MIT
Quest for Excellence

Maharashtra Institute of Technology

Chhatrapati Sambhajinagar

An Autonomous Institute Affiliated to

Dr. Babasaheb Ambedkar Marathwada University,

Chhatrapati Sambhajinagar, Maharashtra (India)

M. Tech Syllabus

(Polymer Science and Technology)

(NEP 2020 Based Curriculum)

WEF AY 2024-25

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Abbreviations used in this document

ESE	End-Semester Examination
Hrs	Hours
ISE	In-Semester Examination
L	Lecture (Theory)
MIT	**Maharashtra Institute of Technology**
MTP	**M. Tech in Polymer Science and Technology**
NEP	National Education Policy 2020
OEC	Open Elective Course
OJT	On-Job Training
P	Practical
PCC	Program Core Course
PEC	Program Elective Course
RM	Research Methodology
RP/DI	Research Project/Dissertation
S1	Semester -I
S2	Semester -II
S3	Semester -III
S4	Semester -IV
SEM	Seminar
T	Tutorial
TA	Teacher Assessment
WEF	With Effect From
Wk	Week

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First Year M. Tech (Polymer Science and Technology) Syllabus Structure
WEF 2024-25 (NEP 2020 Based Curriculum)

Semester-I

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	ISE -I	ISE -II	TA	ESE/ Oral Exam	Total
1	PCC	MTP501	Advanced Polymer Technology	3	1	-	4	4	15	15	20	50	100
2	PCC	MTP502	Polymeric Materials	3	1	-	4	4	15	15	20	50	100
3	PCC	MTP503	Polymer Processing Technology	3	-	-	3	3	15	15	20	50	100
4	PEC	MTP511 TO MTP513	Program Elective Course -1	3	-	-	3	3	15	15	20	50	100
5	RM	RMP521	Research Methodology	3	1	-	4	4	15	15	20	50	100
6	SEM	MTP531	Seminar-1	-	-	2	2	1	-	-	25	25	50
7	PCC	MTP541	Advanced Polymer Technology Laboratory	-	-	4	4	2	-	-	50	-	50
S1				15	3	6	24	21	75	75	175	275	600

Semester-II

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	ISE -I	ISE -II	TA	ESE/ Oral Exam	Total
1	PCC	MTP551	Polymers for Diversified Applications	3	1	-	4	4	15	15	20	50	100
2	PCC	MTP552	3D Printing Technology	3	1	-	4	4	15	15	20	50	100
3	PCC	MTP553	Advanced Polymer Characterisation	3	1	-	4	4	15	15	20	50	100
4	PEC	MTP561 TO MTP563	Program Elective Course -2	3	-	-	3	3	15	15	20	50	100
5	OEC	MTP571	Open Elective Course	3	-	-	3	3	15	15	20	50	100
6	SEM	MTP581	Seminar-2	-	-	2	2	1	-	-	25	25	50
7	PCC	MTP591	Advanced Polymer Characterisation Laboratory	-	-	4	4	2	-	-	50	-	50
S2				15	3	6	24	21	75	75	175	275	600
**	OJT	MTP611	Internship/ Field Project/OJT **	To be done In the Summer Vacation (Min 4 Weeks) after 2nd Sem for 04 Credits and to be evaluated in the IIIrd Semester.									

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Academic Council
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Semester-III

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	ISE -I	ISE -II	TA	ESE/ Oral Exam	Total
1	PCC	MTP601- To MTP605	MOOC Course specific to Program of Study #	$	-	-	$	3	--	--	--	100	100*
2	OJT	MTP611	Internship/ Field Project/OJT **	-	-	-	01	4	--	--	100	--	100
3	RP/DI	MTP649	Dissertation- I	-	-	-	04	14	--	--	200	100	300
S3				-	-	-	05	21	--	--	300	200	500

Semester-IV

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	ISE -I	ISE -II	TA	ESE/ Oral Exam	Total
1	RP/DI	MTP699	Dissertation- II	-	-	-	04	21	--	--	300	200	500
S4				-	-	-	04	21	--	--	300	200	500

$ - Lecture hours are not mentioned as the course offered is either in the online or self-paced study mode. The Contact hours per week is mentioned for actual contact with the Mentor / Research Supervisor. The student is expected to devote minimum 28 hours and 42 hours per week for Dissertation –I and II work respectively. ** To be done in Summer Break.

Program Elective Course-1 Basket:

Course Code	Course Title
MTP511	Total Quality Management
MTP512	Chemical Engineering for Polymers
MTP513	Plastic Packaging Technology

Program Elective Course-2 Basket:

Course Code	Course Title
MTP561	Polymer Blends and Composites
MTP562	Rubber and Fibre Technology
MTP563	Polymer Product and Mould Design

Open Elective Course:

Course Code	Course Title
MTP571	BOS recommended Interdisciplinary course at PG level (Physical or through Online Mode /MOOC)

MOOC Course specific to Program of Study:

Course Code	Course Title
MTP601	# These MOOC Courses will be as per the approved basket of Courses from Board of Studies (Program offering) and subsequently approved by the Academic Council as per the availability from time to time, available on the SWAYAM, NPTEL, Coursera, etc. If required, department can offer some courses in the self-paced study mode, where the learning materials is available in the e-content form either prepared by the department or available on University/National body recognized portal. The course selected must be of **minimum 3 Credits** and available at the time of study. * In case, if the Proctored exam is not conducted by the MOOC Platform, department will conduct the Internal Assessment and End-Semester examination. Total evaluation Converted (out of 100 marks) will be forwarded to Examination cell through Dean (Academics) for grading.
MTP602	
MTP603	
MTP604	
MTP605	

Students may opt for Exit after successful completion of First Year provided s/he earns 4 additional credits through Internship/OJT/Field Project during the summer vacation mentioned at the end of 2nd Semester. S/he will be awarded a 1-Year PG Diploma in Polymer Science and Technology. Details are available at the Department.

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Semester-I
Detail Course Curriculum

First Year M. Tech Syllabus
(Polymer Science and Technology)

(NEP 2020 Based Curriculum)

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PCC** Course Code: MTP501 **Advanced Polymer Technology** Teaching Scheme: Theory - 3 Hrs./week Tutorial - 1 hr./week	**Credits: 3-1-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.
Prerequisite	• Basic knowledge of polymers
Objectives	• To acquire knowledge on structures, different characteristics and synthesis of polymers. • To learn about testing methods and structure-property relationships in polymers.
Unit-I	**Overview of Polymers:** Classification of polymers, molecular structures of monomers and polymers, degree of polymerization. Molecular weight and its distribution, overview of molecular weight determination methods. Free volume concept, T_g, T_m and T_c. **(7 Hrs)**
Unit-II	**Polymer Solution:** Good, bad and theta solvent. Flory-Huggins theory. Hilderbrand and Hansen solubility parameters. Miscibility and immiscibility. Phase diagram and thermodynamic criteria of miscibility. **(5 Hrs)**
Unit-III	**Fundamentals of Polymer Synthesis:** Overview of different methods and techniques of polymer synthesis: condensation and addition polymerization; emulsion, bulk, solution, suspension and interfacial polymerization; co-polymerization. **(8 Hrs)**
Unit-IV	**Miscellaneous Routes of Polymerization and Grafting:** Overview of different routes of polymerization: ROMP, ATRP, RAFT, DA-rDA, Zieglar-Natta polymerization, Suzuki polymerization, electropolymerization. Examples of miscellaneous routes of grafting of polymer. **(5 Hrs)**
Unit-V	**Polymer Testing:** Destructive non-destructive testing of polymers. Overview of testing of mechanical characteristics: tensile, tear and impact strength; modulus and elongation at break, resilience, compression set, flexural rigidity, flex fatigue. Overview of miscellaneous testing methods and their significances: bulk density, MFI, abrasion resistance, stress relaxation, environmental stress cracking, flammability, gas permeability. Possible correlations among different testing results. **(8 Hrs)**

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Unit-VI	**Structure-Property Relationships in Polymers:** Effects of molecular structures, functional groups, molecular weight and its distribution on the characteristics of polymer. Effects of synthesis routes on the characteristics of polymers. Factors influencing crystallinity, T_g and T_m as well as their effects on the properties of polymers. **(6 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Physical Chemistry of Polymers	A. Tager, D. Sobolev, N. Bobrov	Mir Publishers, Moscow	1978
2.	Polymer Science and Technology: Plastics, Rubbers, Blends and Composites	Premamoy Ghosh	McGraw Hill Education (India)	Third
3.	Textbook of Polymer Science	Fred W. Billmeyer	Wiley-Interscience	Third
4.	Polymer Science	V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar	New Age International Pvt. Ltd.	Fourth
5.	Functional Polymers: Design, Synthesis, and Applications	Raja Shunmugam	Apple Academic Press Inc.	2017
6.	Synthesis of Polymers - New Structures and Methods	A. Dieter Schlüter, Craig J. Hawker, Junji Sakamoto	Wiley-VCH	2012
7.	Handbook of Polymer Testing: Physical Methods	Roger Brown	CRC Press	1999
8.	Structure-Property Relationships in Polymers	Charles E. Carraher Jr., R. B. Seymour	Springer-Verlag	2012

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PCC** Course Code: MTP502 **Polymeric Materials** Teaching Scheme: Theory - 3 Hrs./week Tutorial - 1hr /week	**Credits: 3-1-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Basic knowledge of polymers
Objectives	• To learn about synthesis, manufacturing and characteristics of different polymeric materials.
Unit-I	**Natural Polymers:** Sources, characteristics and applications of cellulose, starch, lignin, alginate, chitosan, collagen, shellac, casein, hyaluronic acid. **(6 Hrs)**
Unit-II	**Commodity Polymers:** Synthesis/ manufacturing and properties of polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyethylene terepthalate, polymethyl methacrylate. **(7 Hrs)**
Unit-III	**Engineering Polymers:** Synthesis/ manufacturing and properties of alkyd, epoxy, formaldehyde resins, Nylon 6, Nylon 6.6, Nylon 6.10, silicone resin, polycarbonate. **(8 Hrs)**
Unit-IV	**Polymeric Hydrogel:** Preparation, properties, synthesis strategies and applications of different types of hydrogels. Hydrogels, based on natural and synthetic polymers. **(6 Hrs)**
Unit-V	**Polymeric Nanomaterials:** Overview of the different types of polymeric nanomaterials, their synthesis strategies. Self-assembled polymeric nanoparticles. Polymeric nanofibers, nanotubes, nanorods and nanospheres. Polymeric nanohybrids and nanocapsules. **(7 Hrs)**

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Unit-VI	**Miscellaneous Polymers** Molecular structure, synthesis and application of polyurethane, PTFE, ABS, polylactic acid. **(5 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Introduction to Biopolymer Engineering	John G. McDaniel	CRC Press	2019
2.	Polymer Science and Technology	Robert O. Ebewele	CRC Press	2020
3.	Handbook of Engineering Polymers	K. K. Choudhury, R. P. Singh	CRC Press	2021
4.	Hydrogels: A Guide to Their Properties and Applications	Stephen M. Ross-Murphy	CRC Press	2020
5.	Polymeric Nanomaterials: Design, Characterization, and Applications	Robert E. D. Williams	Wiley	2019
6.	Introduction to Polymers	Robert J. Young, Peter A. Lovell	CRC Press	2020
7.	Plastics Materials	J.A. Brydson	Elsevier	1999

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PCC** Course Code: MTP503 **Polymer Processing Technology** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Basic knowledge of Polymer materials
Objectives	• To learn construction and working of polymer processing methods. • To understand the process parameter and their effect on product quality. • To learn about the possible defects on products and their solutions. • To get the idea of few post-moulding operations.
Unit-I	**Introduction:** Processing industries and market, materials requirement, thermal behavoiur of polymers, flow properties of polymers, pre-processing preparations like preheating, mixing, preforms etc. industry 4.0 relevance. **(4 Hrs)**
Unit-ii	**Injection Moulding:** Reciprocating screw type of injection moulding, materials, construction and working of machines, process cycle, clamping systems, process parameters, defects and troubleshooting, thermoset injection moulding, RIM process, computer aided flow analysis. **(8 Hrs)**
Unit-III	**Extrusion:** Single and twin screw extrusion systems, materials, process, construction and working of machines, extruder output, process parameters, pipe extrusion, sheet extrusion, blown film extrusion, wire coating. **(8 Hrs)**
Unit-IV	**Compression Moulding and Thermoforming Transfer Moulding:** Materials, process cycle, mould and machines, process parameters, defects on products for compression and transfer moulding. **(6 Hrs)**
Unit-V	**Blow Moulding, Calendering and Roto Moulding:** Materials, process cycle, types of machines, process parameters, preform and parison, multilayer roto moulding, defects on products for blow and roto moulding. **(7 Hrs)**

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Unit-VI	**Post Moulding Operations:** Operations like trimming, finishing, assembling, surface treatments, joining, welding, printing, mechanical operations like drilling, boring etc. **(6 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	SPI Plastics Engineering Handbook	Michael L. Berins	Springer	1991
2.	Plastics Engineering Handbook	Frados, Joel	Van Nostrand Reinhold	1976
3.	Plastics Processing Handbook	A. S. Athalye	Multi-tech Publishing Company	2002
4.	Principles of Polymer Processing	Costas G. Gogos and Zeev Tadmor	John Wiley & Sons, Inc.	2006
5.	Polymer Processing: Principles and Design	Donald G. Baird, Dimitris I. Collias	John Wiley & Sons, Inc.	2014

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PEC** Course Code: MTP511 **Program Elective Course-1: Total Quality Management** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Basic principles of manufacturing and quality control.
Objectives	• To understand TQM fundamentals and principles. • To get an idea about TQM tools and techniques. • To integrate TQM with polymer production. • To analyze and learn from case studies. • To address future trends and challenges.
Unit-I	**Introduction to Total Quality Management:** Definition and evolution of TQM, history and development of TQM, key concepts and principles of TQM, customer focus, continuous improvement, process approach. **(4 Hrs)**
Unit-II	**TQM Tools and Techniques:** Basic control tools, Statistical Process Control (SPC), control charts (e.g., X-bar, R-chart, P-chart). Root cause analysis, Failure Mode and Effect Analysis (FMEA), Six Sigma methodology, performance metrics and KPIs (Key Performance Indicators), Juran's Quality Trilogy. Overview of ISO 9000 standards, EHS policies, 5S, KAIZEN and TPM. **(11 Hrs)**
Unit-III	**TQM in Polymer Industries:** Quality challenges in polymer processing, variability in polymer properties, impact of processing conditions on quality. Quality control in polymer synthesis, process optimization for polymer production, role of material properties in quality management. **(7 Hrs)**
Unit-IV	**TQM Implementation Strategies:** Developing a TQM Strategy, creating a vision and mission for quality, establishing quality goals and objectives, building a quality management plan, engaging stakeholders in the TQM process, training programs for employees, developing quality-focused culture. **(6 Hrs)**
Unit-V	**Case Studies and Applications:** Any analysis of successful TQM initiatives in polymer companies, lessons learned from quality failures and recoveries. **(4 Hrs)**

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Unit-VI	**Future Trends and Emerging Issues in TQM:** Role of digital technologies (e.g., IoT, AI) in quality management, emerging trends in quality assurance and control, integrating sustainability with quality management, environmental impact of polymer products and processes, international quality standards relevant to polymers, regulatory considerations in global markets. **(7 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
References	1.	Total Quality Management	P. N. Mukherjee	Prentice Hall India Learning Private Limited	2006
	2.	Total Quality Management	Dale H. Besterfield	Pearson	Third
	3.	Total Quality Management: Key concepts and case studies	D. R. Kiran	Pearson	2017
	4.	Fundamentals Of Total Quality Management	Dahlgaard J. J.	T&F INDIA	2010

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PEC** Course Code: MTP512 **Program Elective Course-1: Chemical Engineering for Polymers** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Knowledge of units and conversion, basics of heat and mass transfer.
Objectives	• Students will be able to acquire knowledge related to design of industrial equipments. • Students will be able to understand the instrumentation in chemical/polymer plant. • Students will be able to know the safety aspects in chemical/ polymer industry.
Unit-I	**Material and Energy Balances:** Material balance with chemical reactions, material balance without chemical reactions, energy balances. **(7 Hrs)**
Unit-II	**Fluid Mechanics:** Fluid statics, Hagen Poiseuille equation, friction loss in laminar flow and turbulent flow, friction factor, friction loss in expansion, contraction and pipe fittings. **(6 Hrs)**
Unit-III	**Heat Transfer:** Evaporation, single effect evaporator, design of cooling tower. **(7 Hrs)**
Unit-IV	**Process Instrumentation and Control:** Temperature measuring devices such as thermoelectric sensors. Pressure measuring devices such as bellow diaphragm, piezoelectric pressure transducer, level measurement devices such as level transmitters. **(6 Hrs)**
Unit-V	**Mass Transfer:** Distillation, batch distillation, Mccabe Thiele method and multicomponent distillation. **(6 Hrs)**
Unit-VI	**Industrial Safety:** Layers of plant safety, materials hazards, Materials Safety Data Sheet (MSDS), process hazards, HAZAN, HAZOP, loss prevention, safety check lists. **(7 Hrs)**

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	Sr. No.	Title	Author	Publication	Edition
References	1.	Mass Transfer Operation	R. E. Trybel	McGraw Hill	Third
	2.	Chemical Engineering Vol I, II, III	Richardson & Coulson	McGraw Hill	Sixth
	3.	Unit Operations of Chemical Engineering	McCabe & Smith	McGraw Hill	Seventh
	4.	Principles of mass transfer and separation processes	Binay Dutta	PHI learning Pvt.Ltd, New Delhi	2007
	5.	Unit Operations of Chemical Engineering vol 1 & 2	P. Chattopadyay	Khanna Publishers, New Delhi	2003
	6.	Process Equipment Design	Shrikant Dawande	Denett & Compant	Fifth
MOOC course links	**Web links of MOOC courses**				
	1.	nptel.ac.in/courses/103/103/103103145/			
	2.	nptel.ac.in/courses/103/105/103105140/			
	3.	nptel.ac.in/courses/112/105/112105269/			

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PEC** Course Code: MTP513 **Program Elective Course-1: Plastic Packaging Technology** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Basic knowledge of Polymer materials, Processing and Testing.
Objectives	• To impart knowledge and skills related to packaging system for various products. • To understand the concepts of materials used in packaging, machinery in packaging and testing of packaging material.
Unit-I	**Introduction:** Packaging: history, need and evolution, elements, approach, functions of packaging, advantages of plastic packaging, applications. Elements of package design, importance of a good design. **(6 Hrs)**
Unit-II	**Plastic Packaging Materials:** Selection criteria, origin, types, properties, applications and limitations of plastic packaging materials (PE, PP, PVC, PS, PA, PVDC, EVA, EVOH, PC Etc.) Biodegradable material. Principle and concepts of sustainable packaging. **(6 Hrs)**
Unit-III	**Packaging Machineries and Systems:** Packaging machineries for conversion; flexible laminates, Co-ex film, thermoforms/ bottles/ jerry cans/ drums, blow, injection, extrusion, machine for VFFS, HFFS, wrapping machines, bag filling/ stitching, ancillary machinery and equipments. **(8 Hrs)**
Unit-IV	**Speciality and Innovative Packaging:** CAP, MAP, vacuum/gas packaging; retort and aseptic packaging; active packaging; smart and intelligent packaging; new developments in flexible packaging for foods; technology of canning. **(7 Hrs)**
Unit-V	**Packaging Distribution and Logistic:** Elements of logistics; supply chain management and distribution channels; product package lifecycle; significance of modes of transportation; classification of pallets and containers; material handling techniques. Introduction to hazards in distribution and their control. **(6 Hrs)**

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Unit-VI	**Package Finishing Operations and Testing:** Functional basics of decoration; technical and commercial considerations; various printing processes and techniques; designing, manufacturing and application of labels and sleeves. Physical, chemical, mechanical tests for packaging materials. **(6 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Understanding Plastic Packaging Technology	Susan E.M. Seleke	Hanser publications - Munich	1997
2.	Plastics in Packaging	A.S. Althalye	Tata McGrawHill publishing Co. Ltd., New Delhi.	1992
3.	Package Engineering	Honlon J F	McGraw Hill	1984
4.	Plastics Packaging	Turtle Ivor	Pira International	1990
5.	Handbook of Packaging-Plastics	A.S. Althalye	Multi-tech Plastics publishing co. Mumbai.	2013
6.	The Wiley Encyclopedia of Packaging Technology	Kit L Yam	John Wiley & Sons Inc. Publication	2009
7.	The Packaging User's Handbook	F.A. Paine	Blackie Academic & Professional	1999
8.	Printing Technology	Michael Adams	Delmar	First
9.	Integrated packaging systems for transportation and distribution	Charles W Ebeling	Marcel Dekker INC, New York	First
10.	Design and Technology of Packaging Decoration for the Consumer Market	Giles	Blackwell	2001
11.	Understanding Plastic Packaging Technology	Susan E.M. Seleke	Hanser publications - Munich	1997

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **RM** Course Code: RMP251 **Research Methodology** Teaching Scheme: Theory - 3 Hrs./week Tutorial - 1hr /week	**Credits: 3-1-0** In Semester Examination-I: 15 In Semester Examination-II: 15 Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Nil
Objectives	• To acquire knowledge on the fundamentals of research, its overall planning and execution maintaining research ethics. • To acquire knowledge on the fundamentals of scholarly publication and intellectual property rights.
Unit-I	**Introduction to Research:** Significance, objectives and motivations in research. Characteristics and limitations of research. Components of research work. Criteria of good research. Fundamental, and applied research. Qualitative and quantitative research. Theoretical and experimental research. Significance of collaborative research. Research proposal. **(6 Hrs)**
Unit-II	**Data Collection and Interpretation:** Data collection through survey, experiment, peer review etc. Primary and secondary source of data. Numerical and statistical fundamentals: sampling, mean, median, number average, weighted average, linear regression, interpolation and extrapolation, curve fitting, normal distribution, standard deviation, coefficient of variance. Overview of ANOVA and Taguchi method. **(8 Hrs)**
Unit-III	**Fundamentals of Scholarly Publications:** Types of scholarly publications (article, review article, book, book chapter etc.). Peer reviewing process, single blind and double-blind peer reviewing. Indexing of journals, impact factor, journal H-index, quartile system, SJR, SNIP, DOI, ISSN and ISBN. SCI, SCIE, ESCI, SSCI journals and STM signatory publishers. Identification of suitable journals. Overview of reviewing and editing manuscripts for scholarly publications. Author metrices (citation, H-index, i10 index). **(7 Hrs)**
Unit-IV	**Report Writing and Related ICT Tools:** Structures of manuscript in scholarly articles. Literature review from references and cross-references. Citation and referencing. ICT tools used for literature survey, drawing graph, drawing molecular structures and reactions, image processing and rescaling, referencing and plagiarism checking.

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Unit-V	**Research and Publication Ethics:** Research integrity and ethical practices. Reproducibility and accountability. Types and scopes of publication of scholarly articles. Scientific misconduct: Falsification, Fabrication and Plagiarism (FFP), conflict of interest, self-citation, hiding the facts, misinterpretation of data, predatory publishers and journals. Ethical practice in collaborative research and publications: authorship, research contribution, citation and acknowledgement. Permission for reuse of data. **(6 Hrs)**
Unit-VI	**Intellectual Property Rights:** Fundamental ideas of patent, copyright and technology transfer. Patentability and non-patentability. The characteristic differences among Indian, European and US patent. The steps of filing patent and copyright. **(6 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Research Methodology: Methods and Techniques	C. R. Kothari, Gaurav Garg	New Age International Publishers	Fourth
2.	Research Methodology for Scientific Research	K. Prathapan	I. K. International Publishing House Pvt. Ltd	2014
3.	Engineering Research Methodology: A Practical Insight for Researchers	Dipankar Deb, Rajeeb Dey, Valentina E. Balas	Springer	2019
4.	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	John W. Creswell, J. David Creswell	Sage Publications	Sixth
5.	Research Methodology: For Engineers	R. Ganesan	MJP Publishers	2011
6.	Research Methodology & IPR	Dr. A. Gnana Soundari, Dr. S. Muthubalaji, Dr. S. Gopalakrishnan	Scholars' Press	2024
7.	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	SAGE Publications Pvt. Ltd	Fourth
8.	Text Book of Research Methodology & IPR	Dr. Gampa Vijaya Kumar, Dr. Akkaladevi Muralidhar Rao	Notion Press	2024

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **SEM** Course Code: MTP531 **Seminar-1** Teaching Scheme: Practical: 02 Hrs/Week	Credits: 0-0-1 Teacher Assessment: 25 Marks End Semester Examination: 25 Marks
Prerequisite	• Nil
Objectives	• To review the literature (research papers, relevant books and internet) for identifying topics related to polymer engineering. • To develop technical report writing skills and improvise the presentation skills on technical matters.
Evaluation process	1. Individual students are required to choose a topic of their interest from topics relevant to their specialization stream. 2. The students are required to review literature (research papers, e-books) on the selected topic and deliver a presentation on the same. 3. A committee consisting of at least three faculty members (preferably specialized in the respective stream headed by Head of the Department wherein guide should be one of the members) shall assess the presentation of the seminar and award marks based on the content, quality and other aspects to the students. 4. Each student shall submit two copies of the seminar report. 5. The student should authenticate that the seminar report submitted does not have any plagiarized content. 6. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other copy shall be kept in the departmental library. 7. Teacher`s assessment marks shall be awarded based on the relevance of the topic, presentation skill, quality of the report and participation. 8. It is recommended to the students to do practical /experimental work related to the chosen topic and present the results at the end of the semester.

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Rubrics for Assessment:

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Inadequate (1)
Topic Selection and Proposal	Highly relevant and innovative topic. Clear and feasible proposal.	Relevant and clear topic. Feasible proposal with minor improvements needed.	Adequate topic. Proposal is clear but lacks innovation.	Topic relevance is questionable. Proposal lacks clarity and feasibility.	Irrelevant or inappropriate topic. Poor or no proposal.
Literature Review	Comprehensive and insightful review. Uses a wide range of credible sources.	Thorough review with mostly credible sources.	Adequate review with some credible sources. Basic synthesis of information.	Limited review with few credible sources. Weak synthesis and analysis.	Poor or no review with irrelevant or no credible sources. No synthesis or analysis.
Seminar Outline and Content Development	Clear, logical, and well-organized outline. Content is comprehensive and well-developed.	Good outline and organization. Content is clear with minor gaps.	Adequate outline with some organization. Content covers basic points.	Poorly organized outline. Content is incomplete or lacks coherence.	No clear outline. Content is disorganized and lacks substance.
Presentation Skills	Engaging, clear, and confident presentation. Effective use of visual aids. Handles Q&A expertly.	Clear and confident presentation. Good use of visual aids. Handles Q&A adequately.	Adequate presentation with some clarity issues. Basic use of visual aids. Manages Q&A with difficulty.	Unclear or hesitant presentation. Limited use of visual aids. Struggles with Q&A.	Poor or no presentation. Ineffective or no use of visual aids. Unable to handle Q&A.
Seminar Report	Thorough and well-written Report. Proper formatting and citations. Reflects deep understanding.	Good Report with minor errors. Mostly proper formatting and citations. Shows good understanding.	Adequate Report with some errors. Basic formatting and citations. Shows basic understanding.	Poorly written Report with many errors. Inadequate formatting and citations. Limited understanding.	No or very poorly written Report. Incorrect or no formatting and citations. Lacks understanding.

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)	
Course Category: **PCC** Course Code: MTP541 **Advanced Polymer Technology Laboratory** Teaching Scheme: Practical: 04 Hrs/Week	Credits: 0-0-2 Teacher Assessment: 50 Marks
Objectives	• To learn the practical aspects related to polymer synthesis, processing and testing.
List of Practical	1. To synthesize a polymer through bulk/ solution/ suspension/ emulsion polymerization. 2. To analyze reaction kinetics for polymerization. 3. To compare molecular weight of synthesized polymers with commercially available polymer. 4. To analyze viscosity of elastomer using Mooney Viscometer. 5. To study the impact strength of various polymers using Izod impact test. 6. To analyze effect of processing parameters on injection moulded product. 7. To rectify the defects occurring in extrudate profile. 8. To optimize roto moulding process parameters for desired quality product. 9. To analyze particle size of polymer using Zetasizer. 10. To analyze mechanical properties of polymer by using Universal Testing Machine. 11. To compare flow properties of various polymers by using Melt Flow Index. **Note: A minimum of 10 practicals should be performed.**

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Semester-II
Detail Course Curriculum

First Year M. Tech Syllabus
(Polymer Science and Technology)

(NEP 2020 Based Curriculum)

WEF AY 2024-25

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PCC** Course Code: MTP551 **Polymers for Diversified Applications** Teaching Scheme: Theory - 3 Hrs./week Tutorial - 1hr /week	**Credits: 3-1-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Knowledge of polymer structure and their applications.
Objectives	• To acquire knowledge about the various fields of applications of polymers.
Unit-I	**Polymers in Agriculture:** Polymers used in green houses, control release of agricultural chemicals, seed coatings, mulching, irrigation systems, packaging, rainwater harvesting etc. **(5 Hrs)**
Unit-II	**Polymers in Construction:** Polymers used in windows, flooring, water proofing, cladding, membranes, pipes, glazing, seals, insulation, polymer concretes. **(6 Hrs)**
Unit-III	**Polymers in Electronics Field:** Polymeric materials used in telecommunication and power transmission applications, conducting polymers: polyacetylene, polyaniline, polypyrrole, polythiophene. Conducting mechanisms, charge carriers, Doping: dopants, doping techniques, applications. Photoconducting polymers. **(6 Hrs)**
Unit-IV	**Polymers in Medical Field:** Polymers used in drug delivery systems, pharmacology, surgical applications, implants. Polymers used in dental field, ophthalmology. **(8 Hrs)**
Unit-V	**Polymers in Automotives:** Polymers used in interior and exterior parts, batteries, engine components, tyre linings, seat backs, door panels etc. **(6 Hrs)**

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Unit-VI	**Miscellaneous Applications of Polymers:** Polymer composites in aerospace. Polymers used in the fields of nuclear science, defence. Liquid crystalline polymers. Polymers with piezoelectric, pyroelectric and ferroelectric properties. Polymers for high temperature resistance- PBT, PBO, PBI, PPS, PPO, PEEK. **(8 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Automotive Plastics and Composites	Joseph P. Greene	Elsevier	2021
2.	Polymers for Agri-Food Applications	Tomy J. Gutiérrez	Springer	2019
3.	Handbook of Polymers in Medicine	Masoud Mozafari and Narendra Pal Singh Chauhan	Woodhead Publishing	2023
4.	Polymers in Electronics: Optoelectronic Properties, Design, Fabrication, and Applications	Zulkifli Ahmad, M. Khalil Abdullah, Muhammad Zeshan Ali, Mohamad Adzhar Md Zawawi	Elsevier	2023
5.	Liquid Crystalline Polymers	Vijay Kumar Thakur, Michael R. Kessler	Springer	2016

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PCC** Course Code: MTP552 **3D Printing Technology** Teaching Scheme: Theory - 3 Hrs./week Tutorial - 1hr /week	**Credits: 3-1-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Knowledge of CAD, polymeric materials, basics of polymer processing.
Objectives	• Students will be able to understand methods used in 3D printing. • Students will be able to understand theories governing the additive manufacturing, information on materials, relations between materials to be processed. • To apply 3D printing techniques into various applications and business opportunities with future directions.
Unit-I	**Introduction to Additive Manufacturing (AM):** Introduction to AM, evaluation and short history of AM, classification of AM processes, selection criteria for AM processes. Applications, advantages and limitations of AM, CAD/CAM for AM. Vat photo polymerization AM processes: stereo lithography (SL), materials, process modelling, SL resin curing process, SL scan patterns, micro-stereo lithography, mask projection processes, two-photon vat photo polymerization, process benefits and drawbacks, applications of vat photo polymerization, material jetting and binder jetting AM processes. **(6 Hrs)**
Unit-II	**Extrusion - Based AM Processes:** Fused Deposition Modelling (FDM), principles, materials, process modelling, plotting and path control, bio-extrusion, contour crafting, process benefits and drawbacks, applications of extrusion-based processes. Sheet lamination AM processes: bonding mechanisms, materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), gluing, thermal bonding, LOM and UC applications. **(7 Hrs)**
Unit-III	**Powder Bed Fusion AM Processes:** Selective laser Sintering (SLS), materials, powder fusion mechanism and powder handling, process 11 modelling, SLS metal and ceramic part creation, Electron Beam Melting (EBM), process benefits and drawbacks, applications of powder bed fusion processes. **(7 Hrs)**
Unit-IV	**Directed Energy Deposition AM Processes:** Process description, material delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), electron beam based metal deposition, processing-structure,

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	properties, relationships, benefits and drawbacks, applications of directed energy deposition processes. materials science for AM - multifunctional and graded materials in AM, role of solidification rate, evolution of non-equilibrium structure, microstructural studies, structure property relationship. **(7 Hrs)**
Unit-V	**Post Processing of AM Parts:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques. Guidelines for process selection: introduction, selection methods for a part, challenges of selection, example system for preliminary selection, process planning and control. **(7 Hrs)**
Unit-VI	**AM Applications:** Application – material relationship, application in design, application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, arts and architecture. RP medical and bioengineering applications: planning and simulation of complex surgery, customized implants and prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules. Web based rapid prototyping systems. **(5 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer	Second
2.	Rapid Prototyping: Laser-based and Other Technologies	Patri K. Venuvinod, Weiyin Ma	Springer	2004
3.	Rapid prototyping: Principles and Applications	Chua C. K., Leong K. F., LIM C. S.	World Scientific publications	Third
4.	The 3D Printing Handbook: Technologies, design and applications	Ben Redwood, Filemon Schoffer, Brian Garret	3D Hubs	-
5.	3D Printing for Dummies	Richard Horne, Kalani Kirk Hausman	John Wiley & Sons	Second

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PCC** Course Code: MTP553 **Advanced Polymer Characterization** Teaching Scheme: Theory - 3 Hrs./week Tutorial - 1hr /week	**Credits: 3-1-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Fundamental idea about polymers.
Objectives	• To acquire knowledge about the analysis techniques by different characterization techniques. • To acquire knowledge about applicability and selection of suitable characterization methods.
Unit-I	**Spectroscopy:** Overview of spectroscopic methods used in polymer: FTIR, UV-VIS, NMR, MS. Analysis strategies of known and unknown samples through spectroscopic methods. Identification of molecular structures by using multiple techniques of spectroscopy. Applicability and selection of spectroscopic techniques. **(10 Hrs)**
Unit-II	**Microscopy:** Overview of microscopic techniques: OM, SEM, TEM, AFM. Morphology and elemental analysis through microscopic techniques. Analysis strategies of known and unknown samples through microscopic techniques. Applicability and selection of microscopic techniques. **(8 Hrs)**
Unit-III	**X-ray Analysis:** Overview, analysis strategies and applicability of XRD and SAXS. Brief idea about different types of analysis using XRD and SAXS. **(8 Hrs)**
Unit-IV	**Thermal and Thermomechanical Characterizations:** Overview, analysis strategies and applicability of different thermal and thermomechanical characterization techniques: DSC, TGA and DMA. **(10 Hrs)**
Unit-V	**Miscellaneous Characterization Techniques:** Overview, analysis strategies and applicability of different characterization techniques: contact angle, BET SLS, DLS, cyclic voltammetry, ICP, EPR. **(10 Hrs)**

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Unit-VI	**Ambiguity in Polymer Characterization:** Overview of determination of similar characteristics through different characterization methods. Possible cases of ambiguous and misleading data interpretation. **(6 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Spectroscopy of Polymers	Jack L. Koenig	Elsevier	Second
2.	Thermal Analysis Fundamentals and Applications to Polymer Science	Joseph D. Menczel, R. Bruce Prime	John Wiley & Sons	First
3.	Polymer Microscopy	Linda C. Sawyer, David T. Grubb, Gregory F. Meyers	Springer	Third
4.	Advanced Techniques for Materials Characterization	A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha, S. Banerjee	Trans Tech Publications Ltd.	2009
5.	Materials Characterization Techniques	Sam Zhang, Lin Li, Ashok Kumar	CRC Press	2008

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PEC** Course Code: MTP561 **Program Elective Course-2: Polymer Blends and Composites** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Fundamental idea about polymers.
Objectives	• To acquire knowledge about preparation, characteristics and analysis of polymer blends. • To learn about preparation, characteristics and analysis of polymer composites.
Unit-I	**Fundamentals of Polymer Blending:** Interface and interphase. Continuous, discrete and co-continuous phase. Miscible, partially miscible and immiscible blend. Thermodynamics of polymer blending. Analysis of phase separation from phase diagram. **(6 Hrs)**
Unit-II	**Strategies Influencing Polymer Blend Characteristics:** Significance of blend ratios, blending sequence, solvent system, extent of shearing during melt mixing on the characteristics of polymer blends. Influence of compatibilizers and process aids on the characteristics of polymer blends. Modifications of polymers for blending (copolymers, grafting, plasma treatment). Classification, formation strategies and significance of interpenetrating network. **(8 Hrs)**
Unit-III	**Additives in Polymer Composites:** Reinforcing and non-reinforcing filler systems. Particulate and fibrous fillers. Rule of mixing in fiber-reinforced composites. Critical fiber length for reinforcement. Applications of miscellaneous pristine and surface-modified fillers. Applications of coupling agents in polymer composites. **(6 Hrs)**
Unit-IV	**Processing of Polymer composites:** Factors to be considered for processing, hand lay-up, spray lay-up, filament winding, pultrusion, resin transfer moulding, vacuum bagging. **(6 Hrs)**
Unit-V	**Polymer Nanocomposites and Nanohybrids:** Applications of different nanoparticles in polymer nanocomposites and nanohybrids. Strategies for polymer nanocomposite and nanohybrid preparation. Characteristics of layered nanomaterial-based polymer composites. Advanced applications of polymer nanocomposites and nanohybrids.

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	(6 Hrs)
Unit-VI	**Analysis of Polymer Blends and Composites** Significance of instrumental analysis methods for analysis of polymer blends, composites and nanocomposites (FTIR, DSC, TGA, SEM, TEM, AFM), and their possible correlations with different characteristics (mechanical, electrical, gas barrier) of polymer blends and composites. **(7 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Polymer Blends Handbook	Leszek A. Utracki, Charles A. Wilkie	Springer	Second
2.	Handbook of Polymer Blends and Composites (Vol. 1)	Cornelia Vasile, A. K. Kulshreshtha, Kumar Kulshreshtha	Rapra	2002
3.	Handbook of Polymer Blends and Composites (Vol. 3)	Cornelia Vasile, A. K. Kulshreshtha	Rapra	2003
4.	Polymer Nanocomposites: Processing, Characterization, And Applications	Joseph H. Koo	McGraw Hill LLC	2010
5.	Polymer matrix composites and technology	Ru-Min Wang, Shui-Rong Zheng, Ya-Ping Zheng	Woodhead Publishing	2011
6.	Physical Properties and Applications of Polymer Nanocomposites	S. C Tjong, Y. -W. Mai	Elsevier	2010
7.	Characterization of Polymer Blends: Miscibility, Morphology and Interfaces (Vol. 1)	P. Jyotishkumar, Sabu Thomas, Yves Grohens	Wiley	2015

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PEC** Course Code: MTP562 **Program Elective Course-2: Rubber and Fiber Technology** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.
Prerequisite	• Fundamental idea about polymers.
Objectives	• To acquire knowledge on the characteristics of rubbers and vulcanization process. • To learn about the characteristics, manufacturing techniques and processing of textile fibers, yarns and fabrics.
Unit-I	**Fundamentals of Rubbers:** Characteristics of rubbers. Gough-Joule effect. Natural rubber and its derivatives. Characteristics of different polar and non-polar rubbers. Overview of thermoplastic elastomers. **(7 Hrs)**
Unit-II	**Rubber Compounding:** Additives used un rubber compounding. Vulcanization methods, systems and techniques. Rheograph analysis. **(6 Hrs)**
Unit-III	**Analysis of Rubbers:** Identification of rubbers through analytical and spectroscopic techniques. Analysis of crosslink density in rubber vulcanizates. Analysis strategies of rubbers through DSC and DMA. **(6 Hrs)**
Unit-IV	**Fundamentals of Fiber Technology:** Basic terminologies in fiber technology. Classifications and applications of natural and man-made fibers. Physical and chemical characteristics of textile fibers. Miscellaneous applications of technical textiles. **(7 Hrs)**
Unit-V	**Manufacturing of Textile Fiber, Yarn and Fabric:** Outline of the manufacturing techniques of man-made textile fiber (melt spinning, dry spinning, wet spinning, dry-jet-wet spinning, electrospinning), yarn (ring spinning) and fabric (woven, non-woven, knitted). **(7 Hrs)**

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Unit-VI	**Chemical Processing of Fibers** Overview of textile chemical processing: desizing, scouring, dyeing, printing, finishing, mercerization. **(6 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Rubber Technology	Maurice Morton	Van Nostrand Reinhold	1987
2.	Rubber Technology and Manufacture	C. M. Blow	Butterworths for the Institution of the Rubber Industry	1971
3.	Handbook of Elastomers	Anil K. Bhowmick, Howard Stephens	CRC Press	Second
4.	Rubber Engineering	Indian Rubber Institute	McGraw Hill, India	1998
5.	Manufactured Fiber Technology	V. B. Gupta, V. B. Kothari	Springer	First
6.	Textile Science: An Explanation of Fiber Properties	E. P. G. Gohl, L. D. Vilensky	Guilford Publications	First
7.	Textile Yarns: Technology, Structure, and Applications	B. C. Goswami, J. G. Martindale, F. L. Scardino	John Wiley & Sons Inc.	First
8.	Principles of Weaving	R. Marks, A. T. C. Robinson	The Textile Institute	First

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PEC** Course Code: MTP563 **Program Elective Course-2: Polymer Product and Mould Design** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Basic knowledge of polymer materials and processing.
Objectives	• To understand the principles of mould design and its impact on product quality. • To understand CAD and simulation tools for designing and optimizing moulds and products. • To analyze manufacturing processes and their influence on product design. • To develop problem-solving skills for real-world design challenges.
Unit-I	**Introduction to Mould Design:** Overview of moulding processes: injection moulding, blow moulding, compression moulding, and rotational moulding. Key components of moulds: core, cavity, ejector systems, and cooling channels. Mould design principles: tolerances, draft angles, and parting lines. Material considerations: metal alloys, surface treatments, and wear resistance, polymer materials and their behaviour. **(6 Hrs)**
Unit-II	**Injection Mould Design:** Principles of injection moulding, design of core and cavity, types of ejection system and cooling systems, feed system, runner and gate balancing, guidelines for draft angles, parting line, tolerances and fits, troubleshooting, mould maintenance and repair. **(7 Hrs)**
Unit-III	**CAD and Simulation in Mould Design:** Introduction to CAD software: SolidEdge, MoldFlow. 3D Modelling techniques for mould design. Simulation tools: flow analysis using MoldFlow software. Optimization strategies: reducing cycle time, minimizing defects using MouldFlow software. **(7 Hrs)**
Unit-IV	**Product Design and Development:** Product design considerations, functionality, aesthetics, ergonomics. Design for Manufacturing (DFM) and Design for Assembly (DFA). Prototyping methods: rapid prototyping, 3D printing. Case studies: analysis of successful polymer products and their design considerations. **(6 Hrs)**

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Unit-V	**Mould Manufacturing Techniques:** Manufacturing processes: CNC machining, Electrical Discharge Machining (EDM), wire EDM. Tolerance and surface finish considerations. Tooling materials and their impact on manufacturing. Quality control: inspection techniques and standards. **(6 Hrs)**
Unit-VI	**Emerging Trends and Costing:** Smart moulding technologies: sensors, automation, and Industry 4.0. Advanced moulding techniques: multi-material moulding, micro-moulding. Mould and material costing. Future trends: innovations in mould and product design. **(7 Hrs)**

References

Sr. No.	Title	Author	Publication	Edition
1.	Moulds Design And Processing Hand Book	Eiri Board	Engineers India Research Institute	2007
2.	Fundamentals of Plastic Mould Design	Sanjay Nayak	McGraw Hill Education India	2012
3.	Injection Mould Design	R G W Pye	Affiliated East-West Press	2000
4.	Polymer Products: Design, Materials, and Processing	David H. Morton-Jones	Chapman & Hall	2000

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Course Code	Course Title
MTP571	BOS recommended Interdisciplinary course at PG level (Physical or through Online Mode /MOOC)

Faculty of Science & Technology
Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester I)

Course Category: **OEC** Course Code: MTP571 **Open Elective Course: Plastic Waste management and Circular Economy [Physical Mode]** Teaching Scheme: Theory - 3 Hrs./week	**Credits: 3-0-0** In Semester Examination-I: 15 Marks In Semester Examination-II: 15Marks Teacher Assessment: 20 Marks End Semester Examination: 50 Marks End Semester Examination (Duration): 2 Hrs.

Prerequisite	• Basics of polymers/ polymer engineering. processing technology, polymer testing.
Objectives	• To prepare graduates with the theoretical, practical, and research expertise in circularity, equipping them with the skills and aptitude needed to secure opportunities in the plastics industry. • To familiarize students with the demands businesses face concerning circularity
Unit-I	**Introduction - Plastic and Its Impact:** Plastic industry in India, global production and consumption of plastic, stakeholders across the plastic value chain, plastic waste in India and its challenges and implications, existing policy and regulatory framework for plastic industry in India, material flow of plastics, environmental impact of plastics, impact of plastics on humans, plastic waste management techniques. **(6 Hrs)**
Unit-II	**Municipal Solid Waste Collection Systems and Disposal:** Introduction to collection services and infrastructures; examples of colection service and infrastructure; quantification of total generated MSW; quantification of collection rate; institutional and organizational considerations around waste collection; disposal. Plastic in municipal waste, negative impact of plastic. **(6 Hrs)**
Unit-III	**Introduction to Circular Economy:** Linear Economy and its emergence, economic and ecological disadvantages of linear economy, replacing linear economy by circular economy, development of concept of circular economy, a differential - linear vs circular economy, introduction to waste and circular economy; sources of waste and municipal waste in low- and middle-income countries; special waste fractions; institutional and organizational considerations around waste management; waste prevention and 7Rs principles. **(6 Hrs)**

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Unit-IV	**Characteristics of Circular Economy:** Material recovery, waste reduction, reducing negative externalities, explaining butterfly diagram, concept of loops. **(6 Hrs)**
Unit-V	**Circular Economy of Plastics:** Introduction to Plastic circular economy, Evolution of Plastic circular economy. Circular economy solutions for the plastic sector. **(6 Hrs)**
Unit-VI	**Case Studies, Legal and Policy Framework** Business models, solid waste management / wastewater, plastics: a case study, EPR: polluters pay principle, industrial symbiosis/ eco-parks, role of governments and networks, sharing best practices, universal circular economy policy goals, India and CE strategy. **(9 Hrs)**

	Sr. No.	Title	Author	Publication	Edition
References	1.	The Circular Economy A User's Guide	Walter R Stahel	Routledge	First
	2.	Circular Economy: (Re) Emerging Movement	Shalini Goyal Bhalla	Invincible Publisher	-
	3.	Circular Economy: Global Perspective	Sadhan Kumar Ghosh	Springer	2020
	4.	An Introduction to Circular Economy	Lerwen Liu, Seeram Ramakrishna	Springer	2021

MOOC course links	**Web links of MOOC courses**	
	1.	https://www.gefislands.org/course/e-learning-course-waste-management-and-circular-economy
	2.	https://www.ellenmacarthurfoundation.org
	3.	https://www.ellenmacarthurfoundation.org/topics/plastics/examples
	4.	https://www.coursera.org/learn/circular-economy
	5.	https://online-learning.harvard.edu/course/introduction-circular-economy?delta=0

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Course Category: **SEM** Course Code: MTP581 **Seminar-2** Teaching Scheme: Practical: 02 Hrs/Week	**Credits: 0-0-1** End Semester Examination: 50 Marks

Prerequisite	• Nil
Objectives	• To review the literature (research papers, relevant books and internet) to identify an expected potential dissertation topic for polymer engineering. • To develop technical report writing skills and improvise the presentation skills on technical matters. • To enhance critical thinking abilities.
Evaluation process	1. Individual students are required to choose a topic of their interest. In this process they will acquire state-of-the art knowledge in that area and would be able to define the gray area related to topic (gap analysis) so as to carry dissertation in that area. 2. The students are required to review literature (research papers,e-books) on the chosen topic and deliver a presentation on the same. 3. A committee consisting of at least three faculty members (preferably specialized in the respective stream headed by HOD wherein guide should be one of the members) shall assess the presentation of the seminar and award marks based on the content, quality and other aspects to the students. 4. Each student shall submit two copies of the seminar report. 5. The student should authenticate that the seminar report submitted does not have any plagiarized content. 6. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other copy shall be kept in the departmental library. 7. Teacher`s assessment marks shall be awarded based on the relevance of the topic, presentation skill, quality of the report and participation. 8. It is recommended to the students to do practical /experimental work related to the chosen topic and present the results at the end of the semester.

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Literature Review	Comprehensive and insightful review. Uses a wide range of credible sources.	Thorough review with mostly credible sources.	Adequate review with some credible sources. Basic synthesis of information.	Limited review with few credible sources. Weak synthesis and analysis.	Poor or no review with irrelevant or no credible sources. No synthesis or analysis.
Seminar Outline and Content Development	Clear, logical, and well-organized outline. Content is comprehensive and well-developed.	Good outline and organization. Content is clear with minor gaps.	Adequate outline with some organization. Content covers basic points.	Poorly organized outline. Content is incomplete or lacks coherence.	No clear outline. Content is disorganized and lacks substance.
Presentation Skills	Engaging, clear, and confident presentation. Effective use of visual aids. Handles Q&A expertly.	Clear and confident presentation. Good use of visual aids. Handles Q&A adequately.	Adequate presentation with some clarity issues. Basic use of visual aids. Manages Q&A with difficulty.	Unclear or hesitant presentation. Limited use of visual aids. Struggles with Q&A.	Poor or no presentation. Ineffective or no use of visual aids. Unable to handle Q&A.
Seminar Report	Thorough and well-written Report. Proper formatting and citations. Reflects deep understanding.	Good Report with minor errors. Mostly proper formatting and citations. Shows good understanding.	Adequate Report with some errors. Basic formatting and citations. Shows basic understanding.	Poorly written Report with many errors. Inadequate formatting and citations. Limited understanding.	No or very poorly written Report. Incorrect or no formatting and citations. Lacks understanding.

Chairman Board of Studies
Plastic & Polymer Engineering
MIT Aurangabad
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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester II)	
Course Category: **PCC** Course Code: MTP591 **Advanced Polymer Characterization Laboratory** Teaching Scheme: Practical: 04 Hrs/Week	**Credits: 0-0-2** Teacher Assessment: 50 Marks

Prerequisite	• Nil
Objectives	• To analyze the given different characterization results of polymeric materials. • To predict different characteristics of different polymeric materials from the characterization results.
List of Practical	1. To compare multiple FTIR spectra by peak normalization. 2. To compare multiple UV-VIS spectra by peak normalization. 3. To predict the change of FTIR spectrum after grafting in polymer. 4. To determine optical band gap from UV-VIS spectrum. 5. To predict the probable NMR spectrum of a known molecular structure. 6. To analyze the NMR spectrum of a known sample. 7. To predict the molecular structure of an unknown sample from the given different spectroscopic results. 8. To predict the percent composition of a known polymer blend from DSC and TGA analysis. 9. To analyze thermal degradation kinetics from the given test results. 10. To determine the crystal structure and lattice parameters from the given XRD data. 11. To analyze a given sample from SEM, TEM and AFM result. 12. To analyze the intercalation and exfoliation characteristics of nanoclay-filled polymer composite from XRD and TEM results. **Note: A minimum of 10 practicals should be performed.**

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Faculty of Science & Technology Syllabus of First Year M. Tech (Polymer Science and Technology) (Semester III)	
Course Category: **OJT**** Course Code: MTP611 **On-Job Training/ Internship/Field Project** Teaching Scheme: Nil	**Credits: 0-0-4** Teacher Assessment: 50 Marks

Prerequisite	• Nil
Objectives	• Enhance leadership skills and abilities. • Build effective teams and improve collaboration among team members. • Develop strategic planning and decision-making skills.
Evaluation process	1. Students must complete On-the-job training/ Internship/ Field work for a duration of minimum four weeks during semester break, before the commencement of first semester of second year in their respective field of specialization. 2. The company/ organization for On-job training/ Internship/ Field work must be approved by the Departmental Board of Studies. 3. The student must submit the report of On-job training / Internship / Field Work, in the format prescribed by the Department.

**	OJT	MTP611	Internship/ Field Project/OJT **	To be done In the Summer Vacation (Min 4 Weeks) after Second Sem for 04 Credits and to be evaluated in the IIIrd Semester.

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