



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Branch: Plastics Engineering

Course Code : DI02023011

Course Name : Polymer Chemistry

| | |
|-------------------------|-----------------------------|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 2 nd |
| Category of the Course: | Professional Core Course 02 |

| | |
|----------------------|--|
| Prerequisite: | Basic Polymer Chemistry |
| Rationale: | The course deals with structures, properties & fundamentals of polymer preparation by various polymerization techniques. This course will help students to understand micro structure analysis of polymers, its solutions & degradation. Learning of this course would make students aware about the concepts of polymer chemistry and morphology for understanding the structure and manufacturing of polymers. |

Course Outcome:

After Completion of the Course, Student will able to:

| No | Course Outcomes | RBT Level |
|----|--|-----------|
| 01 | Select suitable polymerization technique. | A |
| 02 | Describe morphology and its effect on polymer. | U |
| 03 | Compare various polymer degradation mechanisms. | U |
| 04 | Identify suitable polymer reaction for polymer modification. | U |
| 05 | Select manufacturing process for a polymer. | A |

*Revised Bloom's Taxonomy (RBT)

Teaching and Examination Scheme:

| Teaching Scheme (in Hours) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|-------------------------------|---|----|------------------------------------|------------------------------|----------------|-----------|----------------------|----------------|
| L | T | PR | | C | Theory | | Tutorial / Practical | |
| | | | ESE (E) | | PA / CA (M) | PA/CA (I) | ESE (V) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 20 | 30 | 150 |



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Course Content:

| Unit No. | Content | No. of Hours | % of Weightage |
|-----------|---|--------------|-------------------|
| UNIT – I | Polymerization Technique <ul style="list-style-type: none">- Introduction- Bulk Polymerization- Solution Polymerization- Suspension Polymerization- Emulsion Polymerization | 06 | 15% (10 Marks) |
| UNIT– II | Glass Transition Temperature & Polymer Structure <ul style="list-style-type: none">- Introduction<ul style="list-style-type: none">• Glass transition temperature and associated properties• Factors affecting T_g• Significance of T_g- Polymer morphology- Polydispersity- Degree of polymerization- Molecular weight of polymer<ul style="list-style-type: none">• Concept• Molecular weight distribution• Significance of molecular weight- Microstructure based on (Chemical structure & Geometric structure)- Polymer crystallinity<ul style="list-style-type: none">• Concept• Number average & weight average molecular weight• Crystalline and amorphous structure of polymer• Crystallisability• Factors affecting crystallisability• Effect of crystallinity on polymer properties | 12 | 25% (20 Marks) |
| UNIT– III | Polymer degradation <ul style="list-style-type: none">- Introduction- Types of degradation (Chain-end & Random)- Degradations – factors & its impact and remedies of:<ul style="list-style-type: none">• Thermal• Mechanical | 06 | 15% (10 Marks) |



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|------------------|---|-----------|----------------------------------|
| | <ul style="list-style-type: none">• Ultrasonic wave• Photo• Oxidative• Hydrolytic | | |
| UNIT – IV | Polymer Reaction and Polymer Solution <ul style="list-style-type: none">- Introduction- Hydrolysis- Acidolysis- Aminolysis- Hydrogenation- Addition reactions- Substitution reactions- Cross-linked reactions | 06 | 15% (10 Marks) |
| UNIT – V | Industrial Manufacturing of Polymer <ul style="list-style-type: none">- Introduction- Industrial manufacturing process of polymers:<ul style="list-style-type: none">• Low density polyethylene (LDPE)• High density polyethylene (HDPE)• Poly Propylene (PP)• Poly Vinyl Chloride (PVC)• Poly Styrene (PS)• Acrylo Nitryl Butadine Styrene (ABS)• Poly Amide (Nylon)• Poly Carbonate• Poly Methyl Methacrylate (PMMA)• Phenol Formaldehyde (PF)• Urea Formaldehyde (UF)• Melamine Formaldehyde (MF) | 12 | 30% (20 Marks) |
| | Total | 42 | 100% (70 Marks) |

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks (in %) | | | | | |
|-------------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 35% | 35% | 30% | - | - | - |



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Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

| S. No. | Title of Book | Author | Publication with place, year and ISBN |
|--------|--|-------------------------|---|
| 1 | Textbook of Polymer Science | Fred W. Billmeyer | John Wiley & sons, Singapore, 2009, 978-0-471- 03196-3 |
| 2 | Polymer Science | Govariker V.R | New Age International Pub, Delhi, 2019, 9788122438130 |
| 3 | Polymer Science and Technology | Fried J.R | Prentice Hall, Delhi, 2014, 9780137039555 |
| 4 | Polymer Science and Technology | Ghosh Pramamoy | Tata McGraw Hill Education Pvt. Ltd, Delhi, 2010, 9780070707047 |
| 5 | Polymer Chemistry | Charles E. Carraher Jr. | CRC Press, Delhi, 2017, 9781498737388 |
| 6 | Plastics Materials | J A Brydson | ISBN: 978-0-7506-4132-6 Publisher: Elsevier Science Published: 22 Nov 1999 |
| 7 | Polymer Degradation and Stabilization | W. L. Hawkins | ISBN :9783642693762 Publisher: Springer Berlin Heidelberg Published:6 December 2012 |
| 8 | Thermoplastic Materials: Properties, Manufacturing Methods, and Applications | Christopher C. Ibeh | ISBN 1420093835 Publisher CRC Press Published 25 April 2011 |

(b) Open source software and website:

- <https://ndl.iitkgp.ac.in>
- <https://onlinecourses.nptel.ac.in>
- <https://swayam.gov.in/explorer>
- www.cheresources.com



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Suggested Course Practical List:

| Sr. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------------|---|----------|-----------------------|
| 1 | Compare different types of polymerization techniques with respect to its physical parameters. | 1 | 02 |
| 2 | Prepare Polystyrene by bulk polymerization technique. | 1 | 04 |
| 3 | Determine T_g of High Density Polyethylene by Dilatometer method. | 2 | 02 |
| 4 | Determine number average molecular weight of Polypropylene by End Group Analysis. | 2 | 02 |
| 5 | Determine molecular weight of polystyrene using Ostwald viscometer. | 2 | 02 |
| 6 | Compare different types of polymer degradation method. | 3 | 02 |
| 7 | Prepare vinyl alcohol from PVAc using polymer modification method. | 3 | 04 |
| 8 | Prepare MMA monomer from depolymerization of PMMA. | 3 | 04 |
| 9 | Prepare PMMA using suspension polymerization technique. | 5 | 04 |
| 10 | Manufacture Polycaprolactum by interfacial condensation polymerization technique. | 5 | 04 |
| 11 | Prepare polyester from ethylene glycol and maleic anhydride by interfacial polymerization. | 5 | 04 |
| 12 | Prepare Phenol Formaldehyde by polycondensation process. | 5 | 04 |
| Total | | | 38 |

List of Laboratory/Learning Resources Required:

| Sr. No. | Equipment Name with Broad Specifications |
|---------|--|
| 1 | Dilatometer |
| 2 | Ostwald viscometer with fittings |
| 3 | Various glasswares |
| 4 | Laboratory scale polymerizer set-up |
| 5 | Drying oven |



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Suggested Project List:

1. Prepare comparative chart for different polymerization techniques
2. Prepare a chart of polymers showing classification based on microstructure
3. Compare different polymer degradations
4. Prepare charts for various polymer reactions
5. Prepare model of polymerizer
6. Prepare a flow chart of manufacturing a polymer

Suggested Activities for Students:

1. Assignments
2. Technical Quiz/MCQ Test
3. Presentation on some course topic
4. I-net based assignments
5. Students are encouraged to register themselves in various MOOCS such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning

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