DEPARTMENT OF CHEMISTRY

Ph.D. Course Work

Syllabus

Ph.D. Programme in Chemistry

Course Code	Course Name	Course Type	Hours per Week			
			L	T	P	C
	Characterization Techniques	Paper III-Elective Course DSC-I	3	0	0	3
	Green and Environmental Chemistry	Paper IV, Elective Course DSC-II	3	0	0	3
Total Credit -6						

	Characterization Techniques	L	T	P	C
		3	0	0	3

Pre-requisite: Knowledge of M.Sc. level Chemistry

Course Objectives:

1. To provide knowledge of different spectroscopic techniques and their application in research.
2. To provide knowledge on surface characterization through various microscopic technique.
3. The provide knowledge on thermal characterization techniques.
4. To provide knowledge on X-Ray Diffraction (XRD).
5. To provide knowledge on electrical and mechanical properties of materials.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To perform structural characterization using the knowledge of various spectroscopic techniques.

CO2: To explain surface morphology of samples using microscopic techniques.

CO3: To explain the thermal stability of compounds via various thermal analysis techniques.

CO4: To predict crystalline properties of samples through XRD analysis

CO5: To analyze electrical and mechanical properties of materials.

Module 1: SPECTROSCOPIC TECHNIQUES — **12 hours**

UV-Vis and fluorescence spectroscopy. Characterization of molecules, applications, data analysis and instrumentation.

FT-IR spectroscopy, Raman spectroscopy, their applications in characterizing chemical structures, data analysis and instrumentation.

NMR-spectroscopy, X-Ray photoelectron spectroscopy and their applications in structural characterization. Data analysis and instrumentation.

Mass spectroscopy, applications in characterizing chemical structures, data analysis and instrumentation.

Module 2: MICROSCOPY — **12 hours**

Analysis of samples using Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning probe microscopy (AFM, STM). Instrumentation.

Module 3: THERMAL ANALYSIS — **6 hours**

Thermo gravimetric analysis (TGA), Differential thermal analysis (DTA), Differential scanning calorimetric (DSC), Dynamic mechanical thermal analysis (DMTA). Data analysis and instrumentation.

Module 4: X-RAY DIFFRACTION — **8 hours**

Powder XRD, single crystal XRD. Data analysis and Instrumentation.

Module 5: ELECTRICAL AND MECHANICAL ANALYSIS — **7 hours**

Resistivity measurements, two-probe, four-probe measurements, stress-strain profiles of ceramics, metals and polymers, measurement of tensile strength, flexural strength and compressive strength.

Total Lecture hours — **45 hours**

Text Book(s)

1	Vogels Inorganic Qualitative Analysis, Arthur Vogel and G. Svehla, Pearson 2009.
2	D. B. Murphy, M. W. Davidson, Fundamentals of Light Microscopy and Electronic Imaging, Wiley, 2013.
3	D. B. Williams, C. B. Carter, Transmission Electron Microscopy A Textbook for Materials Science, Springer, 2009.
Reference book(s)	
1	A. R. West, Solid State Chemistry and Application, Wiley Student Edition, 1998.
2	B. D. Cullity, Elements of X-Ray Diffraction, 3rd Edition, Addison Wesley Publishing Company, Inc., 2004.

	Green and Environmental Chemistry	L	T	P	C
		3	0	0	3

Pre-requisite: M.Sc. knowledge in Chemistry

Course Objectives:

1. To provide insights of green chemistry and sustainability.
2. To provide knowledge on the atmospheric chemistry, air pollution and prevention, etc.
3. To provide knowledge on the chemistry of soil.
4. To provide knowledge on the chemistry of water.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To understand the principles of green chemistry and environmental chemistry

CO2: To have an insight of the chemistry of atmosphere, different causes of air pollution.

CO3: To have an insight of the chemistry of soil, different causes of soil pollution, different parameters to monitor soil quality, etc.

CO4: To have an insight of the chemistry of water, different causes of water pollution, etc.

Module 1: GREEN CHEMISTRY — **12 hours**

Perspective of green chemistry and sustainability; principles of green chemistry, discussion with examples of each principle. Green chemistry matrices. Solvent free synthesis and its advantages; sonochemical synthesis; microwave assisted synthesis; use of green solvents in chemical synthesis. Recent progress on green chemistry with real world examples.

Carbon footprint and ways to reduce them.

Module 2: CHEMISTRY OF ATMOSPHERE — **12 hours**

Atmosphere & atmospheric chemistry, importance of the atmosphere, solar influence on the chemical composition of atmosphere, photochemical and chemical reactions in atmosphere, ions and radicals in the atmosphere.

Solar radiation and plant and animal life, stratospheric ozone, ozone formation reactions, ozone destruction reactions, antarctic and arctic ozone hole.

Inorganic air pollutants, control of particulate emissions, carbon oxides and global warming, sulpher dioxide and sulpher cycle, nitrogen oxides in atmosphere, acid rains.

Organic air pollutants: examples, smog, types of smog, photochemical smog, smog forming reactions of organic compounds mechanism of smog formation effects of smog.

Climate change, International agreements/efforts on climate change- Montreal protocol, Rio-summit, Kyoto protocol, Paris agreement, International Solar Alliance.

Module 3: CHEMISTRY OF SOIL — **6 hours**

Soil formation- physical weathering and chemical weathering, soil organic matter, chemical properties of soil- cation exchange cap., pH, macro and micronutrients, leachate formation, environmental issues associated with soils- nutrient leaching, acidification, salinity and alkalinity, metal contamination.

Module 4: CHEMISTRY OF WATER — **6 hours**

Distribution of chemical species in water, phosphorus and sulphur systems, acidity and alkalinity, chelation in water, humic matter in water-origin, formation and environmental role. Partitioning of small organic molecules between water and soil or sediment, octanol – water partition coefficient.

Water pollution, inorganic pollutants, organic pollutants, eutrophication, radio-nuclides in

aquatic environment.		
Module 5: SEMINARS, GROUP DISCUSSION ON HOME ASSIGNMENTS RELATING TO RECENT RESEARCHES ON ENVIRONMENT AND GREEN CHEMISTRY, INTERNAL ASSESSMENT		**9 hours**
Total Lecture hours		**45 hours**
Text Book(s)		
1.	S.E. Manahan, Fundamentals of Environmental Chemistry, Lewis Publishers	
2.	G. W. Vanloon, S. J. Duffy, Environmental Chemistry, 3rd Edison, Oxford University	
3.	Shivangi Sonvanshi, Renu Dhupper, Fundamentals of Environmental Studies	
Reference Book(s)		
1.	Ritu Bir, Environmental Studies	
2.	J.P. Sharma, Environmental Studies	
3.	Sankar P. Dey, Nayim Sepay, A Textbook of Green Chemistry	
4.	Bailey, Clark, Ferris, Krause and Strong, Chemistry of Environment	