GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: Plastics Engineering

Subject Code: BE05053071

Subject Name: Plastic Characterization Techniques

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

Prerequisite:	• Basic knowledge of polymer science. • Fundamental understanding of metrology. • Basic knowledge of mathematics.
Rationale:	Testing of plastic products is essential to ensure that polymer materials and finished plastic components meet required performance, safety, durability, and quality standards. This subject introduces students Characterization techniques of plastics. The course builds a strong foundation for advanced testing methods, failure analysis, and product certification.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Understand the importance of characterization techniques.
02	Understand analysis with using DSc, TGA, etc.
03	Analyze with UV / visible spectroscopy.
04	Interpret test results as per ASTM, ISO and BIS standards.
05	Select appropriate test methods for different plastic products and applications.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	00	30	15	90	03	70	30	20	30	50	200

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.	**Molecular Characterization of Polymers** Determination of molecular weight, viscometry, end group analysis, colligative property, osmometry, light scattering technique, determination of molecular weight and molecular weight distribution, gel permeation chromatography (GPC).	8	15
2.	**Thermal Analysis of Polymers:** Differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), thermomechanical analysis (TMA), dynamic mechanical thermal analysis (DMTA).	7	15
3.	**X-ray diffractometry:** X-ray diffraction analysis, experimental methods, applications – chain conformations, chain packing, disorder in the crystal, degree of crystallinity, micro structural parameters, degree of orientations. **Principles of microscopy:** Optical, SEM, TEM, AFM; Morphology of polymers, crystallization behavior, phase separation and applications.	6	10
4.	**UV/Visible Spectroscopy** Introduction, principle, Lambert law, Beer's law, theory, instrumentation, procedure, advantages, disadvantages, interpretation of spectrogram, applications – qualitative analysis, quantitative analysis, purity, cis- and trans-conformation.	8	25
5.	**Fourier Transformer Infrared (FTIR) Spectroscopy** Introduction, principle, theory, instrumentation – ATR attachment – methods of sample preparation, advantages, disadvantages, interpretation of spectra – applications – establishment of chemical structure of polymers, reaction kinetics, polymer linkage, hydrogen bond formation, purity, copolymerization, qualitative and quantitative results – gas chromatograph (GC) – Mass spectrometer.	9	25
6.	**Nuclear Magnetic Resonance (NMR) Spectroscopy** (^{1}H NMR and ^{13}C NMR) – Introduction, principle, theory, spin-spin coupling, coupling constant, chemical shifts, instrumentation, procedure, method of sample preparation, applications – chemical structures, purity, tacticity.	7	10

	Solid state NMR – applications.		
	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**
15	20	20	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:

Text Book

(b) Hunt & James, *Polymer Characterization*, Chapman & Hall, London, 1993.

References

(c) Chermisinoff, *Polymer Characterization – Laboratory Techniques and Analysis*.
(d) Hunt & James, *Polymer Characterization*, Chapman & Hall, London, 1993.
(e) Kampff, *Characterization of Plastics using physical methods, Experimental techniques and practical applications*.
(f) Hoffman, *Rubber Technology Handbook*, Hanser Publishers, Munich, 1996.

(g) Open source software and website:

1) https://nptel.ac.in/
2) https://www.astm.org/
3) https://www.iso.org/
4) https://www.bis.gov.in/

Suggested Course Practical List:

1. Determine melting point of plastics by DSC.
2. Determine filler content by using TGA.
3. Deterrmine presence of UV stabilizer by using UV spectrometer.

- **List of suggested activities for Problem Based 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
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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