



GATE Syllabus

Part I – ENGINEERING SCIENCE (XE)

Section–XE-F Polymer Science and Engineering



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SECTION – XE-F: POLYMER SCIENCE AND ENGINEERING

Course Syllabus

Unit 1: Chemistry of High Polymers

Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization bulk, solution, suspension, emulsion.

Unit 2: Polymer Characterization

- Solubility and swelling
- Concept of average molecular weight
- Determination of number average
- Weight average
- Viscosity average and Z-average molecular weights
- Polymer crystallinity
- Analysis of polymers using IR
- XRD
- Thermal (DSC, DMTA, TGA)
- Microscopic (optical and electronic) techniques

Unit 3: Synthesis and Properties

- Commodity and general purpose thermoplastics:
 - PE
 - PP
 - PS
 - PVC
 - Polyesters
 - Acrylic
 - PU Polymers
- Engineering Plastics:
 - Nylon
 - PC

- PBT
- PSU
- PPO
- ABS
- Fluoropolymers
- Thermosetting polymers:
 - PF
 - MF
 - UF
 - Epoxy
 - Unsaturated polyester
 - Alkyds
- Natural and synthetic rubbers:
 - Recovery of NR hydrocarbon from latex
 - SBR
 - Nitrile
 - CR
 - CSM
 - EPDM
 - IIR
 - BR
 - Silicone
 - TPE

Unit 4: Polymer Blends and Composites

- Difference between blends and composites
- Their significance
- Choice of polymers for blending
- Blend miscibility-miscible and immiscible blends
- Thermodynamics
- Phase morphology
- Polymer alloys
- Polymer eutectics
- Plastic-plastic
- Rubber-plastic and rubber-rubber blends
- FRP
- Particulate
- Long and short fibre reinforced composites

Unit 5: Polymer Technology

- Polymer compounding-need and significance
- Different compounding ingredients for rubber and plastics
- Cross-linking and vulcanization
- Vulcanization kinetics

Unit 6: Polymer Rheology

- Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions
- Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer
- Viscoelasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR

Unit 7: Polymer Processing

- Compression molding
- Transfer molding
- Injection molding
- Blow molding
- Reaction injection molding
- Extrusion
- Pultrusion
- Calendaring
- Rotational molding
- Thermoforming
- Rubber processing in two-roll mill
- Internal mixer

Unit 8: Polymer Testing

- Mechanical-static and dynamic tensile
- Flexural
- Compressive
- Abrasion
- Endurance
- Fatigue
- Hardness

- Tear
- Resilience
- Impact
- Toughness
- Conductivity-thermal and electrical
- Dielectric constant
- Dissipation factor
- Power factor
- Electric resistance
- Surface resistivity
- Volume resistivity
- Swelling
- Ageing resistance
- Environmental stress cracking resistance