BHASKARACHARYA COLLEGE OF APPLIED SCIENCE
B.Sc. (HONOURS) POLYMER SCIENCE

Category I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) – : INTRODUCTION TO POLYMER SCIENCE

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		
INTRODUCTION TO POLYMER SCIENCE	4	3	0	1	PCM	PCM

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize with the structure of polymers.
- To acquaint students with knowledge of molecular weight determination and polymersolubility.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand physical state of polymers
- Develop fundamental knowledge of thermal transitions of temperature
- Understand structure-property relationship of polymers
- Apply mathematical formulae to depict polymer solution properties

SYLLABUS OF DSC-1
UNIT – I (9 hours)

INTRODUCTION TO POLYMER SCIENCES

Introduction and history of polymeric materials, classification of polymers, configuration and conformation of polymers, nature of molecular interaction in polymers, cumulative interaction, entanglement, random chain model and RMS end-to-end distance, Various structures of copolymers such as linear branched and cross-linked copolymers and their types.

UNIT – II (6 hours)
POLYMER CRYSTALS

Crystal morphologies, extended chain crystals, chain folding, lamellae, spherulites, crystallization, crystallinity, crystallizability & orientation, crystalline melting point, crystallization kinetics, effect of orientation and crystallinity on polymer properties, determination of crystallinity.

UNIT – III (9 hours)
PROPERTIES OF POLYMERS

Physical properties, introduction of mechanical properties (stress–strain curves, tensile, flexural, impact, fatigue, hardness, creep and abrasion), electrical properties (dielectric strength, volume resistivity and power factor)

UNIT – IV (9 hours)
POLYMER MOLECULAR WEIGHT
Nature and structure of polymers: structure-property relationships, molecular weight of polymers (Mn, Mw, MV and MZ), polydispersity, molecular weight distribution and determination of molecular weight by solution viscosity and end group analysis,

UNIT – V (6 hours)
SOLUTION PROPERTIES OF POLYMERS
Polymer solutions, solubility parameter, athermal solvents, theta solvents, solution viscosity, thermodynamics of polymer solutions, Flory-Huggins theory

UNIT – VI (6 hours)
GLASS TRANSITION BEHAVIOUR OF POLYMERS
Glass transition temperature (Tg) and measurement of Tg, factors affecting the glass transition temperature, WLF equation

Practical component – (30 hours)

1. Chemical identification of polymers- • Unsaturation • Testing of functional groups(associated with polymers).
2. Measurement of glass transition temperature (Tg).
3. To determine the melting point of crystalline polymers.
4. To check the solubility of the given polymeric sample in different solvents.
5. Determination of molecular weight by solution viscosity.
6. Determination of number average molecular weight by end group analysis.
7. To find out the acid number and hydroxyl number of a given polymer.
8. To measure volume resistivity of polymer samples.

Essential/recommended readings

1. Odian, G., (2004) Principles of Polymerization, Wiley-interscience.
2. Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rdEdition.
3. Billmeyer F.W., (2007) Textbook of Polymer Science, Wiley, India.
4. Shah V., (1998) Handbook of Plastics Testing Technology, Wiley Interscience.

5. Seymour R.B., Carraher C.E., (2003) Polymer Chemistry, Marcel Dekker.
6. Teraoka, I. (2002). Polymer solutions: an introduction to physical properties.
7. Hiemenz, P. C., & Lodge, T. P. (2007). Polymer chemistry. CRC press.

Suggestive readings

1. Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
2. Schultz J.M., (2001) Polymer Crystallization, American Chemical Society.
3. Ghosh P., (2010) Polymer Science and Technology: Plastics, Rubbers, Blends andComposites, Tata McGraw Hill.
4. Shah V., (2006) Handbook of Plastics Testing and Failure Analysis,John Wiley & Sons,Inc., 3rd Edition.

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): RAW MATERIALS FOR POLYMERS

Credit distribution, Eligibility and Prerequisites 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		
RAW MATERIALS FOR POLYMERS	4	3	0	1	PCM	

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the resources of polymers
- To learn about basic concepts of polymer latex
- To gain knowledge of properties of monomers and their synthesis XXX

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the knowledge of latex manufacturing and compounding
- Apply the knowledge of techniques used in monomer production

SYLLABUS OF DSC- 2

UNIT – I (6 hours)

INTRODUCTION TO CRUDE OIL AND IT'S REFINING

Petroleum oil, natural gas, coal: capabilities and limitations. general consideration of petrochemicals, an overview of petroleum refining, desalting, distillation, cracking and its types

UNIT – II (15 hours)

SYNTHESIS OF MONOMERS FROM PETROCHEMICALS

Ethylene, vinyl acetate, vinyl chloride, ethylene oxide and ethylene glycol, acrylonitrile, methyl methacrylate, isoprene, phenol, styrene, terephthalic acid, adipic acid, caprolactam, hexamethylenediamine

UNIT – III (6 hours)

LATEX

Natural rubber latex: collection process, composition, concentration and stabilization of latex

UNIT – IV (9 hours)

LATEX ADDITIVES AND IT'S COMPOUNDING

Vulcanizing agents, fillers, accelerator, coagulating agent, wetting, dispersing and emulsifying agents, stabilizers, thickening agents and other additives, compounding formulations for product manufacturing

UNIT –V (9 hours)

LATEX PRODUCT MANUFACTURING TECHNIQUES

Latex compound formulation, process of manufacturing, finishing and applications of spreading, casting and dipping (Dipping-principle and procedure of dipping process- different types of dipping –after treatment of latex deposits -Manufacture of dipped goods with formulation and flow chart-defects and remedies . latex casting – principle and procedure of casting-production of cast articles –mould preparation, latex thread and latex foam

Practical component- (30 hours)

1. Analysis of formalin/phenol/epichlorohydrin/Plasticizer
2. Determination of hydroxyl value/carboxyl value/ester value/epoxy value
3. Determination of colour and viscosity by gardner's tube method
4. Fractional distillation of crude oil.
5. To calculate dry rubber content (DRC) of latex.
6. To determine the coagulation strength of latex.
7. Preparation of balloon by dipping process.
8. Latex compounding for preparation of gloves & balloons.
9. Synthesis of adipic acid from cyclohexanol using Conc. HNO3.
10. To prepare monomers from C4 hydrocarbons.
11. Determination of percentage purity of phenol.

Essential/recommended readings

1. Kumar D., Chandra R., (2001) Latex Technology, Dhanpat Rai & Co.
2. Rao B.K.B., (2007) Textbook on Petrochemicals, Khanna Publishers.

3. Blackley, D.C., "High Polymer Latices", Vol 1 and 2, Chapman and Hall, 1997
4. Mausser,R.F., "The Vanderbilt Latex Hand book" 3rd edn.R.T. Vanderbilt Company,1987.

Suggestive readings

1. Rao B.K.B., (2007) Modern Petroleum Refining Processes, Oxford and IBH
2. Maiti S., (2002) Introduction to Petrochemicals, Oxford & IBH Publ. Co.
3. Speight J.G., (2006) Chemistry and Technology of Petroleum, CRC Press.
4. Martin J. M., Smith W.K., (2007) Handbook of Rubber Technology, CBS Publishers.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): UNIT OPERATIONS

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		
UNIT OPERATIONS	4	3	0	1	PCM	PCM

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand concepts of unit operations and their importance in polymer industries
- To learn about the concepts of separation equipments used in the process industry XXX

Learning outcomes

The Learning Outcomes of this course are as follows:

- Select suitable criteria for solving material and energy balance problems
- Illustrate energy and material balance equations for open and closed systems

SYLLABUS OF DSC-3

UNIT – I (6 hours)

INTRODUCTION TO UNIT OPERATIONS

Unit operations: concept and requirement, material and energy balances (with and without chemical reactions), energy transport in non-isothermal systems

UNIT – II (9 hours)

MECHANICAL OPERATIONS

Mechanical Operations: Size reduction and its equipment (ball mill, jack crusher, end and

edge roller mill), filtration: theory of filtration, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter, etc., factors affecting filtration

UNIT – III (15 hours)

HEAT TRANSFER

Conduction (Fourier law, Reynolds number), convection, radiation, heat exchangers (tube shell, shell plate)

UNIT – IV (15 hours)

MASS TRANSFER MECHANISM

Mass diffusion, factors affecting diffusion, gas absorption (Henry's Law, Langmuir Absorption Isotherm, BET equation), types of distillation, drying

Practical component (30 hours)

1. Handling of jaw crusher, ball mill for crushing and grinding.
2. Calculate the rate of evaporations of different volatile liquids.
3. Distillation of various liquid mixtures.
4. To evaluate diffusion percentage of a plasticizer in a PVC.
5. Filtration of solids from slurry.
6. Calculation of pressure drop and pipe size.
7. Heat Transfer through different materials like glass and plastics.
8. Analysis of different adsorption isotherms.

Essential/recommended readings

1. Mccabe W., Smith J., Harriott P., (2005) Unit Operations in Chemical Engg., McGraw-Hill Education.
2. Chattopadhaya P., (2003) Unit Operations in Chemical Engg., Vol. 1 & Vol. 2, KhannaPublishers.
3. Coulsan J.M., Richardson J.F., (2010) Chemical Engg., Vol. 1, Elsevier.

Suggestive readings

1. Kumar D. S., (2009) Heat and Mass Transfer, S K Kataria & Sons.
2. Rao G. K., (2002) Solved Example in Chemical Engg., Khanna Publishers.
3. Treybal R., (2012) Mass Transfer Operations, Tata McGraw Hill.