COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)
COURSES OFFERED IN ODD SEMESTERS BY THE DEPARTMENTS

*{**Note1**: DSE Paper 1 to DSE: Paper 7 will be offered in odd semesters & DSE: Paper 8 to DSE: Paper 14 will be offered in even semesters.*

***Note 2**: Paper 15 is compulsory for all the students who want to pursue VII and VIII semesters. It will be offered in both VI and VII semesters.}*

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
ADVANCED ANALYTICAL TECHNIQUES FOR POLYMERS	**4**	**2**	**0**	**2**	**Class 12th with Physics, Chemistry**	**---**

Learning objectives

The Learning Objectives of this course are as follows:

- To acquaint the students with the advancements in different characterisation techniques (spectroscopy, microscopy and separation), their principle, instrumentation, and applications in characterization of polymeric materials.
- Students will be able to determine a chemical structure, purity, property and functionality in polymer samples.

Learning outcomes

After studying this paper, students will be able to

- Interpret NMR, raman, mass and IR–spectra for characterization of molecular structure of polymeric materials
- Elucidate the morphology, size, homogeneity and distribution of various polymers and polymeric samples

- Acquire the knowledge about separation process of components from polymer mixture and samples.

SYLLABUS OF DSE-1

THEORY COMPONENT-

UNIT 1 (14 Hours)

SPECTROSCOPIC TECHNIQUES

Principles, instrumentation, and applications for structural determination of polymers (functional group, tacticity, molecular structure, purity, unsaturation etc.) using FT-IR, electron spin resonance, Raman, nuclear magnetic resonance (^{13}C NMR).

Mass Spectroscopy: Introduction, basic principles, instrumentation, fragmentation patterns, and interpretation of mass spectra and applications. Basis and application of MALDI-TOF, and ESI-MS in characterisation of different polymers including biopolymer for determination of molecular mass and structures (branching, and chain length).

UNIT 2 (8 Hours)

CHROMATOGRAPHY TECHNIQUES

Introduction to chromatographic methods: thin layer chromatography, column and gas chromatography. Principles, instrumentation and application of Gas liquid Chromatography, High performance liquid chromatography and gel permeation chromatography (GPC) including brief about column, detectors and stationary phases and their significance.

UNIT 3 (8 Hours)

MICROSCOPIC AND MISCELLANEOUS TECHNIQUES

Optical microscopy, electron microscopy (SEM, TEM, AFM) and XPS, XRD: principle, instrumentation and applications (Particle size by Scherrer formula, d-Spacing, Crystal parameter, morphology etc.) for polymers characterization. Different methods used for determination of molecular mass, Particle size analyser, and measurement and importance of zeta potential.

PRACTICAL COMPONENT (60 Hours)

- To identify the functional groups and components in various polymers (homo and co polymers) using FTIR.
- To determination of Reactivity ratio by FTIR.
- To determination of purity of monomers by spectrophotometer
- To determine the cross linking density of a polymer samples by FTIR.
- To analyse the Raman spectra of given polymers(demonstrative).
- Evaluate percentage crystallinity and size of polymeric samples by XRD curve.
- To separate and identify additives in a given polymeric sample by thin layer chromatography.
- To separate and identify the polymeric samples and mixture by TLC.
- To analyze film morphology (homogeneity, distribution and size) by optical microscope.
- To determine the size of polymer/additives particles by particle size analyzer.
- Visit to an analytical laboratory and submit a report.

ESSENTIAL/RECOMMENDED READINGS

- Willard H.H., Merritt L.L., Dean J.A. (1988) Instrumental method of analysis, Wads worth Publishing Company.
- Skoog D.A, (1997) Principle of Instrumental Analysis, Harcourt College Pub.
- Shah V., (2007) Handbook of Plastic Testing, Technology, Wiley-Inter science.
- Banwell C.N., McCash E.M., (2008) Fundamentals of Molecular Spectroscopy, Fourth Edition, Tata McGraw-Hill.
- Maus, A. (2008). Characterization and Analysis of Polymers, Wiley and Sons.
- Malik, A. Mays, J. Shah, M. R. (2021) Molecular Characterization of Polymers: A Fundamental Guide, Elsevier.

SUGGESTIVE READINGS

- Tanaka T., (1999) Experimental Methods in Polymer Sciences, Academic Press.
- Silverstein R.M., (1991) Spectrometric identification of organic compounds, John Wiley.
- Macomber R.S., (2008) A complete introduction to NMR spectroscopy, Wiley-inter science.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.