COURSE DESCRIPTION

Approval: 24th Senate Meeting

Course Name: Introduction to Polymer Science & Technology
Course Number: CY 555
Credits: 3-0-0-3
Prerequisites: IC 130 for B.Tech students
Intended for: UG/PG
Distribution: Elective for B.Tech. (all Branches), M.Tech./M.Sc. (Chemistry & all branches), & Ph.D. students
Semester: Odd/Even

Preamble:

The course forms an elective course for the M.Sc. (Chemistry) degree program. The existing core courses in this program include chemical kinetics while the other elective courses in this basket include synthesis and characterization of nanomaterials for interdisciplinary applications. This course will give a preview on designing polymer based materials. It will discuss polymers at various fronts: polymer properties, polymerization methods, kinetics of polymerization, polymer functionalization, characterization, processing, and designing polymer based advanced materials. Thus, this course will facilitate the students to develop critical thinking towards how the structure and properties of polymers can be tailored which is one of the most important prerequisites for developing new materials for desired applications. This course will provide the students an appreciation of the versatility which is inherent in polymerization processes and which is available to the polymer technologist in conjunction with other core and elective courses in the M.Sc. program.

Outline:

The course is designed to impart knowledge on a range of aspects of polymer science and technology starting from the fundamental science to practical applications. Students will learn about the advancement in the synthesis and characterization techniques. This course will also provide the students an understanding and knowledge of designing polymer based materials for advanced applications.

Modules:

Module 1: Introduction to polymers (6 hours)
History and recent developments, monomers, oligomers, polymers and their characteristics, classification and nomenclature of polymers, physical state of polymers, Tg, Tc, molecular weight and MWD, natural polymers

Module 2: Radical polymerization (6 hours)
Mechanism, kinetics, chain transfer, autoacceleration, gel effect, copolymerization, reactivity ratios, composition of copolymers, living radical polymerization: ATRP and RAFT

Module 3: Ionic polymerization (5 hours)
Mechanism and kinetics of cationic and anionic polymerization

Module 4: Stereospecific polymerization (2 hours)
Stereoisomerism, complex catalyst polymerization

Module 5: Step growth polymerization (6 hours)

Kinetics, step copolymerization, detailed methods for the preparation of polyesters, polyamides, polycarbonates etc., high performance polymers

Module 6: Techniques of polymerization (3 hours)
Bulk, solution, emulsion, suspension, melt polycondensation, solution polycondensation, interfacial and gas phase

Module 7: Polymer characterization (8 hours)
Molecular weight by GPC, light scattering, osmotic pressure etc., IR, UV, NMR, TGA, DSC, radiation scattering: SAXS, WAXS, DLS

Module 8: Processing, testing and applications of polymer materials (6 hours)
Extrusion, molding, tensile, impact, flexural testing, adhesives, foam, polymer fibers, catalysis, environment care, medicine etc.

Text Books:

1. V. R. Gowarikar, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age International. Wiley, 3rd Edition, 2019.
2. F. W. Billmeyer, Textbook of Polymer Science, Wiley, 3rd Edition, 2007.

Reference Books:

1. G. Odian, Principles of polymerization, 4th Edition, Wiley, 2004.
2. P. C. Heimenz, T. P. Lodge, Polymer Chemistry, 2nd Edition, CRC press, 2007.
3. C. E. Carraher, Seymour/Carraher's Polymer Chemistry, 6th Edition, Marcel Dekker, Inc., 2003.
4. J. M. G. Cowie, Polymers: Chemistry and Physics of Modern Materials, 3rd Edition, CRC Press, 2007.
5. H. F. Mark, Encyclopedia of Polymer Science and Technology, 3rd Edition, Wiley, 2004.