); organic solvents (Diels-Alder reaction and Decarboxylation); solvent-free reactions (solid state reaction)-Michael addition and Knoevenagel reaction), multistep V/s single pot synthesis.

UNIT-IV:

Organoboranes and Silanes:

Organoboranes: Synthetic applications of organoboranes–protonolysis, oxidation, carbonylation Reaction of alkenyl borane –enantioselective synthesis of secondary alcohols from alkenes.

Organosilanes: Synthesis of organosilanes, general features of carbon-carbon bond forming reactions of organosilicon compounds, addition reactions with aldehydes and ketones, acylation reactions, conjugate addition reactions.

UNIT-V:

Supramolecular Chemistry: Introduction- the meaning of supramolecular chemistry, phenomenon of molecular recognition and their quantification Building blocks of supramolecular chemistry- acyclic receptors for neutral and charged guests, macrocycles and crown ethers, macrobicycles and cryptands, macropolycycles, cucurbituril and cyclodextrins.

REFERENCE BOOKS:

1) New trends in green Chemistry by V.K. Ahluwalia
2) Organic synthesis by Robert & Ireland (Printce Hall ofIndia)
3) Designing Organic Synthesis B staurt Warron, John Wiley &Sons
4) Green chemistry, V.K. Ahluwalia, Ane books.
5) P.T. Anastas and J.C. Warner, Green chemistry, Oxford.
6) G.A.Ozin, A.C. Arsenault Nano chemistry, RSC.
7) Diwan, Bharadwaj, Nanocomposites, Pentagon.
8) V.S. Muralidharan, A. Subramania, Nanoscience and Technology, Ane Books.
9) J.W Steed and J.L Atwood, Supramolecular chemistry, John Wiley & Sons, Ltd. New York.
10) Piet W. N. M. van Leeuwen, Supramolecular Catalysis, Wiley-VCH Verlag GmbH & Co.
11) Principles and methods in supramolecular chemistry, Hans-Jorg Schneider and A. Yatsimirsky, John Wiley and Sons.
12) Analytical Chemistry of Macrocyclic and Supramolecular Compounds, S.M. Khopkar, Narosa Publishing House.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3			3		3		
2	3	3	3			3		3		
3	3	3	3			3	2	3		
4	3	2	3			3	1	3		
5	3	2	3			2		3		

***1-Low *2- Medium *3- Strong**

R22OC43B: ENGINEERING CHEMSITRY

(ELECTIVE–B)

COURSE OUTCOMES:

- Knowledge on Chemistry of engineering materials and their applications.
- Understand the Principles of polymer chemistry and engineering applications of polymers.
- Knowledge on Principles of electro chemistry, electrochemical cells, Reference electrodes, Solar and fuel cells,Energy Storage Devices.
- Understand the mechanism of corrosion and Principles of corrosion control.
- Knowledge on analytical techniques and their importance.

UNIT-I: Engineering Materials

Refractories: Classification – Acidic, Basic and Neutral refractories; Properties: refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling; Preparation, Properties and applications of alumina, magnesite and zirconia bricks,

Composites: Introduction Constituents of Composites, types- Fibre reinforced Particulate and Layered composites and their applications.

Lubricants: Mechanism of lubrication, Liquid lubricants - properties: viscosity index, flash and fire points, cloud and pour points, oiliness; Solid lubricants - graphite and molybdenum sulphide.

UNIT-II: Polymer Chemistry

Introduction, polymerization: types – addition and condensation polymerization; Mechanism of free radical addition polymerization with suitable example; Polymer Tacticity and Ziegler Natta polymerization (mechanism).

Plastics: Classification (Thermoplastic and thermosetting); Preparation, properties and uses of PVC, Teflon, Bakelite, Nylon-6,6.

Rubbers: Natural rubber**,** drawbacks of raw rubber**,** Vulcanization of rubber; Synthetic rubbers: Buna-S, Buna-N and Poly urethane.

UNIT-III: Electro Chemistry

Electrode potential, Determination of single electrode potential; Nernst equation (problems); Electrochemical series – significance; Electro chemical cells, Reversible and irreversible cells, Reference electrodes – Standard Hydrogen electrode, Calomel electrode, Ion selective electrode (glass electrode) – measurement of pH;

Solar cells: Introduction, Solar Panels,
Applications;**Fuel Cells**: Hydrogen – Oxygen
Fuel Cell; **Batteries**: Lead – acid, NiCad and
Lithium Batteries.

UNIT-IV: Corrosion and Corrosion Control

Corrosion: Types of corrosion-Chemical or dry corrosion, Pilling–Bedworth rule; Electrochemical or wet corrosion; Galvanic corrosion, pitting, stress and differential aeration corrosion; factors influencing corrosion;

Corrosion Control–sacrificial anodic method and impressed current cathodic methods, corrosion inhibitors; Protective coatings: Metallic coatings–electro plating (Au) and electroless plating (Ni). Paints–constituents and functions,

UNIT-V: Analytical Techniques

Beer-Lambert's law; Colorimetry: principle, instrumentation (with block diagram) and Estimation of iron, Flame photometry: principle, instrumentation (with block diagram) and estimation of sodium; **A**tomic **A**bsorption Spectroscopy: principle, instrumentation (with block diagram) and estimation of nickel.

Conductometric titrations (Acid-Base) and Potentiometric titrations (Redox titrations–Fe^{2+} *vs* dichromate).

REFERENCE BOOKS:

1) P.C. Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi 15thedition (2010).
2) S.S. Dara & Mukkanti K. "A text book of engineering chemistry" S. Chand & Co. Ltd., NewDelhi (2006).
3) B. Sivasankar "Engineering Chemistry" Tata McGraw Hills co., New Delhi (2008).
4) Dr. B. K. Sharma, Instrumental methods of analysis, Krishna Prakashan Media, 2000.
5) Text Book of Engineering Chemistry by C.P. Murthy, C.V. Agarwal, A. Naidu B.S. Publications,Hyderabad (2006).
6) Engineering Chemistry by K. Maheswaramma, Pearson publishers 2015.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3	2		3	2	3		
2	3	3	2	3		3	1	3		
3	3	3	3	2		3	2	2		
4	3	3	2	1		3	2	3		
5	2	3	3	2		3	1	3		

***1-Low *2- Medium *3- Strong**

R22OC44A: CHEMISTRY OF ANTIBIOTICS AND DRUGS

(ELECTIVE–A)

COURSE OUTCOMES:

- Knowledge on chemistry of Antibiotics, synthesis, and their importance and various drugs used in medicinal chemistry.
- Understand Chemotherapy and drugs for anticancer agents and its synthesis and Knowledge on CNS stimulants, depressants, and mode of action of Sedatives & Hypnotics.
- Knowledge on chemistry of structures and synthesis of some antimalarials and sulpha drugs used in medicine.
- Knowledge on chemistry of structures and synthesis of some antiseptic and Antifungals agents used in medicine.
- Identify the classification of herbal drugs in various types and understand their therapeutic efficacy and isolation methods.

UNIT-I:

Antibiotics:

Synthesis of penicillin-G, ampicillin, amoxicillin, chloramphenicol, cephalosporin. Streptomycin, tetracyclines, Terramycin, aureomycin, gramicidin.

UNIT-II:

Drugs and Medicinal chemistry:

Anticancer Agents: Synthesis & Activity relationship of Taxol, Vinblastine, Vincristine, Camptothecin.

CNS Stimulants: Strychnine (CNS activity only), caffeine, Nicotine; CNS depressants, Generalanesthetics, mode of action of Sedatives & Hypnotics.

UNIT-III:

Antimalarials: Paludrin – quinacrin – chloroquin – camoquin – pamaquin – sontoquine.

Sulpha Drugs: Sulphanilamide – Dihydrocurprine – Prontosil

UNIT-IV:

Antiseptics and Antifungal agents

Antiseptics: Common types, triclosan, aminacrine hydrochloride. Antiseptics *Vs* Disinfactants-Properties, Mechanism of action, classification

Antifungal Agents: 1,8-dihydroxyanthranol – griseofulvin.

UNIT-V

Herbal Drugs: i) Classification of herbal drugs- Pharmacological and Chemical classification. ii) Adulteration and evaluation of drugs. iii) Different chemical groups of Herbal drugs- Alkaloids, Terpenoids, Glycosides, Volatile oils, Isolation of volatile oils, Tannins, and carbohydrates.

iv) Herbal drugs and their therapeutic efficacy. Isolation of- Laxative-Aloe- emodin from Aloes. Anti-diabetics- Neem oil (Neem); Anti-malarial- Quinine (cinchona); Anti-hypertensive- Reserpine (rauwolfia).

REFERENCE BOOKS:

1) Introduction to Medicinal Chemistry – Wiley VCH.
2) Text Book of Organic Medicinal and Pharmaceutical Chemistry, Wilson and Gisvild, (ed Robert F. Dorge).
3) An introduction to drug design by SS Pandeya.
4) Buger's Medicinal Chemistry and drug discovery Vol.I by (Ed) ME Wolff – John – Wileyby A. Burger.
5) The Organic Chemistry of drug design and drug action by RB Silverman, Academic press.
6) Principles of Medicinal Chemistry by William O. Foye, Lea & Febiger, Philadelphia / London, 1989.
7) Natural products. By P.S. Kalsi
8) Medicinal chemistry. By Chatwal- And by Ashtoshkar.
9) Chemistry of Drugs. By V.N.Ivers.
10) May's chemistry of synthetic drugs. Hand Book of Reagents for organic synthesis. ByReich, Rigby.
11) Top Drugs: The synthetic routes. J.Saunders.
12) Organic natural products By Barton and Ollis.
13) Organic natural products by OP Agarwal.
14) Organic natural products By Barton and Ollis.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	3	3			3		3		
2	3	3	3			3		3		
3	3	3	3			3		3		
4	3	3	2			3		3		
5	3	3	3			2		3		

***1-Low *2- Medium *3- Strong**

R22OC44B: FORENSIC SCIENCE IN SOLVING CRIME

(ELECTIVE–B)

COURSE OUTCOMES:

- Understand definition and difference between Forensic Science and Criminalists.
- Knowledge on major contributors to the development of Forensic Science.
- Understand the Importance of physical evidence.
- Knowledge on Forensic Technology solving crimes with advanced technology
- Understand the steps typically required to maintain appropriate health and safety standards at the crime scene.

UNIT-I:

Introduction to Forensic Science: Need and functions of Forensic science. Historical aspects ofForensic science. Development of Forensic Science Laboratories. Definitions and concepts in Forensic science. Basic principles of Forensic science. Scope of Forensic science. Governing principals of Forensic Science. Forensic Science in Indian scenario. Admissibility in Indian Courts. Frye standard and Daubert standard.

UNIT-II:

Divisions of Forensic Science

Branches of Forensic science and their importance. Hierarchical set up of various Government Forensic Science Laboratories.

Forensic Evidences: Concise of Forensic Physical, Biological, Chemical and Psychological evidences, Medico-Legal Cases. Legal and Scientific problems. Forensic intelligence and Interviews.

UNIT-III:

Crime Scene

Types of crime scenes. Safety measures at crime scenes. Role of First Responding Officer. Coordination between police personnel and Forensic scientists at crime scenes. The evaluation of 5Ws (who? what? when? where? why?) and 1H (how?)

UNIT-IV:

Police and Forensic Science

Relationship between police and forensic expert, Role of Police at the Crime scene, scientific help at crime scene, Importance of Chain of custody, handling of various types of crime scenes by police, forensic teaching of police personals, forensic case documentation by Police, Technological Advance and Police, Mobile device forensics, Role of Media, Human Rights Commission & Criminal Justice System.

UNIT-V

Administration and Organizational Setup:

DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTS, NCRB, BPR&D,

Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic Science, American Board of Forensic Odontology, Bureau of Alcohol Tobacco and Firearms, Interpol and FBI, Australian Academy of Forensic Sciences. Forensic Science in India: Teaching Courses and Research fields in Forensic Science, Scope and jobs in Forensic Science.

REFERENCE BOOKS:

1) Max. M. Houck, Forensic Science: Modern Methods of Solving Crime.
2) U.S. Attroney's Bulletion: Forensic Science & Forensic Evidence.
3) Ross M. Gardeneer and Tom Bevel: Practical Crime scene analysis and reconstruction.
4) Dr. Karanam Satyanarayana: Step by step in police investigation and ground realities, Ist edition.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	2	2	3			3		3		
2		2	3	3		3		3		
3	3	2	3	2		3		2		
4	3	3	1	1		3		3		
5	2	3	3			3		3		

***1-Low *2- Medium *3- Strong**

R22OC44C: AIR, WATER, NOISE & THERMAL POLLUTION

(ELECTIVE–C)

COURSE OUTCOMES:

- Understand the properties and measurement of air pollution.
- Knowledge on the control methods of SO2, NOX & CO.
- Understand the various types of water pollution & water quality methods.
- Understand the study of noice pollution & its parameters.
- Knowledge on the thermal pollution.

UNIT-I: Air Pollution

Classification and properties of air pollutants-emission sources-major emissions from global sources-importance of anthropogenic sources-behavior and fate of air pollutants photochemical smog and its effects on health-vegetation-material damage in India.

Air pollution sampling and measurement-ambient air sampling-collection of gaseous air pollutants-collection of particulate pollutants-stack sampling-analysis of air pollutants-sulphur dioxide-carbon monoxide-nitrogen dioxide-oxidants-ozone-hydro carbons and particulate matter.

UNIT- II: Control Methods

Sources-correction methods-particulate emission control-gravitational settling chambers-cyclone separators-fabric filters-electrostatic precipitator-wet scrubbers-control of gaseous emissions by adsorption of solids and liquids-control methods of sulphur dioxide emission, flue gasesanalysis- control method, nitrogen oxides, carbon monoxide and hydrocarbon-mobile sources.

UNIT-III: Water Pollution and Quality Assessment:

Domestic, industrial, agricultural, soil and radioactive wastes as sources of pollution; assessment of toxic metal ions in water; impact of organic pollutants. DO, BOD, COD, TOC.

UNIT-IV: Noise Pollution

Noise pollution: sources-measurement of noise and indices-effect of meteorological parameters on noise propagation-noise exposure levels and standards–measurement of noise-impact of noiseon human health

UNIT-V: Thermal Pollution

Thermal Pollution: Introduction-definition-sources-harmful effects-toxic compounds in traces-prevention and control of thermal pollution –thermal power projects in India.

REFERENCE BOOKS:

1) Environmental Chemistry by AK.DE.
2) Environmental Chemistry by Tyagi & Mehra.
3) Engineering Environmental Chemistry P. Anandan.

OUTCOME MAPPING:

Course Outcomes (CO)	Program Outcomes (POs)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	2	3		2	3	3	3	3	
2	3	2	3	3	2	3	2	3	3	
3	3	3	3	2	2	3	3	2	3	
4	3	3	1	2	3	3	2	3	3	
5	2	3	3	2	3	3	3	3	3	

***1-Low *2- Medium *3- Strong**

PRACTICAL–I:

R22OC45: ANALYSIS OF BINARY ORGANIC MIXTURE

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

Part-I: One Theory question relating to any topic out of four semesters or any practical or as wish by the examiner.

Part-II: Two Component Organic Mixture Analysis

The Mixture Separation should be done by chemical methods and their identification by chemical reactions. Separation is based on solvent selection like ether, dil HCl, 5 % aqueous $NaHCO_3$, and Na_2CO_3 solutions, checking the purity of two components by TLC, identification of the compounds by a systematic study of the physical characteristics (mp/bp), extra elements (nitrogen, halogens and sulfur), functional groups, preparation of crystalline derivatives and identification by referring literature data.

(The student must be given trained in at least eight mixtures with different functional groups)

Note: 1. *For University examinations the student has to submit at least one derivative for each individual component. Examination- Duration: 9 hours.*

Part-III: Record submission

Note: For University Practical Examination the Duration is a 9 hours.

PRACTICAL-II:

R22OC46: PROJECT WORK / SPECTRAL PROBLEMS

(MINIMUM FIVE EXPERIMENTS MUST BE CARRYOUT)

TITLE SELECTION: 1) PROJECT WORK / 2) SPECTRAL PROBLEMS

1) **Project Work:** For University students- Project Work / Internship is compulsory and have tosubmit a dissertation containing Background of the work, Experimental, Results and Discussion and Summary.

   In respect of Affiliated Colleges-Project work is optional for only colleges having doctorate degree faculty and students may opt for project work and others have to select *Spectral Problems paper*.

2) **Spectral Problems:** For students who selected spectral problems will be given spectra of two different compounds for structural elucidation along with Viva-voce. (A minimum of 10 representative examples should be studied in regular practical hours).

Note: For University Practical Examination the Duration is a 6 hours.

PRACTICAL–III:

R22OC47: COMPREHENSIVE VIVA-VOCE

1) The students will be analyzed with questions covering 3rd & 4th semester topics.

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