



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: Plastics Engineering

Subject Code: BE05053061

Subject Name: Conductive Plastics

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 2

Prerequisite:	<ul style="list-style-type: none">• Basic understanding of polymer chemistry, structure-property relationships and classification of thermoplastics and thermosets.• Knowledge of polymer processing techniques.• Fundamental concepts of electrical properties of materials, including conductivity, resistivity, dielectric behavior and percolation in filled polymers.
Rationale:	The growing demand for lightweight, corrosion-resistant and multifunctional materials in electronics, automotive, aerospace and energy sectors has led to the rapid development of conductive plastics. By incorporating conductive fillers or intrinsically conductive polymers, conventional insulating polymers can be engineered to exhibit controlled electrical conductivity, electromagnetic interference (EMI) shielding, antistatic behavior and sensing capabilities. This course provides students with fundamental and applied knowledge of conduction mechanisms in polymers, selection of conductive fillers, compounding techniques, structure-property relationships and performance evaluation. It also addresses practical applications, such as electronic housings, flexible circuits, energy storage devices and smart materials. The subject equips students with the technical expertise required for careers in advanced polymer compounding, electronics materials development and high-performance functional plastics industries.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Remember the basic concepts of polymer conductivity, electrical properties of materials, and types of conductive polymers and fillers.
02	Understand the mechanisms of electrical conduction in polymers, including percolation theory, charge transport and dielectric behaviour.
03	Apply techniques for compounding polymers with conductive fillers to achieve targeted electrical, mechanical and thermal properties.
04	Analyze the effect of polymer matrix, filler type, dispersion and processing conditions on the conductivity, EMI shielding and antistatic performance of conductive plastics.
05	Evaluate suitable polymer-filler combinations and processing methods for specific engineering applications, considering cost, performance and environmental impact.
06	Create innovative conductive polymer formulations or component designs for practical applications, such as electronic housings, sensors, flexible circuits and energy storage devices.



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Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH / 30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	TH		Theory		Tutorial / Practical			
						ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	00	30	15	90	03	70	30	10	10	30	150

Where L = Lecture, T = Tutorial, P = Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End- Semester Examination, PA = Progressive Assessment

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction to Conductive Plastics: Overview of conductive polymers and plastics; need and applications in electronics, automotive, aerospace and energy sectors; types of conductive plastics – intrinsically conductive polymers, filled polymers and composites; advantages and limitations.	6	13
2.	Electrical Properties of Polymers: Basic electrical concepts – conductivity, resistivity, dielectric properties; conduction mechanisms in polymers; percolation theory; influence of polymer structure and morphology on conductivity; temperature and frequency effects.	8	18
3.	Conductive Fillers and Additives: Types of conductive fillers – carbon black, graphite, graphene, carbon nanotubes, metal powders; filler selection criteria; role of filler size, shape, aspect ratio and surface treatment; synergistic effects of hybrid fillers; antistatic and EMI shielding applications.	8	18
4.	Processing of Conductive Plastics: Compounding and blending techniques; melt mixing, solution processing and <i>in situ</i> polymerization; dispersion and distribution of fillers; effect of processing parameters on electrical, mechanical and thermal properties; molding and fabrication methods.	7	15
5.	Properties and Performance Evaluation: Mechanical, thermal and electrical testing of conductive plastics; surface resistivity and volume resistivity measurement; EMI shielding effectiveness; durability, thermal stability and environmental effects; structure–property relationships.	8	18
6.	Applications and Emerging Trends: Practical applications – electronic	8	18



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housings, flexible circuits, sensors, batteries, fuel cells, antistatic components and smart materials; trends in high-performance conductive polymers; sustainability and recyclability considerations; case studies from industry.		
Total	45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	25	10	5	5	5

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:

- 1) Conducting Polymer: A New Era in Electrochemistry by G. Inzelt.
- 2) Conducting Polymers, Fundamentals and Applications by P. Chandrasekhar.
- 3) Conductive Polymers and Plastics by L. Rupprecht.
- 4) Conductive Polymers and Plastics by J. M. Margolis.

(b) Open source software and website:

- 1) <https://nptel.ac.in/>

Suggested Course Practical List:

Practical based on above topics.

List of suggested activities for Term-Work / Self-Learning:

S. No.	Activity	No. of Hours	Total Hours Claimed	Evaluation Criteria
1	Industry / Research laboratory visit	Visit = 5 h, Report preparation = 5 h	10	Based on report submitted
2	Poster / chart / power point preparation on technical topics	Duration = 10 h	10	Based on Poster / Chart / PPT preparation and presentation skills
3	Assignment writing	5 assignments of 2 h each	10	Based on the assignment submitted
4	Technical Video based learning related to the subject	Duration of video = 5 h Report preparation = 5 h	10	Report / presentation based on the video learning outcomes



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5	Group Discussion on emerging / trending technical topics based on subject	Duration = 1 h each	-	Based on performance in group discussion, technical depth, knowledge, etc.
6	Attending Expert Lecture / Webinar / Seminar	Duration = 1 h each	-	Based on Short report
7	Self-learning on-line course	Minimum duration of the course should be 10 h	10	Examination based assessment at the end of course. Based on the certificate produced
8	Exhibition / Conference / Trade Fair / Industrial exposure for 2-3 days	Visit = 15 h, Report preparation = 5 h	20	Based on learning, observations and short report
9	Working model on technical topics	Working = 15 h	15	Based on design, understanding & presentation of the model
10	Non-working model on technical topics	Non-working = 5 h	5	Based on design, understanding & presentation of the model
11	Videos on Industrial safety aspects based on subject	Duration of video = 5 h Report preparation = 5 h	10	Based on report submitted

- Above activities are suggestive, faculty can choose any of these activities and cover up the rest of the 15 Self Learning Hours.
- The number of hours is suggestive.
- Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.

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