Approved in 39th BoA Meeting (25-03-2021)

Course Number: ME 516
Course Name: Polymer Technology for Engineers
Credits: 3-0-0-3
Prerequisites: Materials Science for Engineers (IC241) or equivalent material science course
Intended for: UG/PG
Distribution: Elective for UG (ME), M Tech/MSc., MS, and PhD

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1. **Preamble:** Polymers or commonly known as plastics as commodity materials have been around for more than 50 years. In the 1950s, plastics were considered to be specialist materials for niche applications or were used by artists. With the greater availability of polymers in the 1960s, a number of engineers started to explore their application in a variety of areas- automobiles to aeroplanes, day- to-day utensils to biomedical implants and many more. Now plastics have found ways to become the most common material in our lives. For engineers to be able to successfully use plastics they need to recognise that, unlike metals, alloys and ceramics, the physical properties of polymers can vary significantly with stresses and temperature. This course will help students to identify the properties of polymers, and thereby engineer them according to the demands following several manufacturing technique.

2. **Course Outline:** The course will highlight different aspects polymer chemistry, mechanical and physical properties of polymers, common and advanced manufacturing techniques followed by several case studies with applications.

3. **Course Modules:**

Module-1: Introduction to Polymer **(3 hrs)**
Brief history of polymers; polymer classification; molar mass and molar mass distribution; polyethylene-polymerization process; chemical bonding- primary, secondary and tertiary structure; crystallinity

Module-2: Thermal Transitions in Polymers **(4 hrs)**
Glass transition temperature; factor affecting glass transition temperature- molar mass dependence, plasticization, chain entanglement effect; crystalline melting point; differential scanning calorimetry

Module-3: Mechanical Properties of Polymers **(6 hrs)**
Stress-strain measurements; dynamic modulus; methods of measurements of polymers- tensile testing, fracture, creep, relaxation time, compression; effect of structural and environmental factors on mechanical properties- molecular weight, cross-linking, crystallinity, strain rate, temperature.

Module-4: Viscoelastic Properties of Polymer **(6hrs)**
Simple rheological responses- ideal elastic, pure viscous and rubberlike elastic; viscoelasticity; mechanical models for viscoelastic responses- Maxwell model, Kelvin-Voigt model, Four-parameter model; relaxation time; material response time-Deborah number;

Module-5: Polymer processing- Melt: Thermoplastics and Thermoset **(8 hrs)**
Processing thermoplastics- rotational moulding, injection moulding, compression moulding; melt spinning; processing thermosets- hand lay-up process, spray lay-up method, vacuum bagging, resin transfer moulding, resin infusion process; dry spinning, Spun bonding

Module-6: Polymer processing- Solution: Thermoplastics **(3 hrs)**
Electrospinning; centrifugal spinning; wet spinning

Module-7: Composites **(3 hrs)**
Importance of composites; classification- fiber and particle reinforced; factors affecting composite performance; failure

Module-8: Case Studies **(4 hrs)**
Application of polymers in special cases-vibration damping; energy; adhesives; bio-medical-drug delivery, tissue engineering; water and air purification; electronics

Module-9: Recycling of Plastics and Environmental Issues **(3 hrs)**
Need of recycling: degradation-thermal, chemical, hydrolysis, mechanical; incineration; bioplastics; issues with recycling

4. **Text Books:**
   - Robert O. Ebewele, 2000, Polymer Science and Technology, CRC press.
   - Richard A. Pethrick, 2010, Polymer Science and Technology for Scientists and Engineers, Whittles Publishing

5. **Similarity Content Declaration with Existing Courses**

S.No.	Course Code	Similarity Content	Approx. % of Content
1.	CY 641	Classification, polymerization process (Here limited to one model case – Polyethylene compared to vast polymerization chemistry emphasized in CY 641)	Less than 5%
2	CY 555	History of Polymers, Molecular weight, Glass transition temperature, Physical state of polymers, DSC, Polymer fibers	Less than 10%

6. **Justification for new course if cumulative similarity content is > 30%:** Not Applicable