YENEPOYA
(DEEMED TO BE UNIVERSITY)
Recognized under Sec 3(A) of the UGC Act 1956

Chemistry

Core course for Pre-PhD: 4 credits

Yenepoya Research Centre
Yenepoya (Deemed to be University)
University Road, Deralakatte
Mangalore – 575018

Course Name: Chemistry

1.	Course Type	: Core
2.	Level	: Pre-Ph.D. course work
3.	Credit Value	: 4 Credits
4.	Total Hours	: 60 (L:P:S: 10:25:25)
5.	Total Marks	: 100 (IA= 40 + Final exam= 70)

6. Course Objectives

- To train to understand the fundamentals of Chemistry and Nanomaterial for lab skills needed for PhD research.
- To expose the candidates to modern techniques undertaking experiments and data analysis tools for interpreting the results.

7. Learning Outcome

- This course will enable the students to design detailed work plan to execute the entrusted research topic related to chemistry/nanomaterials/polymer science.

8. Competencies

On completion of the course, the scholars will be able to perform activities as follows;

1. Comprehend the different types of analytical, chromatographic and separation techniques used for material research
2. Apply different spectroscopic methods for surface characterization/chemical characterization of nanomaterials.
3. Describe protocols used for polymer synthesis, structure, properties and their associated applications including bio-degradable polymeric materials
4. Demonstrate different synthesis methods, basic properties, morphological and structural characterization studies of nonmaterial and nanocomposites of biological interest
5. Plan protocols and experiments for the synthesis of new complex organic molecules based on retro synthetic analysis method
6. Analyze the experimentally generated data using the basic statistical methods and validate analytical solution
7. Practice of care and safety protocols in handling chemicals, biohazardous materials or equipments and disposal of chemicals biological/hazardous wastes as per prescribed guidelines.

9. Content of the course

Module 1: Bio-Analytical methods and instrumentation

1.1. Microscopy: image formation, resolution, techniques, limitations, and types and applications

1.2. Spectroscopy-different types of spectroscopy (UV-Vis, IR, AA,ESR,NMR, florescence) and their applications

1.3. Separation and purification methods, centrifugation sedimentation principle, differential centrifugation, type of centrifuges; Chromatography (Thin layer, adsorption, partition, affinity, ion exchange, and size exclusion) and applications; Electro-analytical techniques,

1.4. Molecular biology techniques-PCR, blotting techniques, ELISA, immuno-precipitation and immune-histochemistry.

Module 2: Validation of Bio-Analytical methods

2.1. Introduction;Precisionandaccuracy;Meanandvariance;Relativestandarddeviation

2.2. Limit of detection and quantification; Matrix effect; Recovery; Parallelism; Interferences; Qualitative (Screening) assays; Figures of merit for qualitative (Screening).

Module 3: Nano-materials and characterization methods

3.1. Nanomaterials, Nanocomposites, consumer goods, smart materials, application to various field, optics, telecommunication, electronics, digital technology and environment, biomedical application, protein engineering, drug delivery, biomimetics, quantum dots

3.2. Understanding and data analysis of Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS), Transmission Electron Spectroscopy (TEM), Dynamic Light Scattering(DLS), Atomic Force Microscopy (AFM) and X-ray Photoelectron Spectroscopy (XPS) and Peak Fitting (XPSPEAK41 software).

Module 4: Advanced organic synthesis:

4.1. Design of organic synthesis; Planning of synthesis; Convergent and reiterative processes

4.2. Retrosyntheticanalysis;Transformsandretrons;Selectingtransforms;transformbaseddis connections;Stereochemicalstrategies;Topological strategies

4.3. Carbon-carbon bond forming reactions – nucleophilic/electrophilic displacements, addition reactions; Coupling reactions (Suzuki, Negishi, Kumada, Hiyama, Heck, Sonogoshira, Buchwald-Hartwig couplings) with applications

4.4. Selectivity in organic synthesis: asymmetric alkylation, oxidation and cycloadditions; Advances in C-Heteroatom bond formation; General approach to heterocyclic synthesis - cyclisation and cycloaddition routes.

Module 5: Macromolecular science

5.1. History of macromolecular science; Introduction and classification of polymers; monomer, oligomer, and polymer

5.2. Structureandclassificationofpolymers;Propertiesofpolymers(physical, thermal and mechanical properties)

5.3. Molecular weight-concept of average molecular weight of polymers; Molecular weight distribution and determination, polydispersity index

5.4. Polymerization reactions – Types of polymerization reactions and examples

5.5. Conducting polymers, examples, doping, applications; Biodegradable polymers Synthesis strategies, characterization, and applications intra cellular delivery, bioimaging and sensing.

Teaching-learning methods

Modules	Teaching-learning		
	Lecture	Practical/Hands on	Self study
Module 1: Bio-Analytical methods and instrumentation	1.1	1.1	
		1.2	1.2 (Seminar)
	1.3		
	1.4	1.4	
Module 2: Validation of Bio-Analytical methods	2.1	2.1	2.1
	2.2	2.2	
Module 3: Nanomaterials and characterization methods	3.1		3.1
	3.2	3.2	3.2 (Seminar)
Module 4: Advanced organic synthesis	4.1		4.1 (Seminar)
			4.2 (Seminar)
	4.3	4.3	
	4.4		4.4
Module 5: Macromolecular science	5.1		
	5.2		5.2
	5.3		
	5.4		5.4
	5.5		

10. Assessment

Formative assessments: (40 Marks)

1	Internal Exams - 40 marks each (2)	20 M
2	Seminar (2)	8 M
3	Journal Club (2)	8 M
4	Assignments (5)	4 M

Summative assessments: (60 Marks)

Sl. No.	Details	Q X M
1	Questions related to knowledge on the use of different types of analytical/chromatographic/separation techniques for research in chemistry. (e.g. Investigating the spectroscopic properties of gold nanoparticle, separation of carbon dots and electrochemical characterization of nanomaterials etc.)	2X10M= 20 M
2	Questions related to problem solving. (e.g. Interpretation of data for bioconjugation of nanomaterials)	
3	Questions related to designing methodology for the synthesis and characterization (e.g. how to ascertain the size and shape of clustered	1X20M=20 M

	nanomaterials and single nanoparticles)	
4	Descriptive questions from module 2, 4 and 5 to assess the knowledge.	4X5M=20M

Learning Resources

Student should refer leading journals and publishers in the subject category and list is not limited to specific titles.

Text Books

1. C. N. R. Rao, A. Muller & A. K. Cheetham (2004). The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Volume 1. Wiley-VCH, Verlag GmbH, Germany.
2. I Joseph Wang (2004). Analytical Electrochemistry, 2nd Edition. Wiley-VCH, Verlag GmbH, Germany.
3. J. Clayden, N. Greeves, S. Warren & P. Wothers (2001). Organic Chemistry. Oxford University Press INC, New York,
4. M A. Ratner and D. Ratner, Nanotechnology (2003): A Gentle Introduction to the Next Big Idea. Pearson education Inc., Prentice Hall / PTR, New Jersey, USA.
5. P. L Nayak and S. Lenka (2012). Text book of Polymer science. Kalyani Publishers, New Delhi.
6. Susan R Mikkelsen and Edurdo Corton (2004). Bioanalytical Chemistry. Wiley-VCH, Verlag GmbH, Germany.

Reference Books

1. C Boyer (2009). Bio-applications of RAFT Polymerization. Chem. Rev, 109 (11), pp 5402-5436.
2. E.J. Corey & X.-M. Cheng (1989). The Logic of Chemical Synthesis. John Wiley and Sons.
3. Fred W. Billmeyer, Jr (1984). Textbook of Polymer Science, 3rd Edition. Wiley-Interscience, New York.
4. G. S. Misra. (2007). Introductory Polymer Chemistry. New Age International.
5. K Matyjaszewski & TP. Davis. Handbook of Radical Polymerization. DOI: 10.1002/0471220450.
6. R.O.C. Norman & J. M. Coxon (1993). Principles of Organic Synthesis. 3rd Edition, London; New York : Blackie Academic & Professional.
7. R.S. Ward (1999). Selectivity in Organic Synthesis. John Wiley & Sons.

Online Resources: Journal articles, reviews, perspective, case studies, regulatory issues, national guidelines on ethics, research integrity and reporting of the data.

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