GUJARAT TECHNOLOGICAL UNIVERSITY
PLASTIC TECHNOLOGY
B. E. SEMESTER: VII

Subject Name: **Project-I**
Subject Code: **170001**

Teaching Scheme				Evaluation Scheme			
Theory	Tutorial	Practical	Total	University Exam (E)		Mid Sem Exam (Theory) (M)	Practical (Internal)
				Theory	Practical		
0	0	4	4	0	100	0	50

Sr. No	Course Content
1.	As part of requirement of practical project work, student has to identify his project in stage 1. (ie Project I) which he will continue as Project II. (in next semester) For identification of Project work, the student may follow any one of the options. 1. Industrial training of 3 to 4 weeks at the end of semester V and/or VI. ie. before start of semester VII, under the guidance of industrial person or faculty. A student will identify an industrial problem to work on. 2. Industrial Problem identified by the faculty and or industrial person may be assigned as Project work. 3. Faculty may assign a research based work as project to students. In preparing the report he may include the following topics. 1. Introduction 2. Definitions 3. Raw materials/selection criteria of process 4. Process in details. 5. Various process parameters 6. Properties 7. Application 8. Test 9. Recent development in topic 10. Cost Estimation. 11. Environmental Issues. 12. Fire and Safety measures 13. Conclusion

	14. Appendix 1. Demand/supply gape 2. Name of the manufacturers a) Raw material b) Machine c) Mold/die d) Auxiliary equipment 3. Process control and instrumentation 15. References

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Plastic Technology (23)
SUBJECT NAME: Plastics Mold and Die Design
SUBJECT CODE: 2172302

B.E. 7TH SEMESTER

Type of course: CORE

Prerequisite: Basic Plastic Processing, IMT, PET
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives: To learn basics of mold and Die Design.

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction** Basics , Principles of mould design, selection of materials for moulds and dies, method of fabrication, economical consideration	**04**	8%
2	**Material Of Molds & Dies** Steels, various types, selection criteria, ferrous & non ferrous material, alloys, heat treatment processes. Material selection for various parts of mould like cavity, core, back plates, inserts, and guide pins, guide bushes, ejector elements, etc. Material selection for various parts of Dies like approach section , land ,etc.	**06**	10%
3	**Fabrication Techniques** Lathe, milling, grinding, drilling, shaping, planning, spark erosion, honing, electroforming, EDM, CNC, etc.	**06**	10%

4	**Injection Mold Design** **Introduction:** Two plates, three plate, runnerless molds, parting lines, split molds, molds for threaded components. **Feed system:** Designs of various types of runners, gates, balancing of runners,runner efficiency calculations, requirements of runners and gates, positioning of gates, mold filling patterns, etc. **Ejection system:** Pin ejection, stripper plates, valve ejection, blade ejection, air ejection, etc. **Cooling & heating arrangements:** Design of cooling channels, layouts, etc. **Numericals on shot capacity calculations, plasticizing capacity, no.of impressions, to be done. Actual sheet work showing design of hand moulds to be done. Caculations on gate, runners,etc.**	**10**	40%
5	**Design of Extrusion Dies** : Parts of the Die, its functions, design formulae for design of approach section, land, etc. Rheological considerations, Design of straight through dies with calculations.	08	10%
6	**Design Of Compression Moulds:** Design of positive, semi positive and flash moulds in detail along with examples, sheet work, performs, etc.	05	6%
7	**Design of Transfer moulds:** Pot type, plunger type, mould design, design of Pot, feed systems, etc.	04	5%
8	**Practical Design of Moulds, Dies : Sheet work to be highlighted , third angle method of projection , bill of materials, etc.**	08	11%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
10	**15**	**20**	**15**	**10**

Legends: R: Remembrance; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Text Book:

1. Injection Mould Design by RGW PYE

Reference Books:

1. Injection mould design fundamentals by Denton and Glanvill
2. Extrusion Dies Walter Michael
3. Dies for Plastic Extrusion: M. V. Joshi

Course Outcome:

After learning the course the students should be able to:

1. Design and Draw Hand Injection moulds
2. Calculate feed system dimensions
3. Design Extrusion Dies

List of Experiments:

1. Design a hand Injection mould for the product given in figure.
2. Draw the above designed mould in a half imperial sheet.
3. Design and Draw a Hand Injection 2 impression mould for the given product. Show feed System calculations.
4. Draw a detailed sheet for sheet no.1
5. Show calculations for shot capacity for data given. [Based on shot capacity calculations for New material, calculations for required machine shot capacity, etc]
6. For the products given, suggest and design suitable feed system.
7. For the extruded product, design suitable die
8. For the mould parts shown in figure, suggest step by step machining.
9. Design and Draw a suitable compression for the product suggested.
10. Design and Draw a Pot type transfer mould.

Design based Problems (DP)/Open Ended Problem:

1. For the product given, design, draw and fabricate a suitable hand injection mould.
2. For the product given, design, draw and fabricate a compression mould.

Major Equipment: List of Open Source Software/learning website:

1. **www.wikipedia.org**
2. **www.sciencedirect.com**
3. **www.mit.edu**

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Plastic Engineering (23)
SUBJECT NAME: Additives and Compounding of Plastics
SUBJECT CODE: 2172303

B.E. 7TH SEMESTER

Type of course:
Prerequisite: IPMS, Chemistry of Plastic Materials, BPP, Advance Plastic Processing.
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives: To study the additives and compounds that can be used with plastic materials and design newer applications.

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction** – Technological Requirements – Classification – Chemistry and Mechanism – Selection Criteria – General effect on Properties – Evaluation and functions of additives.	5	5
2	**Fillers – Reinforcements** – Thermal Stabilizers- Antioxidants (Heat & UV) – Plasticizers - Impact Modifiers – Lubricants - Processing aids – Blowing agents – Flame Retardants – Anti-static agents – Anti blocking agent- Slip and anti slip agent- processing aids- Mould releasing agents. Conductive additives- Toughening agents – Nucleating agents – Colorants – Additives for Recycling – aids – mould releasing agents, coupling agents, antislip, etc. Commercially available fillers and additives	15	20
3	**Selection of Polymers and Compounding ingredients** – General objectives – possibilities and limitations of mixing and compounding – Methods of incorporation of additives into polymer materials, Mixing	10	15

	and mixing equipments.		
4	**Mixing and mixing equipments. Principles** – Operating characteristics – Machine construction – Specifications – Process control systems and working details of Batch mixers and continuous mixers – High speed mixer – Two roll mill – Banbury Mixer – Ribbon blender – Planetary mixers –Twin screw extruders [co rotating / counter rotating].	10	20
5	Mixing Methodologies : Types of Mixing, Dispersive/Distributive, Agglomerates, mixing of solid additives, mixing of liquid additives, Difference between mixing and compounding, etc.	8	20
6	**End Use Market for Plastics** Principles of Material selection including consideration of conventional materials competitive with plastics – Case studies on material suitability (e.g., Plastic Gears, Feeding Bottle, Bowels for micro wave ovens). Survey and uses of plastics additives with reasons for their importance in major industries like, Agriculture, Packaging, Building, Transport, Electrical, Electronics and Telecommunications, Medical and Furniture.	3	20

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
10	**15**	**20**	**15**	**10**

Legends: R : Remembrance ; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Text Book:

1. J. A. Brydson, Plastics Materials, Butterworth Heinemann, Oxford, 1999.
2. John Murphy, The Additives for Plastics Hand Book, Elsevier Advanced Technology, Oxford, 1996.
3. Mixing and compounding of polymers Theory and Practice, Author: Manas-Zloczower, Ica

Reference Books:

1. R. Gachter and H. Muller, Plastics Additives Hand Book, Hanser Publishers, Munich, 1993.
2. Jesse Edenbaum, Plastics Additives and Modifiers Hand Book, Chapman & Hall, London, 1996.
3. Ica Manas – Zloczower and Zehev Tadmor, Mixing and Compounding of Polymers, Hanser Publications, Munich, 1995.
4. Nicholas P. Cheremisionoff, Polymer Mixing and Extrusion Technology, Marcel Dekker Inc., New York, 1995.

Course Outcome:

After learning the course the students should be able to:

1. Identify additives and compounds suitable for specific applications.
2. Suggest suitable fillers/reinforcements/additives for new applications.
3. Develop new compounds for specific applications.

List of Experiments:

1. To carry out compounding of PP with various additives for specific applications.
2. To do PVC compounding using high speed mixer.
3. To carry out mixing of thermoplastics with rubber materials on two roll mill.To analyse mixing time v/s. Speed of rolls, study effects using microscope on morphology.
4. To study effects of additives on properties of LDPE
5. To study effects of additives on properties of PP
6. To study effects of additives on properties of PVC
7. To study effects of additives on properties of ABS
8. To carry out compounding using twin screw extruder.
9. To prepare compounds of plastic materials with additives suitable for medical applications
10. To prepare compounds of plastic materials with additives suitable for automotive applications.

Design based Problems (DP)/Open Ended Problem:

1. Design and manufacture of compounds of plastic materials for machinery applications.
2. Design and Manufacture of compounds of plastic materials for high impact applications.

Major Equipment:

List of Open Source Software/learning website:

1. **www.wikipedia.org**
2. **www.sciencedirect.com**
3. **www.mit.edu**

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Plastic Engineering (23)
SUBJECT NAME: FRP Technology and Composites
SUBJECT CODE: 2172307

B.E. 7TH SEMESTER

Type of course:
Prerequisite: IPMS, Chemistry of Plastic Materials
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;
Learning Objectives: To enable learning of resins, fibers, FRP and composite product manufacturing processes

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**General introduction.** Introduction- Composites- Advantages of FRP –Role of resin and reinforcements -Applications of FRP. **Designing in FRP –** Selection criteria - material and process selection	3	10
2	**Molds for FRP.** Introduction – Plaster mold, wooden Mold - GRP molds- Epoxide molds- Steel molds- Aluminum alloy molds- Nickel shell molds.	4	10
3	**Polyester resins.** Introduction-polyester resins – glycols - unsaturated acids - saturated acids-monomers- inhibitors - Commercial resins - Gelcoat/top coat resins- General purpose resins - Chemical resistant resins- Reduced flammability resins - Low styrene emission resins – Low shrinkage /low profile resins- Special purpose resin.	7	15

4	**Catalyst/Accelerators and Inhibitors for unsaturated polyester resins.** Introduction – Curing reactions - Catalyst -diacyl peroxides-ketone peroxides-hydro peroxides-dialkyl and diaralkyl peroxide -peroxy esters-perketals. Accelerators or promoters-metal compounds-totality amine - accelerators-mixed motel salts-t-amine accelerators,-inhibitors.	**2**	**10**
5	**Epoxide Resins:** Introduction- Bisphenol A based resins- Glycidyl ester resins- Glycidyl amine resins- Glycidyl ethers of novolac resins- Brominated resins- Diluents- Reactive diluents- Non-reactive diluents. Curing Agents for Epoxide Resins.	**6**	**10**
6	**Reinforcements:** Introduction - Surfacing tissue –Glass fiber - Continuous filament rovings- Chopped strands- Chopped strand mats- Continuous strand mat- Woven glass fabrics- Carbon fiber- Aromatic polyamide (aramid) fibers - Polyester fibers- Polyacrylonitrile fibers - Nylon - PVC and PVDC Cotton – Sisal - Asbestos– Jute- Boron fibers.	**6**	**15**
7	**Molding Processes.** Introduction - Contact molding -hand lay up - Spray lay-up- Vacuum bag molding - Pressure bag molding – Resin transfer or resin injection molding-pressure injection- Vacuum impregnation and injection - Hot press/matched metal molding - Filament winding- Centrifugul molding - Continuous sheet manufacture – Pultrusion - Sandwich construction.	**12**	**20**
8	**Bulk, Dough and Sheet molding Compounds and Prepregs.** Introduction- Dough and bulk molding compounds - Sheet mould compounds- manufacture of SMC- Prepregs - Commercial products	**2**	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
10	**15**	**20**	**15**	**10**

Legends: R : Remembrance ; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Textbooks:

1. FRP TECHNOLOGY by Weatherhead.
2. FIBERREINFORCED COMPOSITES- Materials, Manufacturing, and Design by P.K. Mallick
3. COMPOSITES MANUFACTURING- Materials, Product, and Process Engineering by Sanjay K. Mazumdar
4. Hand book of Reinforcement for plastics – Milewski
5. M O W Richardson "Polymer Engineering Composite" – Applied Science.

References:

1. Reinforced Plastics Handbook by Donald Rosato, Dominick Rosato, Elsevier Science & Technology Books, 2004

Course Outcome:

After learning the course the students should be able to:

1. Know various applications of FRP
2. Identify resins suitable for specific applications
3. Identify reinforcements suitable for particular applications.
4. Design new applications for FRP products

List of Experiments:

1. To manufacture tray using hand layup technique.
2. To manufacture pen stand in FRP using spray up technique.
3. To study RTM process
4. To study pultrusion process
5. To study filament winding process and learn various winding techniques.
6. To prepare FRP articles using centrifugal casting
7. To prepare composites using epoxy resins
8. To fabricate composites using multiple fibers and study effects by testing them.
9. To make composites using fibers and fly ash.
10. To make composites for marine applications.

Design based Problems (DP)/Open Ended Problem:

1. Design and Fabricate Pultrusion machine.
2. Design and fabricate filament winding machine
3. Design and fabricate moulds for hand layup.

Major Equipment: List of Open Source Software/learning website:

1. **www.wikipedia.org**
2. **www.sciencedirect.com**
3. **www.mit.edu**

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Plastic Engineering (23)
SUBJECT NAME: Speciality Plastics and Applications
SUBJECT CODE: 2172307

B.E. 7TH SEMESTER

Type of course:
Prerequisite: IPMS, Chemistry of Plastic Materials
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives: To enable learning of Speciality Plastic Materials, their properties, applications.

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**General introduction.** Introduction- High Performance Plastics definition, Definition of Speciality plastics, commercially available speciality and high performance plastics, Engineered plastics, plastics for specific industry like medical, automotive, textile, Dairy, Machine tools,etc. Selection Criteria	5	5
2	**HIGH PER FORMANCE PLASTICS: PEEK, PES, LCP, PTFE, POLYIMIDES,** PAI/ PPS/ PEI/ E CTFE/ PPE**, etc. Chemistry, properties, applications of each of these**	7	10
3	**Plastics used in Medical Applications:** **Material Requirements for Plastics used in Medical Devices** Introduction, Material Characterization, Sterilization, Chemical Resistance, Biocompatibility, USP Class VI, ISO 10993, Shelf Life	7	10

	and Aging & Joining and Welding. **Polymer Additives Used to Enhance Material Properties for Medical Device Applications** Introduction, Types of Additives, Things to Consider When Using Additives, Plasticizers, Wear-Resistant and Lubricious Additives, Pigments, Laser Marking, Radiopaque Additives, Antimicrobials, Conductive Fillers, Nanoadditives & Stabilizers. **PLASTICS IN DRUG DELIVERY**		
4	**PLASTICS USED IN AUTOMOTIVE INDUSTRIES: Selection Criteria, requirements of materials, Plastics like PP, PU, PVC, PET, PBT, ABS, NYLON6, PE, POM [POLYOXOMETHYLENE], PC, PMMA, ASA (acrylonitrile styrene acrylate). Chemistry, properties, applications.**	**7**	**10**
5	**PLASTICS USED IN AEROSPACE/AVIATION INDUSTRY: Requirements in Aerospace/Aviation, Selection Criteria, Plastics like FLOROPOLYMERS, PI, PEEK, PPS, PPSU, PEI, PPP, ETC. Chemistry, properties, applications.**	**7**	**10**
6	**Plastics in Construction Industry : Requirements in Marine Industry, Selection Criteria, Plastics like PVC, CPVC, PU, EPOXY, PC, ABS,ETC. CHEMISTRY, PROPERTIES, APPLICATIONS**	**6**	**10**
7	**PLASTICS IN MARINE INDUSTRY:** REQUIREMENTS, selection criteria, Platsics like Acrylics, Acetals,Polyethylenes, foams, PP,uhmwpe,etc. Chemistry, properties, applications.	**6**	
8	**PLATICS IN SEMICONDUCTOR INDUSTRY** : REQUIREMENTS, selection criteria, Plastics like PVDF, PP, PTFE (polytetrafluroethylene); FEP (fluorinated ethylene propylene; PFA (perfluoroalkoxy), ECTFE (ethylene chlorotrifluoroethylene) and PCTFE (polychlorotrifluoroethylene),ETC	**6**	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
10	**15**	**20**	**15**	**10**

Legends: R: Remembrance; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Textbooks:

1. High Performance Polymers and Engineering Plastics, Vikas Mittal (Editor), Wiley

2. Practical Guide to High Performance Engg. Plastics, **By David J. Kemmish,RAPRA**

References:

1. Wikipedia

Course Outcome:

After learning the course the students should be able to:

1. Know about speciality and high performance plastics.
2. Know various applications of high performance plastics in specific industries

List of Experiments:

1. **To study the properties and applications of PEEK**
2. **To study properties and applications. Of Flouro polymers.**
3. **To study properties of sulphone based polymers.**
4. **To study properties and applications of IMIDE polymers.**
5. **To study properties and applications of ACETALS.**
6. **To study Medical plastics and do tests to comply for medical applications.**
7. **To study plastic applications in semiconductor industry.**
8. **To study applications of plastics in Cosntuction industry.**
9. **To study applications of plastics in Defence.**
10. **To study applications of plastics in Marine**

Design based Problems (DP)/Open Ended Problem:

Major Equipment: List of Open Source Software/learning website:

1. **www.wikipedia.org**
2. **www.sciencedirect.com**
3. **www.mit.edu**

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Plastic Technology (23)

SUBJECT NAME: Adhesives and sealants

SUBJECT CODE: 2172306

B.E. 7TH SEMESTER

Type of course: ELECTIVE
Prerequisite: CHEMISTRY OF PLASTIC MATERIALS, IPMS
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives: To educate students on the importance of relationship of Plastic Structure with properties and applications of plastics

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Fundamentals of Adhesives** Introduction to Adhesives, the role of Adhesives in the economy, fundamentals of adhesion, surface preparation for adhesion bonding, adhesive selection and screening.	5	5
2	**Natural Adhesive Materials** Animal glue, casein and mix protein adhesives, starch base adhesives	5	5
3	**Rubber Base Adhesive Material** Natural rubber adhesive, butile rubber and polyisobuteline, nitrile rubber adhesive, styeren butadiene rubber adhesive, thermoplastic rubber in adhesive, carboxylic polymers in adhesive, neo prene based solvent and latex adhesive, polysulfide sealant and adhesives.	5	10

4	**Resin Based Adhesives** Phenolic resin adhesive, amino resin adhesive, epoxy resin adhesive, Polyurethane & isocyanate based adhesive	5	10
5	**Polyvinyl Based Adhesive** Polyvinyl acetate emulsions for adhesives, polyvinyl alcohol for adhesives, polyvinyl acetal adhesive	5	10
6	**High Performance Based Adhesive** polyester and polyamide high performance hot melt adhesives, high temperature organic adhesives, silicone adhesives sealants and abrasives, organofunctional silane coupling agents, non-silance coupling agents, resins for elastomer based adhesives, polyolefin and ethylene copolymer based hot melt adhesives, acrylic adhesives, anaerobic adhesives, cyanoacrylate adhesives.	7	10
7	**Bonding Technology :** Bonding plastics, bonding textiles to rubber, bonded adhesives	5	10
8.	**Adherends And Bonding Technology** Wood adhesive, sealants and caulks, pressure sensitive adhesives for taps and labels, coated abrasives.	7	10
9	**Adhesives For Industrial Application** Adhesives for building construction, adhesives in electrical industry, conductive adhesives, structural adhesives in aerospace industry, adhesives in automobile industry, Meter, Mix & dispersing equipments-basic design, robotic dispersing of sealants and adhesives.	7	30

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
15	**15**	**20**	**10**	**10**

Legends: R: Remembrance; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Text Book:

1. Handbook of adhesives (Third edition) by Irving Skeist
(Publication- VAN NOSTRAND REINHOLD, NEW YORK)

2. Handbook of Adhesives and Sealants by Edward M. Petrie

3. Adhesives and Sealants: Technology, Applications and Markets by David J Dunn

4. Handbook of Adhesives and Sealants: Basic Concepts and High Tech Bonding

   Phillipe Cognard

Course Outcome:

After learning the course the students should be able to:

1. **Understand and apply the knowledge of adhesives and sealants in practical life.**
2. **Know how to effectively use this knowledge to design new polymer systems**

List of Experiments:

1. **Develop Epoxy based adhesive in lab**
2. **Develop PU based adhesive in lab**
3. **Develop TPE based adhesive in lab**
4. **Develop adhesive for roofing applications**
5. **Develop sealants based on thermoplastics**
6. **Develop sealants based on thermoset materials**
7. **Develop Adhesives for furniture industry**
8. **Develop adhesives for piping systems**
9. **Study adhesives used by electronic industry**
10. **Study sealants used by pharmaceutical industries.**

Design based Problems (DP)/Open Ended Problem:

Major Equipment: List of Open Source Software/learning website:

1. **www.wikipedia.org**
2. **www.sciencedirect.com**
3. **www.mit.edu**

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Plastic Technology (23)

SUBJECT NAME: Plastic Structure Property Relationship

SUBJECT CODE: 2172309

B.E. 7TH SEMESTER

Type of course: ELECTIVE
Prerequisite: CHEMISTRY OF PLASTIC MATERIALS, IPMS
Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Learning Objectives: To educate students on the importance of relationship of Plastic Structure with properties and applications of plastics

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Structure of Polymers** * Thermo set and thermoplastic behavior of polymers * Molecular arrangement of polymers: linear, branched and cross linked • Homo chain & hetero chain plastics • Molecular orientation in polymeric material • Sub molecular structure of polymers	5	5
2	**Elements & their importance in polymer composition:** • Effect of elements and their presence in polymer composition • Carbon, Hydrogen, Oxygen, Nitrogen, Halogens,	10	20

	Sulphur, Silicon • Additives and their effects on properties of polymers • Plasticizers and softeners • Effects of plasticization upon structure and behaviour • Effect of plasticization upon mechanical, thermal and electrical properties • Effect of other additives like Fillers and reinforcement, Anti ageing agents, Flame retardants, Blowing agents, Cross linking agents & Colorants on properties of polymers.		
3	**Mechanical Properties**. • Various mechanical properties of polymers such as tensile strength, flexural strength, impact strength. • Effect of polymer structure on mechanical properties	7	10
4	**Effect of morphology on polymer properties** • Structure of polymer crystals • Factors affecting crystallinity in polymers • Difference in properties of crystalline and amorphous polymers • Effect of crystallinity on properties of polymer	5	15
5	**Chemical properties and Thermal properties** • Relation of structure of polymer to chemical properties by: Chemical bond , Chemical Reactivity, Exposure to energy sources, Other effects • Glass Transition temperature (Tg), Melting temperature (Tm) • Effect of plasticizers on Tg	6	10
6	**Electrical Properties and Optical Properties** • Electrical properties of polymers • Effect of polymer structure on electrical properties of polymers • Optical properties of polymers • Effect of polymer structure on optical properties of polymers • Birefringence and Polarization of light	7	10

7	**Intermolecular Bonding** • Polarity and effect of polarity on properties of polymers such as: • Processibility • Mechanical properties • Thermal properties • Electrical properties • Optical properties • Hydrogen bonding between polymer molecules • Effect of hydrogen bonding on melting behavior, solubility, mechanical strength	5	15
8.	**Relation of structure with properties of individual polymers and their applications** - PET - Nylon - PMMA - PP (isotactic, syndiotactic and atactic) - PE (HDPE,LDPE and irradiated PE) - PVC - Unsaturated polyester resin Etc.	6	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
15	**15**	**20**	**10**	**10**

Legends: R : Remembrance ; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Text Book:

1. Outlines of polymer Technology by R.Sinha
2. Polymer Structure, Properties and Applications by R.Deanin.

Course Outcome:

After learning the course the students should be able to:

1. **Understand and apply the knowledge of polymer structure and properties in practical life.**
2. **Know how to effectively use this knowledge to design new polymer systems**

List of Experiments:

1. **To study effect of presence of Carbon on polymer properties.**
2. **To study how presence of hydrogen affects polymer properties**
3. **To study how the presence of halogen atoms affects polymer properties.**
4. **To study the effects of polymer structure on mechanical properties**
5. **To study effects of polymer structure on Electrical properties**
6. **To study effects of polymer structure on Optical properties.**
7. **To study effects of polymer structure on thermal properties.**
8. **To study the effect of morphology on properties and applications of Nylon.**
9. **To study effect of morphology on properties and applications of PC.**
10. **To study effect of morphology on properties and applications of PMMA**

Design based Problems (DP)/Open Ended Problem:

Major Equipment: List of Open Source Software/learning website:

1. **www.wikipedia.org**
2. **www.sciencedirect.com**
3. **www.mit.edu**