SEMESTER-V

BSc. (Hons.) Polymer Science

DISCIPLINE SPECIFIC CORE COURSE – 13

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 (if any)
		Lecture	Tutorial	Practical/ Practice		
FIBRE SCIENCE	**4**	**2**	**0**	**2**	**Class 12th with Physics, Chemistry, Mathematics**	**-**

Learning objectives

- To study the basic concepts of natural and synthetic fibres
- To learn about the basic concepts of spinning including melt and solution spinning.
- To understand various parameters affecting spinning, drawing and heat setting of fibre structure and properties

Learning outcomes

After studying this paper, students will be able to

- Explain classification, structure and properties of natural and synthetic fibres
- Manufacture fibre with desired properties.
- Explain the various spinning variables

SYLLABUS OF DSC-13

UNIT 1: (4 Hours)

INTRODUCTION TO FIBRES

Introduction, classification, structural requirements of fibre forming polymers, general properties of fibres such as moisture absorption, fineness (tex, denier), tensile properties (elongation at break, elastic recovery, tenacity etc.)

UNIT 2: **(5 Hours)**

NATURAL FIBRES

Brief introduction to structure, properties and application of naturally occurring fibres: vegetable fibres, animal fibres and mineral fibres

UNIT 2: **(10 Hours)**

FIBER SPINNING PROCESSES

Melt spinning process: Spinning line, spinning manifold, spinning pack and manifold, cooling system, spinning variables, Force balance and heat balance in melt spinning; fibre structure development:

Solution spinning process: dry spinning (dope, spinning process, fibre cross section formation) wet spinning (solution preparation, coagulation, effect of process parameters on coagulation and structure of dry and wet spun fibres)

UNIT 3: **(12 Hours)**

SYNTHETIC FIBRES

Structure, properties and applications of synthetic fibres: viscose rayon, cellulose acetate, nylon 6, nylon – 66, polyester, acrylic, carbon fibre and aramid fibres

PRACTICAL COMPONENT **(60 Hours)**

(Students are required to minimum 6 experiments)

- To determine fineness (denier, tex and count) of given fibre, filaments and yarns.
- To study the cross-sectional view of natural and synthetic fibres and to identify them.
- To study the longitudinal view of natural and synthetic fibres and to identify them.
- To investigate moisture regain of fibres by absorption and desorption method.
- To identify fibres through elemental analysis.
- To identify the fibre through solubility tests.
- To analyze the reaction fibres to heat & flame.
- Analysis of chemical structure of fibres by FTIR and UV spectroscopy.
- To study thermal degradation of fibers through Thermo Gravimetric Analysis TGA method.
- To determine composition of fibres in blends.
- To measure electrical resistance of fibres.
- To measure static electricity a static charge in fibres

- To analyze microscopic properties of fibre.
- Quantitative analysis of cellulose/polyester blends.
- R & D Lab visit

ESSENTIAL/RECOMMENDED READINGS

- Cook J.G., (2009), Hand Book of Textile Fibres, Woodhead Publishing.
- Mishra S. P., (2000), A Text Book of Fibre Science and Technology, New Age International Publisher.
- Sperling L. H., (2013), Introduction to Physical Polymer Science, Wiley, 4th Edition
- Gupta V.B., Kothari V.K., (1997) Manufactured Fibre Technology, 1st Ed Chapman and Hall.
- Vaidya A.A., (1988) Production of Synthetic Fibres, First Edition, Prentice Hall of India.

SUGGESTIVE READINGS

- Morton W.E., Hearle J.W.S., (2008) Physical Properties of Fibres, Woodhead Publishing.
- David S. R., (2000) Structure Formation in Polymeric Fibres, First edition, Hanser Publishers.

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

DISCIPLINE SPECIFIC CORE COURSE – 14

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 (if any)
		Lecture	Tutorial	Practical/ Practice		
POLYMER CHARACTERIZATION	**4**	**2**	**0**	**2**	**Class 12th with Physics, Chemistry, Mathematics**	**-**

Learning objectives

- To acquaint the students with the instrumental techniques and their applications in characterization of polymers and polymeric materials
- To determine a chemical property and identify a chemical structure of a polymer.

Learning outcomes

After studying this paper, students will be able to

- Explain the basic principle and application of characterisation techniques.
- Interpret NMR, Raman, Mass and IR–Spectra for characterization of molecular structure of polymeric materials
- Elucidate stability of various polymers and their characterization on the basis of their thermal stability and glass transition temperature

SYLLABUS OF DSC-14

THEORY COMPONENT

UNIT 1: (4 Hours)

INTRODUCTION

Basic principle of spectroscopy, molecular, atomic and electronic spectra, Lambert-Beer's law, Frank-condon principle, electromagnetic radiation and it's properties, interaction of radiation with matter, statistical method of analysis.

UNIT 2: (5 Hours)

SPECTROSCOPIC TECHNIQUES

Principles and applications in structural determination of polymers (functional group, tacticity, molecular structure, purity, unsaturation etc.) by Infra-red spectroscopy, UV-Vis spectroscopy, electron spin resonance (ESR), raman spectroscopy, nuclear magnetic resonance spectrometer (^{1}HNMR).

UNIT 3: **(5 Hours)**

CHROMATOGRAPHY TECHNIQUES IN POLYMER

Paper chromatography, thin layer chromatography, high performance liquid chromatography, gel permeation chromatography (GPC), gas chromatography and size exclusion chromatography.

UNIT 4: **(6 Hours)**

MICROSCOPIC AND X-RAY TECHNIQUES

Optical microscopy, electron microscopy (SEM, TEM, AFM) and XRD: basics principle and applications in polymers characterization, Contact angle and measurement.

UNIT 5: **(6 Hours)**

THERMO-MECHANICAL CHARACTERIZATION

Principle and applications of Thermal gravimetric analysis (TGA), Differential thermal analysis (DTA). Differential scanning calorimeter (DSC), Dynamic mechanical analyser (DMA) and thermal mechanical analyser (TMA) in polymer analysis.

UNIT 6: **(4 Hours)**

MOLECULAR MASS AND MASS SPECTROSCOPY

Mass spectroscopy, Gas chromatography-mass spectrometer (GC-MS): principle and application for determination of molecular mass and chemical structure of polymers.

PRACTICAL COMPONENT **(60 Hours)**

- To verify Lambert-Beer's law by UV-Vis. spectrophotometer.
- Calculate weight percentage of inorganic and organic ingredient in polymeric compound.
- Analyze thermal behaviour of polymers by TGA.
- Quantitative determine of chemical impurities in polymer sample by UV-Vis. spectrophotometer.
- Contact angle and measurement of polymer

- Identification of additives present in a processed polymer by Paper and thin layer chromatography.
- Separation, characterization, and purity determination of polymers by TLC and Paper chromatography.
- Determination of size and particle distribution of additive in polymer sample by optical microscope.
- Determine the size and prepare size distribution curve by microscopy
- Visit of analytical laboratory.

ESSENTIAL/RECOMMENDED READINGS

- Willard H.H., Merrit L.L., Dean J.A. (1988) Instrumental method of analysis, Wads worth Publishing Company.
- Kaushik N.K., Shukla S. K., (2023) Thermal Analysis Techniques and Applications, IK International Pvt. Ltd.
- 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.
- Muhammad Malik, Jimmy Mays, Muhammad Raza Shah, (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.

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DISCIPLINE SPECIFIC CORE COURSE – 15

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 (if any)
		Lecture	Tutorial	Practical/ Practice		
POLYMERS IN PACKAGING	**4**	**2**	**0**	**2**	**Class 12th with Physics, Chemistry, Mathematics**	**-**

Learning objectives

- To learn about the Packaging systems and role of Polymer in packaging
- To acquire knowledge of various types of polymers as packaging materials

Learning outcomes

After studying this paper, students will be able to

- Apprehend the basic concept of packaging and its utilization for desired applications
- Assess the quality of packaging material and packaged product
- Select the packaging material and can design a packaged product

SYLLABUS OF DSC-15

THEORY COMPONENT-

UNIT-1: (10 Hours)

PACKAGING SYSTEMS

Types of packaging systems: box, bottle, tetrapack, pouch, shrink, vacuum packaging, controlled atmospheric packaging (CAP), modified atmospheric packaging (MAP), aseptic packaging.

UNIT 2: (10 Hours)

POLYMERS IN PACKAGING

Importance of polymers in packaging. Property requirements of Polymers for packaging applications: Structure and process requirements for the required Properties and applications. Properties and applications: PE (LLDPE, LDPE, HDPE, HMHDPE), PP, BOPP PVC, nylons, polyester, polycarbonate, PS, EPS, PVA, Ionomers & Fluoro polymers.

UNIT 3: **(10 Hours)**

TESTING OF POLYMER PACKAGING MATERIAL

Bursting strength, tensile strength, tear strength, puncture test, impact test (drop, falling dart), barrier properties test (water vapour, oxygen), sealing strength., migration & compatibility.

PRACTICAL COMPONENT **(60 Hours)**

- Preparation of packaging films (PP/ HDPE/ LDPE/ LLDPE/PVA)
- To prepare polyester film and find its WVTR.
- Identification of packaging materials with the help of FT-IR, DSC, TGA etc.
- Preparation of laminate films by various methods (heat, solvent, adhesives)
- Determination of physico-mechanical properties (density, bursting strength, tensile strength, tear strength, puncture strength, impact strength etc) of packaging materials.
- Determination of water vapor transmission rate of packaging material.
- To determine the seal strength of packaging materials.
- To determine compatibility of packaging film with the packaged material.
- Industrial visit of packaging industry/plant

ESSENTIAL/RECOMMENDED READINGS

- Robertson G.L., (2012) Food Packaging – Principles and Practice, CRC Press Taylor and Francis Group.
- Paine F.A., Paine H.Y., (1992) A Handbook of Food Packaging, Blackie Academic and Professional
- Sharma S., Aggarwal M., Sharma D., (2019), Food Frontiers, New Delhi Publisher
- N. C. Saha, M. Garg, S. Dey Sadhu, A. K. Ghosh(2022) Food Packaging-Materials, Techniques and Environmental Issues" by published by Springer.
- Garg, M., Meena, P.L., Sadhu, S.D., Alam, T. (2019). Food Packaging: A Practical Guide : Viba Press Pvt. Ltd.

SUGGESTIVE READINGS

- Coles R., McDowell D., Kirwan M.J., (2003) Food Packaging Technology, Blackwell.
- Sukhareva L.A., Yakolev V.S., Legonkova O.A., (2008) Polymers for packaging and containers in the food industry, VSP.

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