Syllabus of 4 + 1 Year Integrated UG and PG Programme

w. e. f 2024-25 Academic Year

GRADUATE SCHOOL

Mahatma Gandhi University

P. D. Hills P O

Kottayam, Kerala

www.gs.mgu.ac.in

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Schools offering Majors

SL.No	School/Centre
1	School of Bio Sciences
2	School of Chemical Sciences
3	School of Computer Sciences
4	School of Environmental Sciences
5	School of Gandhian Thought and Development Studies
6	School of International Relations and Politics
7	School of Pure and Applied Physics
8	School of Social Sciences

Sl. No.	Major	Intake
SCIENCE		
1	Bio Sciences	6**
2	Chemistry	6
3	Computer Science	6
4	Environmental Science	6
5	Physics	6
SOCIAL SCIENCES		
1	Development Studies	5
2	Gandhian Studies	5
3	History	10
4	International Relations and Politics	10

Majors offered and Intake *1 seat shall be sanctioned over and above the intake in each major in the 3rd semester for students who opt for a change of major after two semesters.

**Progression to PG Shall be based on the specialization selected by students as Biochemistry (2 seats) Biotechnology (2 seats) and Microbiology (2 seats) based on merit.

Schools offering Minors/MDCs/AECs/VACs/SECs

SL.No	School/Centre
1	School of Artificial Intelligence And Robotics
2	School of Behavioural Sciences
3	School of Biosciences
4	School of Chemical Sciences
5	School of Computer Sciences
6	School of Data Analytics
7	School of Energy Materials
8	School of Environmental Sciences
9	School of Food Science And Technology
10	School of Gandhian Thought And Development Studies
11	School of Gender Studies
12	School of Indian Legal Thought
13	School of International Relations And Politics
14	School of Letters
15	School of Mathematics And Statistics
16	School of Nanoscience And Nano Technology
17	School of Pedagogical Sciences
18	School of Polymer Science And Technology
19	School of Pure And Applied Physics
20	School of Social Sciences
21	School of Tourism Studies
22	International and Inter University Centre for Nanoscience and Nanotechnology
23	K N Raj School of Economics

Scheme for 4 + 1 Integrated UG and PG Programme

Graduate School

Mahatma Gandhi University

School of Polymer Science and Technology

Course Code	Title	Credits	Hours/Week		Level	Type
		Theory	Practical			
SEMESTER I						
MG1MDCUPL101	Polymers: A Boon to Our World	3	3	0	Foundation (100-199)	MDC
MG1MDCUPL102	Rubber Fundamentals: Properties to Processing	3	2	2	"	MDC
MG1MDCUPL103	Basic Concepts of Computational Material Design for Polymers	3	3	0	"	MDC
SEMESTER II						
MG2MDCUPL101	The Science of Polymers: Synthesis, Processing, and Characterization	3	3	0	"	MDC
MG2MDCUPL102	Polymers From Renewable Resources	3	3	0	"	MDC
MG2MDCUPL103	Polymer Nanotechnology: Big Things from A Tiny World	3	3	0	"	MDC
SEMESTER III						
MG3MDCUPL201	Polymers in Waste Water Management	3	3	0	Intermediate (200-299)	MDC
MG3MDCUPL202	Polymer Composites and Nanocomposites	3	3	0	"	MDC
MG3MDCUPL203	The Basics of Polymer Blends: A Gateway to Material Science	3	3	0	"	MDC
MG3VACUPL201	Polymer Recycling and Upcycling	3	3	0	"	VAC
MG3VACUPL202	Computational Methods for Macromolecular Modelling	3	3	0	"	VAC
MG3VACUPL203	Rubber Technology: From Rubber to Tyre	3	2	2	"	VAC
SEMESTER IV						
MG4SECUPL201	Characterization of Polymers and Polymer Composites	3	3	0	Intermediate (300-399)	SEC
MG4SECUPL202	Nanotechnology of Rubber	3	2	2	"	SEC
MG4VACUPL201	Computational Chemistry Software: Hands-on Approach	3	3	0	"	VAC
MG4VACUPL202	Polymers for Biomedical Applications	3	3	0		VAC
SEMESTER V						
MG5SECUPL301	Software for Chemistry	3	3	0	"	SEC

MG5SECUPL302	Latex Technology	3	2	2	"	SEC
MG5SECUPL303	Polymer Product Development on Laboratory Scale	3	3	0	"	SEC
MG5VACUPL301	Polymers in Packaging Smart and Stimuli Responsive Polymers	3	3	0	"	VAC
MG5VACUPL302	Smart and Stimuli Responsive Polymers		3	0	"	VAC
MG5VACUPL303	Polymers in Electronics	3	3	0	"	VAC
SEMESTER VI						
MG6SECUPL301	3D Printing with Polymers and Polymer Composites	3	3	0	"	SEC
MG6SECUPL302	Polymers in energy storage and conversion	3	3	0	"	SEC
MG6SECUPL303	Advanced Polymer Processing Techniques	3	3	0	"	SEC
Total Credits						

*Only for 4-Years Honours Students

**Only for students who opt for theory courses instead of Research Project

Note: General foundations courses shall be offered by different schools. Students can flexibly choose the courses across disciplines.

Level	Foundation (100-199	Intermediate (200-299)	Higher (300-399)	Advanced (400-499)	PG Level (500-599)

Type	Major	Minor	MDC	SEC	VAC	AEC

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Polymers: A Boon to Our World**		
Course Type	MDC		
Course Level	100-199		
Course Code	MG1MDCUPL101		
Course Overview	This course provides a fundamental understanding of the structure, properties, classification, and applications of polymer materials. Students will gain knowledge about the relationship between polymer structure and the properties and applications of polymers. They will develop critical thinking skills to identify different types of plastic in everyday life.		
Semester	1	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	45 (L) + 15(T)	NA	
Pre-requisite	All Disciplines		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	*Upon completion of this course, students will be able to**;***		

1	Understand the fundamental ideas of polymers, their structure, and their formation.	R, U	
2	Study the various classifications of polymers.	R, U	
3	Gain knowledge about the properties of polymers.	U, An	
4	Identify common polymers in everyday objects.	U, An	
5	Recognize various applications of polymers in everyday life.	A, An, E, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
A World Made of Giants Introduction: Monomers and polymers, Examples of polymers in our daily lives, Polymerization: Addition and Condensation. Classification of Polymers: based on source: Natural, Synthetic, and Semi-synthetic polymers with examples, based on structure: Linear, Branched, and Cross-linked polymers. Polymer structure: linear, branched, cross-linked, and network polymers. Molecular Weight of Polymers: Number-average and weight-average molecular weight, Polydispersity index.	15	1,2
Module 2	**Hours**	
Physical and Chemical Properties Physical Properties of Polymers, Thermal Properties, Chemical Properties of Polymers. Structure-Property Relationship of Polymers, Real-World Examples of How Polymer Properties are Used in Engineering	15	3

Applications (Flexible Pipes, Strong Fibers).		
Module 3	**Hours**	
Applications of Polymers in Everyday Life Polymers In Daily Life: Packaging Materials, Clothing and Textiles, Building and Construction Materials, Consumer Electronics, Household Goods, Sports and Leisure Equipment. Polymers in Healthcare. Polymers in Electronics and Computing, Polymers in Energy Storage and Batteries, Optical Polymers for Lenses and Displays, Membranes. Emerging Applications of Polymers: Self-Healing and Smart Polymers, Polymers in 3D Printing.	15	4,5

Mode of Transaction	**Classroom Activities:** • Interactive lectures • Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities:** NA **Lab based activities:** NA
Mode of Assessment	• Assignments and Seminars 20% • Internal Exams 20% • Semester Exam 60%

Learning Resources

1. Textbooks: Basic polymer chemistry textbooks such as Polymer Science by V. R. Gorwarikar, N. V. Vishwanathan, and J. Sreedhar and other basic chemistry books cover these topics of polymers.
2. Online resources – Online polymer introductory courses from websites like Khan Academy, National Institute of Open Schooling (NIOS), MOOC, and NPTEL offer free learning modules on polymers

3. Invited lectures by visiting academic and industrial scientists. Held regularly on Wednesday afternoon and Saturday morning throughout the academic year.

Relevance of Learning the Course/ Employability of the Course
Learning basics about them opens doors to exciting careers and empowers the students to solve global challenges. These are some of the diverse sectors offering jobs for those who have a polymer background: • Biomedical engineering • Textiles and materials science • Packaging and food science • Energy storage and electronics

	MAHATMA GANDHI UNIVERSITY **Graduate School** **4 + 1 Integrated UG and PG Programme**
School	School of Polymer Science and Technology
Programme	4 + 1 Integrated UG and PG Programme
Course Title	**Rubber fundamentals: Properties to Processing**
Course Type	MDC
Course Level	100-199
Course Code	MG1MDCUPL102
Course Overview	The course provides a basic understanding of the important aspects of Rubber Technology by making students thoroughly familiar with natural and synthetic rubber materials, their properties that make them suitable for definite applications and the processing pathway through which they are converted to useful

	products.		
Semester	1	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	45 (L) + 15(T)	NA	
Pre-requisite	All Discipline		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	*Upon completion of this course, students will be able to**;***		
1	Develop an understanding of the production, properties and uses of natural rubber and its synthetic alternatives.	U	
2	Learn about the manufacturing processes, properties, and applications of various specialty rubbers and thermoplastic elastomers.	U, A	
3	Develop an understanding of the important steps in rubber processing like compounding, mixing and vulcanization.	U, A, C	
4	Have a clear idea about the production of different types of rubber products through appropriate moulding/curing processes.	U, An	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Rubbers: Natural and Synthetic Natural Rubber – Latex: Source, Composition, Collection, Preservation, Concentration, Conversion to Dry Rubber: Ribbed Smoked Sheet, Block Rubber.	15	1,2

General Purpose Synthetic Rubbers: Manufacture, Properties and Applications of SBR, Polybutadiene Rubber, Polyisoprene Rubber		
Module 2	**Hours**	
Special Purpose and Specialty Rubbers Manufacture, Properties and Applications of Neoprene Rubber, EPDM, Butyl Rubber, Nitrile Rubber, Polyurethanes, Silicone Rubber, and Fluorocarbon Rubber. Thermoplastic Elastomers.	15	2
Module 3	**Hours**	
Rubber Processing Rubber Compounding: Compounding Ingredients. Vulcanization: Sulfur and Non-Sulfur. Mixing: Two Roll Mills, Internal Mixers. Extrusion. Molding: Compression, Transfer, and Injection. Other Curing Methods - Batch Curing: Autoclave, Oven Curing. Continuous Curing: Fluidized Bed, LCM, Continuous Drum Cure. High-Energy Radiation Curing	15	3, 4

Mode of Transaction	**Classroom activities:** Lecture, Tutorial, Discussion, Student Seminar **Field activities:** Industrial Visit **Lab-based activities:** Analysis of samples and basic processing steps
Mode of Assessment	Internal examination, seminars, assignments, projects, continuous assessment, external examination

Learning Resources

1 C.M.Blow and C. Hepburn,- Rubber Technology and Manufacture, Buttenvorths, London,3nd edition, 2009.

2 Maurice Morton, Rubber Technology, Springer Science + Business Media, 1999

3 Handbook of Elastomers by Anil K. Bhowmick, Howard Stephens, CRC Press, 2000

Relevance of Learning the Course/ Employability of the Course
Rubber materials science and technology represent a wide spectrum of industries, including tyres, conveyor belts, prophylactics, footwear, and specialty products. Expertise in rubber technology will help the students to enter these industries and build a fulfilling career.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology
Programme	4 + 1 Integrated UG and PG Programme
Course Title	**Basic Concepts of Computational Material Design for Polymers**
Course Type	MDC
Course Level	100-199
Course Code	MG1MDCUPL103
Course Overview	In this course, students will gain a solid grasp of computational methods in material design, with a specific focus on polymers. By studying theoretical principles and engaging in practical exercises, students will develop the skills to utilize computational techniques for designing and assessing polymer materials for a wide range of applications.

Semester	1	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	45 (L) + 15(T)	NA	
Pre-requisite	A basic understanding of chemistry and physics concepts, along with proficiency in algebra and computer skills, is recommended for this course.		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	*Upon completion of this course, students will be able to**;***		
1	Grasp the fundamental principles of polymers, including their structure, properties, and classifications.	R, U	
2	Gain proficiency in using computational methods such as molecular modeling and simulation for material design in polymer science.	A, An	
3	Familiar with commonly used software tools in polymer research, enabling them to effectively simulate polymer structures and properties.	U, A	
4	Apply computational methods to analyze and design polymer materials for various real-world applications in fields such as healthcare, automotive, and electronics.	A, An, E	

5	Develop problem-solving skills by tackling case studies and real-world challenges, demonstrating their ability to apply computational approaches to solve complex polymer design problems.	An, E, C	
6	Enhance their critical thinking abilities and learn to evaluate the effectiveness of computational methods in polymer research and development.	An, E, C, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Introduction To Polymers Definition, Types of Polymers, Basics of Polymer Structure and Properties, Application of Polymers in Different Fields.	15	1
Module 2	**Hours**	
Fundamentals Of Computational Approaches in Polymers Introduction to Computational Methods in Material Design, Basics of Molecular Modeling and Simulation: Introduction to Molecular Mechanics, Quantum Mechanics, and Statistical Mechanics Modeling.	15	2
Module 3	**Hours**	
Polymer Modeling Techniques and Software Familiarization Introduction to Software Tools Commonly Used in Polymer Research, Hands-On Exercises to	15	3,4,5,6

Familiarize Students with Polymer Modeling Software and Application of Software Tools in Simulating Polymer Structures and Properties.		

Mode of Transaction	**Classroom activities:** Interactive lectures, discussions, and presentations. **Field activities:** NA **Lab based activities:** NA
Mode of Assessment	• Assignments and Seminars (20%) • Internal Exams (20%) • Semester Exam (60%)

Learning Resources

1. Errol G. Lewars. Computational Chemistry

2. Textbooks: Basic polymer chemistry textbooks such as Polymer Science by V. R. Gorwarikar, N. V. Vishwanathan, and J. Sreedhar and other basic chemistry books cover these topics of polymers.

Relevance of Learning the Course/ Employability of the Course
Data Analyst

SEMESTER II

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**The Science of Polymers: Synthesis, Processing, and Characterization**		
Course Type	MDC		
Course Level	100-199		
Course Code	MG2MDCUPL101		
Course Overview	This course provides a fundamental understanding of the synthesis, processing, and characterization techniques used in polymer science and engineering. Students will explore the principles behind various polymerization reactions, delve into different processing methods used to create polymer products and learn about techniques for analyzing and characterizing polymer properties. The course emphasizes the connection between these areas, allowing students to appreciate the interplay between creating, shaping, and understanding polymers.		
Semester	2	**Credit**	3
Total Student Learning	**Instructional hours for theory**	**Instructional hours for practical/lab work/field**	

Time		**work**
	45 (L) + 15(T)	NA
Pre-requisite	Basic understanding of organic chemistry	

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	*Upon completion of this course, students will be able to**;***		
1	Explain different types of polymerization reactions and their mechanisms.	R, U	
2	Describe various polymer processing techniques and their applications.	R, U, A	
3	Analyze data obtained from common polymer characterization techniques. (Analysis)	R, U, An, E	
4	Interpret the relationship between polymer structure, processing, and properties.	R, U, An, E, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Introduction to Polymer Synthesis: Polymerization Reactions: Types, Mechanisms, Factors Influencing Polymer Structure, Polymerization Techniques for Different Types of Polymers	15	1,4
Module 2	**Hours**	
Polymer Processing Techniques:	15	2,4

Processing Methods: Introduction, Extrusion, Injection Molding, Compression Moulding, Blow Molding Etc. Processing Parameters, Additives Used in Polymer Processing and Their Functions		
Module 3	**Hours**	
Polymer Characterization Techniques: Introduction: Spectroscopy, Chromatography, Thermal Analysis, Mechanical Analysis	15	3,4

Mode of Transaction	**Classroom Activities:** • Interactive lectures • Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities:** NA **Lab-based activities:** NA
Mode of Assessm	• Assignments and Seminars 20% • Internal Exams 20% • Semester Exam 60%

Learning Resources

1. Textbooks: Basic polymer chemistry textbooks such as Polymer Science by V. R. Gorwarikar, N. V. Vishwanathan, and J. Sreedhar and other basic chemistry books cover these topics of polymers.
2. Online resources – Online polymer introductory courses from websites like Khan Academy, National Institute of Open Schooling (NIOS), MOOC, and NPTEL offer free learning modules on polymers

3. Invited lectures by visiting academic and industrial scientists. Held regularly on Wednesday afternoon and Saturday morning throughout the academic year.

Relevance of Learning the Course/ Employability of the Course
Learning basics about them opens doors to exciting careers and empowers the students to solve global challenges. These are some of the diverse sectors offering jobs for those who have a polymer background: • Biomedical engineering • Textiles and materials science • Packaging and food science Energy storage and electronics

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology
Programme	4 + 1 Integrated UG and PG Programme
Course Title	**Polymers from Renewable Resources**
Course Type	MDC
Course Level	100-199
Course Code	MG2MDCUPL102
Course Overview	This course delves into the exciting world of polymers derived from renewable resources. Students will gain knowledge about the depletion of fossil fuels, the environmental impact of traditional polymers, and the

	growing importance of sustainable alternatives. They will explore various bio-based polymers, their production methods, properties, and potential applications in diverse fields. The course also emphasizes the life cycle assessment of polymers and responsible practices for a sustainable future.		
Semester	2	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	45 (L) + 15(T)	NA	
Pre-requisite	All Discipline		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	*Upon completion of this course, students will be able to**;***		
1	Explain the environmental concerns connected with conventional polymer production and the need for renewable resources and analyze the properties of bio-based polymers	R, U	
2	Identify and classify different types of polymers derived from renewable resources.	R, U, An	
3	Describe the production methods and processing techniques for bio-based polymers.	R, U, C	
4	Discuss the potential applications of bio-based polymers in various industries.	R, U, A	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)

COURSE CONTENT

Module 1	**Hours**	**CO No**
Sustainability and Bio-Based Polymers: Environmental Concerns About Conventional Polymers, Life Cycle Assessment of Polymers (LCA), The Need for Renewable Resources, Biobased Polymers: Introduction, Source, Structure and Properties, Advantages, Classification.	15	1,2
Module 2	**Hours**	
Production And Processing of Bio-Based Polymers: Extraction and Purification, Polymerization Methods, Processing Techniques for Bio-Based Polymers.	15	3
Module 3	**Hours**	
Applications, Challenges and Future Prospects of Bio-Based Polymers: Packaging of Food Containers, Agriculture and Waste Management, Textiles and Clothing, Emerging Applications in Biomedicine, Electronics, and Construction, Challenges in Scaling Up Production of Bio-Based Polymers, Cost Competitiveness with Conventional Polymers, Life Cycle Assessment of Bio-Based Polymers and their Sustainability, Future Trends and Advancements in Bio-Based Polymers.	15	4

Mode of Transaction	**Classroom Activities:** • Interactive lectures

	• Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities:** NA **Lab-based activities:** NA
Mode of Assessment	• Assignments and Seminars 20% • Internal Exams 20% • Semester Exam 60%

Learning Resources

1. Biopolymers: Renewable Resources for Sustainable Development" by David Kaplan et al.

2. Green Polymer Chemistry: Biocatalysis and Materials II" edited by H.N. Cheng and Richard A. Gross

3. Renewable Resources for Industrial Materials: Chemicals, Fibers, and Polymers" by Wallace F. Watson

Relevance of Learning the Course/ Employability of the Course
Learning about polymers from renewable resources is crucial as it aligns with global sustainability goals and the increasing demand for eco-friendly materials. This expertise opens diverse career opportunities in industries such as bioplastics, automotive, aerospace, packaging, and textiles, which are all seeking sustainable alternatives. Additionally, it prepares individuals for roles in research and development, quality control, sustainability consulting, and regulatory compliance. The knowledge gained also fosters entrepreneurship, enabling the creation of innovative, sustainable products and businesses.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Program	4 + 1 Integrated UG and PG Programme		
Course Title	**Polymer Nanotechnology: Big Things from a Tiny World**		
Course Type	MDC		
Course Level	100-199		
Course Code	MG2MDCUPL103		
Course Overview	This course provides a fundamental understanding of nanoscience, polymer science, and polymer-based nanoparticles, etc. Students will learn about synthesis methods, characterization techniques, and the relationship between the structure and properties of polymer-based nanoparticles.		
Semester	2	**Credit**	3
Total Student Learning Time	**Instructional hours for theory** 45 (L) + 15(T)	**Instructional hours for practical/lab work/fieldwork** NA	
Pre-requisite	Knowledge of basic physics and chemistry		

COURSE OUTCOMES (CO)

CO	Expected Course Outcome	Learning	PSO

No.	*Upon completion of this course, students will be able to;*	Domains	No.
1	Understand the fundamentals of nanoscience and nanotechnology	R, U	
2	Study different synthesis and characterization methods of nanoparticle	R, U	
3	Gain knowledge about the concept and properties of polymer-based nanotechnology	U, An, E	
4	Identify common polymer-based nanoparticles in everyday life and their applications.	U, A, C	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

OURSE CONTENT

Module 1	**Hours**	CO No
Introduction to nanoscience and nanotechnology Nature nanotechnology, properties of nanoparticles, size-scale effects, classification of nanoparticles, synthesis and characterization.	15	1, 2
Module 2	**Hours**	
Polymer Based Nanoparticles Natural, Synthetic Polymer-Based Nanoparticles, and Biopolymers: Types and Uses.	15	3
Module 3	**Hours**	
Applications of Polymer Nanotechnology Application of Polymer Nanoparticles in Various Fields: Medicine, Agriculture, Defence, and Aerospace	15	4

Mode of	**Classroom Activities:**

Transaction	• Interactive lectures • Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities:** NA **Lab-based activities:** NA
Mode of Assessment	• Internal Exams • Semester Exam • Assignments and Seminars

Learning Resources

- Textbooks: Hussain, C. M., & Thomas, S. (Eds.). (2021). Handbook of polymer and ceramic nanotechnology. Berlin/Heidelberg, Germany: Springer.
- Narain, R. (Ed.). (2020). Polymer science and nanotechnology: fundamentals and applications. Elsevier.
- Online resources – Online introductory courses on polymer nanotechnology from websites like Khan Academy, National Institute of Open Schooling (NIOS), MOOC, and NPTEL offer free learning modules on polymers
- Invited lectures by visiting academic and industrial scientists. Held regularly on Wednesday afternoon and Saturday morning throughout the academic year.

Relevance of Learning the Course/ Employability of the Course

Learning polymer nanotechnology is crucial because it drives innovation across diverse fields like medicine, electronics, and materials science. This course offers career opportunities in cutting-edge research and development, quality control, and product design in high-tech industries. Additionally, it equips individuals with the skills needed for emerging roles in nanomedicine, advanced manufacturing, and sustainable technology solutions, making them highly sought after in the job market.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Polymers in Wastewater Management**		
Course Type	MDC		
Course Level	200-299		
Course Code	**MG3MDCUPL201**		
Course Overview	Wastewater management course specialised in the operation and maintenance of wastewater treatment plants in industrial and housing societies. Government regulations mandate that training for this employment type is necessary to comply with Pollution Control Boards and reduce the pollution of rivers caused by wastewater.		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	35 (L) + 15(T)	NA	
Pre-requisite	All Disciplines		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the Role of Polymers in Wastewater Treatment	R, U	
2	The fundamental scientific processes underlying the design and operation of wastewater treatment plant	R, U	
3	The management of residuals from water and wastewater treatment.	U, An	
4	Identify and analyze different methods of treatment of wastewater	U, An	
5	Analyze Polymer-Based Treatment Techniques	U, An	

6	Design and Optimize Polymer-Based Treatment Systems	U, An, E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Polymeric Material Used in Wastewater Management- Polymeric Adsorbent Materials, Polymeric Flocculants, Polymeric Filters, Polymeric Membranes, And Polymeric Composites.	**15**	**1, 2**
Module 2	**Hours**	
Water And Wastewater Management Includes Biological, Chemical, Adsorption, Flocculation, And Oxidation. Conventional Wastewater Treatment Processes, Advanced Treatment Methods (Membrane Filtration, Advanced Oxidation Processes, Etc.) Biological Treatment Methods (Bioreactors, Biosorption, Etc.)	**15**	**2**
Module 3	**Hours**	
Uses Polymeric Materials for Membranes and Filtration. Water Softening Methods Exchange Process-Principle, Procedure and Advantages.	**15**	**1, 5, 6**

Mode of Transaction	• **Classroom activities** • Interactive lectures • Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities: Required** **Lab based activities:** NA
Mode of Assessment	**Continuous Assessment (40%):** Quizzes and assignments (20%) Internal Exams 20% **End-Semester Examination (60%):** A written examination covering all course topics (60%)

Learning Resources

1. Polymer Science and Innovative Applications: Materials, Techniques, and Future Developments by Mariam Al Ali AlMa'adeed and Igor Krupa
2. Polymer-Based Advanced Functional Composites for Wastewater Treatment edited by Ahmad Fauzi Ismail, Takeshi Matsuura, and Arun M. Isloor
3. Advanced Materials for Wastewater Treatment edited by Shahid Ul-Islam and Seid Mahdi Jafari

Relevance of Learning the Course/ Employability of the Course
The growing demand for environmental sustainability has created a high demand for skills in environmental management and wastewater treatment. Companies and governments are actively seeking experts to develop wastewater treatment solutions and ensure compliance with environmental regulations.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Polymer Composites and Nanocomposites**		
Course Type	MDC		
Course Level	200-299		
Course Code	MG3MDCUPL202		
Course Overview	This course provides a comprehensive introduction to the exciting and rapidly evolving field of polymer composites and nanocomposites. Students will gain a fundamental understanding of the principles underlying the design, synthesis, characterization, and applications of these advanced materials. The course will cover a wide range of topics, including polymer chemistry, reinforcement materials (fibers, particles), composite manufacturing processes, property characterization, and emerging applications in various fields such as aerospace, automotive, and renewable energy.		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	35 (L) + 15(T)	NA	
Pre-requisite	All Disciplines		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the fundamental concepts of polymer chemistry, including polymerization reactions, polymer structure, and properties.	R, U	

2	Acquire knowledge of various reinforcement materials (fibers, particles) and their characteristics.	R, U	
3	Develop skills in characterizing the structure and properties of polymer composites using techniques like microscopy, spectroscopy, and mechanical testing.	S, A	
4	Explore the diverse applications of polymer composites and nanocomposites in various fields, including aerospace, automotive, and renewable energy.	U, A	
5	Demonstrate critical thinking and problem-solving skills in designing and optimizing polymer composites and nanocomposites for specific applications.	An, E, C	
6	Communicate effectively on the concepts of polymer composites and nanocomposites through presentations and written reports.	C, A, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Introduction to Polymers and Composite Materials Polymer chemistry basics, Introduction to composite materials, Types of reinforcement materials	**15**	**1, 2**
Module 2	**Hours**	
Composite Manufacturing Processes and Characterization Manufacturing techniques, Structural characterization, Mechanical Characterization, Thermal Characterizations.	**15**	**2, 3, 4**
Module 3	**Hours**	
Applications of Polymer Composites and Nanocomposites Applications in aerospace: aircraft structures, spacecraft components. Applications in automotive: body panels,	**15**	**4, 5**

structural components. Applications in renewable energy: wind turbine blades, solar panels. Introduction to polymer nanocomposites: types, properties, and applications.		

Mode of Transaction	**Classroom activities:** Interactive lectures Group discussions and problem-solving exercises Quizzes and Assignments **Field activities: NA** **Lab based activities:** Demonstrate experiments to familiarize students with composite preparation techniques and basic characterization methods
Mode of Assessment	**Continuous Assessment (40%):** Quizzes and assignments (20%) Internal Exams 20% **End-Semester Examination (60%):** A written examination covering all course topics (60%)

Learning Resources

1. Polymer Composites by Sabu Thomas, Kuruvilla Joseph, S.K. Malhotra, K.G. Satheesh Kumar, and Sreejith P. Mathew
2. Introduction to Polymer Compounds by H. Dodiuk and S. H. Goodman
3. Polymer Nanocomposites: Processing, Characterization, and Applications by Joseph Koo
4. Polymer Nanocomposites: Synthesis, Characterization, and Modeling edited by Ramanan Krishnamoorti and Raphael A. Vaia

Relevance of Learning the Course/ Employability of the Course

Learning about polymer composites and nanocomposites is highly relevant due to their widespread applications in critical sectors like aerospace, automotive, and renewable energy. This knowledge equips individuals with valuable skills in materials science and nanotechnology, making them highly employable in research, development, manufacturing, and engineering roles within these and other innovative industries.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**The Basics of Polymer Blends: A Gateway to Material Science**		
Course Type	MDC		
Course Level	200-299		
Course Code	MG3MDCUPL203		
Course Overview	This course provides a foundational understanding of polymer blends, a crucial area within materials science. Students will explore the fundamental principles of polymer mixing, blend morphology, and the impact of blending on material properties. The course will cover a wide range of topics, including polymer chemistry, blend compatibility, processing techniques, property characterization, and emerging applications in various fields.		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	45	NA	
Pre-requisite	All Disciplines		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		

1	Understand the fundamental concepts of polymer chemistry, including polymerization reactions, polymer structure, and properties.	R, U	
2	Acquire knowledge of different polymer blending techniques and their impact on blend morphology.	R, U, A	
3	Develop skills in characterizing the structure and properties of polymer blends using techniques like microscopy, spectroscopy, and thermal analysis.	S, A	
4	Explore the diverse applications of polymer blends in various fields, including packaging, automotive, and biomedical.	U, A	
5	Demonstrate critical thinking and problem-solving skills in analyzing and designing polymer blends with tailored properties for specific applications.	An, E, C	
6	Communicate effectively on the concepts of polymer blends and their applications through presentations and written reports.	C, A, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Fundamentals of Polymer Science Polymerization mechanisms (addition, condensation) Polymer structure (linear, branched, cross-linked) Polymer properties (mechanical, thermal, optical) Molecular weight and molecular weight distribution	15	1
Module 2	**Hours**	
Polymer Blends: Principles and Processing Blending techniques, Morphology of polymer blends, Characterization techniques	15	2, 3
Module 3	**Hours**	
Applications and Advanced Concepts	15	4, 5, 6

Applications of polymer blends in packaging, automotive, and biomedical fields. Emerging trends in polymer blend technology: nanocomposites, stimuli-responsive blends.		

Mode of Transaction	**Classroom activities:** • Interactive lectures • Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities: NA** **Lab based activities:** experiments to familiarize students with blend preparation techniques and basic characterization methods
Mode of Assessment	**Continuous Assessment (40%):** Quizzes and assignments (20%) Internal Exams 20% **End-Semester Examination (60%):** A written examination covering all course topics (60%)

Learning Resources

1. Polymer Blends Handbook by D.R. Paul and S. Newman
2. Polymer Blends and Alloys by H.A. Barnes
3. Introduction to Polymer Science and Technology by L. H. Sperling

Relevance of Learning the Course/ Employability of the Course
Learning about polymer blends equips you with both theoretical knowledge and practical skills that are highly applicable in various industries, enhancing employability in a competitive job market. Research opportunities in polymer science and engineering, particularly in developing new blends or improving existing ones, offer potential academic pursuits or careers in research and development.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Polymer Recycling and Upcycling**		
Course Type	VAC		
Course Level	200-299		
Course Code	MG3VACUPL201		
Course Overview	This course focuses on the critical aspects of polymer recycling and upcycling, addressing the growing environmental and economic challenges associated with plastic waste. Students will gain a comprehensive understanding of polymer waste management strategies, recycling technologies, and innovative upcycling approaches. The course will explore the environmental impact of plastic pollution, the principles of polymer degradation, and the development of sustainable solutions for a circular economy.		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
Pre-requisite	All Discipline		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** *Upon completion of this course, students will be able to;*	**Learning Domains**	**PSO No.**
1	Understand the environmental impact of plastic pollution and the importance of sustainable waste management.	R, U	

2	Acquire knowledge of different polymer recycling technologies, including mechanical, chemical, and biological methods.	R, U	
3	Develop skills in analyzing the properties of recycled polymers and their suitability for various applications.	S, An, A	
4	Explore innovative upcycling strategies for converting waste polymers into high-value products.	U, A, C	
5	Demonstrate critical thinking and problem-solving skills in designing sustainable solutions for polymer waste management and upcycling.	An, E, C	
6	Communicate effectively on the challenges and opportunities related to polymer recycling and upcycling through presentations and written reports.	C, A, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
hTe Plastics Challenge: Environmental Impact and Sustainability Global plastic waste generation and its environmental impact. Life cycle assessment of plastics: production, use, and disposal. Principles of polymer degradation, The concept of the circular economy and its relevance to plastics	**15**	**1, 2**
Module 2	**Hours**	
Polymer Recycling Technologies Mechanical recycling, Chemical recycling, Biological recycling, Challenges and limitations of different recycling technologies.	**15**	**2, 3**

Module 3	Hours	
Polymer Upcycling and Innovation Definition and significance of upcycling, Differences between recycling and upcycling, Applications of upcycled polymers	**15**	**4, 5, 6**

Mode of Transaction	**Classroom activities:** • Lectures: Interactive lectures using multimedia presentations, guest lectures from industry experts, and discussions on case studies. **Field activities:** Site visit to a local recycling facility (if possible) **Lab-based activities:** Identification and sorting of different types of polymer waste
Mode of Assessment	**Continuous Assessment (40%):** • Quizzes and assignments (20%) • Internal Exam (20%) **End-Semester Examination (60%):** • Written examination covering all course topics

Learning Resources

1. Plastics Waste Management by Muralisrinivasan Natamai Subramanian
2. Recycling of Polymers: Methods, Characterization and Applications" edited by Dr. Amit Kumar and Dr. Michael J. Realff
3. Polymer Recycling: Science, Technology and Applications" by John Scheirs

Relevance of Learning the Course/ Employability of the Course
Learning the course on Polymer Recycling and Upcycling is highly relevant as it equips students with essential skills for sustainable waste management, contributing to environmental conservation and innovation in materials science. This expertise enhances employability across various sectors, including manufacturing, research, environmental consultancy, and entrepreneurship, where sustainable practices are increasingly valued.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Computational Methods for Macromolecular Modeling**		
Course Type	VAC		
Course Level	200-299		
Course Code	MG3VACUPL202		
Course Overview	This course explores advanced techniques for simulating and analyzing intricate structures and dynamic behaviors of polymer molecules. It covers specialized methods such as quantum mechanics, molecular mechanics, polymer-specific molecular dynamics simulations, coarse-grained modeling, and advanced sampling techniques.		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	A basic understanding of computational material design for polymers, along with proficiency in algebra and computer skills, is recommended for this course.		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Develop proficiency in simulating polymer systems using specialized computational techniques	R, U, A	

2	Gain the ability to analyze polymer structures, including conformational changes and interactions, using computational tools	A, An, E	
3	Gain skills in predicting polymer behavior and designing experiments to validate computational predictions in material science contexts.	A, An, E, S	
4	Learn to integrate experimental data with computational models to gain deeper insights into polymer dynamics and function, fostering interdisciplinary research capabilities.	A, An, E, C, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Classical Mechanics approaches in Macromolecular Modeling Introduction to Molecular Mechanics, Stretching, Bending, Torsional Energies; Force Field Methods, Comparison of Popular Force Fields, Basic Principles of Atomic model in Molecular dynamics, Molecular mechanics, potentials, solutions for newton's equation of motion, running MD: initialization, pre-set ups, periodic boundary condition, positions and velocity, time steps, ensembles, integration equilibration, minimisation in static MD run – steepest descent method, conjugate gradients method, run analysis.	**15**	**1,2,3,4**
Module 2	**Hours**	
Quantum Mechanics approaches in Macromolecular Modeling Computational Quantum Chemistry and its Applications, Prediction of Molecular Properties using Computational Chemistry, an Overview of Quantum Chemistry Theories	**15**	**1,2,3,4**

Semi-empirical and ab initio methods-Hartree-Fock Theory- Density Functional Theory, and their level of accuracy and hierarchy of computational requirements, Overview of material design		
Module 3	**Hours**	
Statistical Mechanics Approaches in Macromolecular Modeling Introduction to statistical mechanics- Monte Carlo methods: stochastic process, Markov chain, ergodicity. Algorithms for Monte Carlo methods. Random Number generators. Applications: systems of classical particles, nucleation, crystal growth. Introduction to Quantum Monte Carlo methods	**15**	**1,2,3,4**

Mode of Transaction	**Classroom activities:** Interactive lectures, discussions, and presentations. **Field activities:** NA **Lab based activities:** NA
Mode of Assessment	• Assignments and Seminars (20%) • Internal Exams (20%) • Semester Exam (60%)

Learning Resources

1 F. Jensen. Introduction to Computational Chemistry (Second Edition, Wiley), 2007.

Relevance of Learning the Course/ Employability of the Course
Data Analyst

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Rubber Technology: From "Rubber" to Tyre**		
Course Type	VAC		
Course Level	200-299		
Course Code	MG3VACUPL203		
Course Overview	This course explores the fundamentals of rubber technology, illustrating how simple rubber products can evolve into highly engineered products such as tyres. It covers the basic principles of rubber chemistry and processing, along with the complexities involved in advanced rubber product design and manufacturing.		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	60	0	
Pre-requisite	A basic background in Organic Chemistry		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Understand the chemistry and properties of natural and synthetic rubbers.	U	

2	Learn about the various additives and compounds used in rubber manufacturing.	U, A, C	
3	Gain insights into the processing techniques for rubber.	U, A	
4	Study the design and engineering aspects of advanced rubber products.	U, A, An	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Introduction to Rubber Technology History and applications of rubber. Introduction to polymerization and vulcanization. Structure and properties of natural and synthetic rubbers. Sources and processing of natural rubber. Synthetic rubber: general purpose and speciality rubbers – SBR, polybutadiene rubber, polyisoprene rubber, Neoprene rubber, EPDM, butyl rubber, nitrile rubber, polyurethanes, silicone rubber, Fluorocarbon rubber - synthesis and properties.	15	1
Module 2	Hours	
Compounding and Processing Techniques Vucanization. Principles of compounding, Compounding ingredients, Compounding for processability, Compounding for vulcanizate properties. Mastication and mixing, Mixing equipments: two roll mill and internal mixers, Cure characteristics: equipments for determination. Shaping: extrusion, calendaring, and moulding, Curing processes: methods and equipment	15	2, 3
Module 3	Hours	
Design and Engineering of Rubber Products Basic principles of product design, Performance characteristics: durability, flexibility, and strength.	15	4

Industrial rubber products: tubes, hoses, belts, diaphragms, automotive parts. Advanced Rubber Products: Tyres - structure, components, and materials, High-performance seals and gaskets. Testing and quality control: Laboratory and field-testing methods. Mechanical properties - tensile, compression and fatigue.		

Mode of Transaction	**Classroom activities:** Lecture, Tutorial, Discussion, Student Seminar **Field activities:** Industrial Visit **Lab based activities:** Basic processing operations, Testing of materials and products
Mode of Assessment	Internal examination, seminars, assignments, projects, continuous assessment, external examination

Learning Resources

1. Maurice Morton, Rubber Technology, Springer Science + Business Media, 1999
2. Werner Hofmann, Rubber Technology Handbook, Hanser Gardner Publications, 1990
3. John S. Dick, Rubber Technology, Compounding and Testing for Performance, Third Edition, Hanser Pub Inc, 2020
4. C.M.Blow and C. Hepburn, Rubber Technology and Manufacture, Buttenvorths, London, 3rd edition, 2009.

Relevance of Learning the Course/ Employability of the Course
Students will get familiarized with various rubber materials and products manufacturing techniques. The vast employment opportunities in rubber industry will be open for them once they acquire expertise in rubber technology.

	MAHATMA GANDHI UNIVERSITY **Graduate School** **4 + 1 Integrated UG and PG Programme**

School	School of Polymer Science and Technology		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Characterization of Polymers and Polymer Composites**		
Course Type	SEC		
Course Level	200-299		
Course Code	**MG4SECUPL201**		
Course Overview	This course comprehensively introduces the characterization techniques used to investigate the structure, properties, and performance of polymers and polymer composites. Students will gain a fundamental understanding of various analytical methods and their applications in materials science and engineering. The course will cover a wide range of techniques, including microscopy, spectroscopy, thermal analysis, and mechanical testing, and their relevance in understanding polymer behavior and optimizing material properties.		
Semester	4	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	60		
Pre-requisite	All Discipline		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Understand the fundamental concepts of polymer chemistry, including polymerization reactions, polymer structure, and properties.	R, U	

2	Acquire knowledge of various nanomaterial synthesis techniques, such as chemical vapor deposition, sol-gel methods, and self-assembly.	R, U	
3	Develop skills in characterizing the structure and properties of polymers and nanomaterials using techniques like spectroscopy, microscopy, and thermal analysis.	S, A	
4	Explore the diverse applications of nanomaterials in various fields, including medicine, electronics, energy, and environmental science.	U, A	
5	Demonstrate critical thinking and problem-solving skills in analyzing and designing novel materials with tailored properties.	An, E, C	
6	Communicate effectively on the concepts of nanomaterials	C, A, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Introduction to Polymers Polymerization reactions, Polymer structure, Polymer properties, Characterization techniques	1, 3	
Module 2	**Hours**	
Introduction to Nanomaterials Types of nanomaterials, Nanomaterial synthesis techniques, Characterization techniques	2, 3	
Module 3	**Hours**	
Nanomaterials and their Applications Stimuli-responsive polymers, Applications in drug delivery, biosensors, and tissue engineering	2, 4, 5, 6	

Mode of Transaction	**Classroom activities:** • Lectures: Interactive lectures using multimedia presentations, demonstrations, and guest lectures from industry experts. • Tutorials: Problem-solving sessions to reinforce theoretical concepts and develop analytical skills. **Field activities:NA** **Lab based activities:** Demonstrate experiments to familiarize students with material characterization techniques and basic synthesis methods.
Mode of Assessment	**Continuous Assessment (40%):** Quizzes and assignments (20%) Internal Exams 20% **End-Semester Examination (60%):** A written examination covering all course topics (60%)

Learning Resources

1. Introduction to Polymer Science and Technology by Joel R. Fried
2. Nanomaterials: Synthesis, Properties, and Applications by C. P. Poole, Jr. and F. J. Owens

Relevance of Learning the Course/ Employability of the Course
Learning polymer characterization techniques is highly relevant in today's technologically driven world. It provides crucial skills for developing new materials, ensuring product quality, and conducting cutting-edge research. This knowledge is highly sought after in various industries, including research and development, quality control, manufacturing, and academia. Graduates with expertise in polymer characterization are well-positioned for successful careers in materials science and engineering.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Nanotechnology of Rubber**		
Course Type	SEC		
Course Level	300-399		
Course Code	MG4SECUPL202		
Course Overview	This course introduces the principles and applications of nanotechnology in rubber, focusing on how nanoscale materials and techniques can enhance the properties and performance of rubber products. It covers fundamental nanotechnology concepts, nanomaterials used in rubber, and the advanced processing, design, and testing of nanocomposite rubber products.		
Semester	4	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
	36	9	
Pre-requisite	Basic knowledge of chemistry and materials science. Introduction to rubber technology.		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** *Upon completion of this course, students will be able to;*	**Learning Domains**	**PSO No.**
1	Understand the basic concepts of nanotechnology and its relevance to rubber.	U, A	
2	Learn about nanomaterials used in rubber and their impact on properties.	U, A, An, C	

3	Explore advanced processing and characterization techniques for nanocomposites of rubber.	U, A	
4	Learn current and future applications of rubber nanocomposites	U, A, C	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Fundamentals of Nanotechnology and Nanomaterials in Rubber Definition and scope of nanotechnology. Basic Concepts: Historical development. Properties of materials at the nanoscale. Types of nanomaterials: nanoparticles, nanotubes, nanofibers, nanoclays. Nanomaterials used in rubber: carbon nanotubes, graphene, nanoclays, silica nanoparticles, nanocellulose. Nanoparticle-Rubber interactions.	15	1, 2
Module 2	Hours	
Processing and Characterization of Nanocomposites Challenges in processing. Composite preparation methods: Melt mixing – compression molding, extrusion, calendaring, injection molding, Solution mixing, In-situ polymerization, Grafting from and grafting to approaches, Sol-Gel process, Latex compounding. Vulcanization. Properties of Rubber Nanocomposites: Mechanical properties, Electrical properties, Thermal properties, Barrier properties. Characterization techniques: Microscopy (SEM, TEM, AFM), Spectroscopy (FTIR, Raman, XPS), XRD. Thermal and mechanical analysis: DSC, TGA and nanoindentation.	15	3
Module 3	Hours	
Applications and Future Trends	15	4

Applications of Nanotechnology in Rubber: Tire technology, Seals and gaskets, Vibration damping, Protective coatings, Sensors, Flexible electronics, Wearable technology, Self healing and shape memory composites, Nanocomposites for energy storage. Antimicrobial composites. Current research trends in rubber nanotechnology.		

Mode of Transaction	**Classroom activities:** Lecture, Tutorial, Discussion, Student Seminar **Field activities:** Industrial Visit **Lab based activities:** Preparation of nanomaterials, Characterization techniques for nanomaterials and composites
Mode of Assessment	Internal examination, seminars, assignments, projects, continuous assessment, external examination

Learning Resources

1. Sabu Thomas, Ranimol Stephen, Rubber Nanocomposites: Preparation, Properties, and Applications", John Wiley & Sons (Asia) Pte Ltd, 2010

2. Sati N. Bhattacharya, Musa R. Kamal and Rahul K. Gupta, Nanocomposites: Theory and Practice, Carl Hanser Verlag, Munich, 2007

3. Relevant research papers from highly regarded journals in materials science and nanotechnology.

Relevance of Learning the Course/ Employability of the Course
Nanotechnology is the emerging trend in all fields of science and technology. It is the future of industry. This course equips students with the knowledge and skills to innovate and excel in the field of rubber nano technology enabling them to be potential technologists in high demand.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Computational Chemistry Software: Hands-on Approach**		
Course Type	SEC		
Course Level	200-299		
Course Code	MG4VACUPL201		
Course Overview	This course focuses on the practical utilization of computational tools in chemistry, covering quantum mechanics basics, molecular modeling techniques, and data analysis. Designed for students, it integrates theoretical concepts with extensive hands-on exercises to enhance proficiency in applying computational methods to solve chemical problems effectively.		
Semester	4	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	A solid grasp of polymer chemistry fundamentals, computational simulation theories, and basic computer programming knowledge facilitates effective engagement with computational chemistry software and techniques.		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Apply quantum mechanics principles to understand and predict molecular properties using computational chemistry software.	U, A, An	

2	Gain proficiency in setting up and executing molecular modeling simulations, including molecular mechanics	U, A, An	
3	Develop skills in analyzing computational data, interpreting results, and critically evaluating the reliability of computational models.	A, An, E, S	
4	Demonstrate competence in integrating theoretical knowledge with practical applications to solve complex chemical problems using computational tools.	C, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Electronic Structure Theory Review of molecular structure calculations, semi empirical and ab- initio methods for macromolecules. Energy minimization, optimization, frequency calculation, Frontier molecular analysis, IR, Raman, UV-Visible spectra analysis, Transition state analysis.	**15**	**1,3,4**
Module 2	**Hours**	
Molecular Mechanics Modeling Review of Force field methods, Conformational analysis, Energy minimization, thermodynamic and kinetic properties, Docking.	**15**	**2,3,4**
Module 3	**Hours**	
Advanced Polymer Modeling Techniques Hands-on exercises will familiarize students with polymer modeling software and the application of software tools based on molecular mechanics and quantum mechanics to simulate polymer structures and properties.	**15**	**3,4**

Mode of Transaction	**Classroom Activities:** • Interactive lectures • Group discussions and problem-solving exercises • Quizzes and Assignments **Field activities: NA** **Lab based activities:** NA
Mode of Assessment	• Internal Exams • Semester Exam Assignments and Seminars

Learning Resources

1 F. Jensen. Introduction to Computational Chemistry (Second Edition, Wiley), 2007.

2 David Young "Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems", John Wiley & Sons, 2001

Relevance of Learning the Course/ Employability of the Course
Data Analyst

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	School of Polymer Science and Technology (SPST)		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Polymers for Biomedical Applications**		
Course Type	MDC		
Course Level	300-399		
Course Code	MG4VACUPL202		
Course Overview	This course provides a fundamental understanding of the structure, properties, classification, and applications of polymer materials. Students will gain knowledge about polymerization reactions, polymer characterization techniques, and the relationship between polymer structure and properties. They will develop critical thinking skills to analyze and solve polymer-related problems.		
Semester	4	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/fieldwork**	
Pre-requisite	Knowledge of basic chemistry and biolo		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	*Upon completion of this course, students will be able to**;***		
1	Understand the basic principles of polymers relevant to biomedical applications and explore the properties required for polymers in biomedical applications.	R, U, An	

2	Discuss the role of polymers in controlled and targeted drug delivery systems and evaluate the design principles for drug delivery using polymers.	R, U, A, E	
3	Explore the use of polymers in tissue engineering applications and discuss the development of medical devices using polymers.	U, An, C, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1	**Hours**	**CO No**
Fundamentals of Biomedical Polymers Introduction to polymers and their classification, Biocompatibility and biodegradability of polymers, Mechanical properties of biomedical polymers, Surface modification techniques, Challenges in polymer degradation in biological environments.	**15**	
Module 2	**Hours**	
Applications of Polymers in Drug Delivery Introduction to drug delivery systems, Polymers as carriers for controlled drug release, Targeted drug delivery using polymers (e.g., nanoparticles, micelles), Polymeric hydrogels for drug delivery applications, Case studies of polymer-based drug delivery systems.	**15**	
Module 3	**Hours**	
Polymers in Tissue Engineering and Medical Devices Polymers in tissue engineering scaffolds, Biomimetic polymers and their role in tissue regeneration, Polymeric materials for medical devices (e.g., implants, prosthetics), Regulatory considerations for biomedical polymers, Emerging trends and future directions in polymer-based biomedical applications.	**15**	

Mode of Transaction	**Classroom Activities:** • Interactive lectures • Group discussions and problem-solving exercises

	• Quizzes and Assignments **Field activities: NA** **Lab based activities:** NA
Mode of Assessment	• Internal Exams • Semester Exam • Assignments and Seminars

Learning Resources

1. Biomaterials Science: An Introduction to Materials in Medicine by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons
2. Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications edited by Surya Mallapragada and Balaji Narasimhan
3. Polymers for Biomedical Applications by Severian Dumitriu
4. Polymer-Based Biomaterials in Tissue Engineering edited by Changyou Gao

Relevance of Learning the Course/ Employability of the Course
Polymers are everywhere, from brushes to automotive to medical devices. Learning basics about them opens doors to exciting careers and empowers the students to solve global challenges. **Biomedical Engineer specializing in Biomaterials** • **Polymer Chemist** • Product Development • Clinical Research • Quality Assurance/Quality Control (QA/QC)