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 Nanoscience and Nanotechnology

Course Code	Title	Credits	Hours per Week		Level	Type
			Theory	Practical		
SEMESTER I						
MG1DSCUNN121	Art of Nanomaterial Synthesis	4	4	-	Foundation (100-199)	Minor A
MG1MDCUNN101	Nano world: History and Evolution	3	3	-	"	MDC
SEMESTER II						
MG2DSCUNN121	Basics of Nanoscience	4	4	-	Foundation (100-199)	Minor A
MG2MDCUNN101	Nanomaterials in Practice: Real-world Applications	3	3	-	"	MDC
SEMESTER III						
MG3DSCUNN221	Nanoscience in Biology	4	4	-	Intermediate (200-299)	Minor A
MG3MDCUNN201	Introduction to Functional Nanomaterials	3	3	-	"	MDC
MG3MDCUNN202	Nanomaterials Properties and Characterization	3	3	-	"	MDC
MG3MDCUNN203	Fundamentals of Computational Material Science and Engineering	3	3	-	"	MDC
MG3MDCUNN204	Modeling and Simulation of Functional Materials	3	3	-	"	MDC
MG3VACUNN201	Environmental Remediation through Nanotechnology	3	3	-	"	VAC

MG3VACUNN202	Green Nanotechnology	3	3	-	"	VAC
SEMESTER IV						
MG4DSCUNN241	Artificial Intelligence and Nanoinformatics	4	4	-	Intermediate (200-299)	Minor B
MG4VACUNN201	Nanotechnology for Agriculture	3	3	-	"	VAC
MG4VACUNN202	Nanotechnology in Food and Health	3	3	-	"	VAC
SEMESTER V						
MG5VACUNN301	Nanotoxicology and Ethics	3	3	-	Higher (300-399)	VAC
MG5VACUNN302	Nanotechnology for Sustainable Energy	3	3	-	"	VAC
MG5SECUNN301	Nanodevice Design and Fabrication Techniques	3	3	-	"	SEC
SEMESTER VI						
MG6SECUNN302	Advanced Electron Microscopic Techniques for Nanomaterial Characterization	3	2	2	Higher (300-399)	SEC
MG6SECUNN303	Scanning Probe Techniques for Nanoscale Characterization	3	2	2	"	SEC
MG6SECUNN304	X-Ray Crystallography for Nanomaterial Structural Analysis	3	2	2	"	SEC
Total Credits						

SEMESTER VII

MG7DSCUNN421	Advanced Computational Material Science and Engineering	4	2	4	Advanced (400-499)	Minor B
SEMESTER VIII						
Total Credits						
SEMESTER IX						
SEMESTER X						
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 Nanoscience and Nanotechnology		
Programme			
Course Title	Nano world: History and Evolution		
Course Type	MDC		
Course Level	100-199		
Course Code	MG1MDCUNN101		
Course Overview	This course offers an introductory course to explore the fascinating world of nanoscience and nanotechnology, tracing its historical development and examining its profound impact on modern science and society. Through a blend of theoretical insights and practical case studies, students will gain a comprehensive understanding of the fundamental concepts of nanostructures - classifications, current opportunities, challenges, ethical considerations, and emerging trends in the field of nanoscience and nanotechnology.		
Semester	1	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	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	Provide a foundation in Nanoscience and Nanotechnology that emphasizes historical milestones, basic understanding and conceptualisation.	U	
2	Expose the students to various nanomaterials, classifications and how these nanomaterials differ from their bulk	A	
3	Promote research interest in students and enable them towards planning and execution of research in frontier areas of nanoscience and nanotechnology.	C	
4	Provide a discussion and critical thinking on ethical, environmental and societal implications of nanotechnology and its interdisciplinary nature.	E	
5	Exposure to various applications and case studies enables students to clearly understand their responsibilities towards societal needs and sustainable development.	An	
6	Investigate future trends and emerging opportunities in nanoscience and nanotechnology, preparing to contribute to ongoing advancements and interdisciplinary applications in the field.	An	

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

COURSE CONTENT

Module 1	Hours	CO No
Definition and scope of nanoscience and nanotechnology, Historical milestones from ancient uses to modern developments, Nano vision - Richard Feynman's lecture "There is plenty of room at the bottom", importance and	15	1, 4

impact of nanotechnology, the evolution of nanotechnology- breakthroughs in microscopy, overview of nanomaterials, fundamental concept of nanoscience-nanoscale and its significance.		
Module 2	**Hours**	
Fundamental properties of nanomaterials- large surface to volume ratio, quantum effect. Classification of nanostructures: one dimensional (ID), two dimensional (2D), three dimensional (3D). Types of nanostructured materials - quantum dots, quantum wire, quantum sheet structures. Carbon nanotubes (CNT), Metals (Au, Ag), Metal oxides (TiO2, Zno), semiconductors (Si, Ge, CdS, ZnSe), Ceramics and composites.	15	1, 2
Module 3	**Hours**	
Recent advancement - cutting-edge research. Case studies on nanotechnology applications – Biomedical, agriculture, energy storage and conversion, nanoelectronics and engineering applications. Challenges-Ethical, environmental and societal implications. Future trends and opportunities.	15	3, 5, 6

Mode of Transaction	**Classroom activities:** Interactive lectures, discussions, and presentations. **Field activities:** NA **Lab based activities:** NA
Mode of Assessment	Attendance: 10% Assignment: 10% Internal Exam: 20% Final Exam: 60%

Learning Resources

1. Charles P. Poole Jr., Frank J. Owens, "Introduction to Nanotechnology", Wiley-Interscience, ISBN-13: 978-0471079354.
2. T. Pradeep, "A Textbook of Nano Science and Technology", Tata McGraw-Hill Education, 2012.
3. Dale A. Stirling, "The Nanotechnology Revolution: A Global Bibliographic Perspective", Jenny Stanford Publishing, ISBN: 9789814774192.

4. Fritz Allhoff, Patrick Lin, James H. Moor, John Weckert, Mihail C. Roco, "Nanoethics: The Ethical and Social Implications of Nanotechnology", Wiley, 1st edition, August 31, 2007.
5. "Nanotechnology: Recent Trends, Emerging Issues and Future Directions", Nova Science Publishers, ISBN: 978-1-63117-561-9.
6. Michael F. Ashby, Paulo J. Ferreira, Daniel L. Schodek, "Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects", Elsevier, 2009.
7. Stuart Lindsay, "Introduction to Nanoscience", OUP Oxford, ISBN-13: 978-0199544219.
8. Jeremy Ramsden, "Nanotechnology: An Introduction", ISBN: 9780323393119 (eBook ISBN: 9780323393140).

Relevance of Learning the Course/ Employability of the Course
Graduates of this course possess a deep understanding of nanotechnology's foundational concepts, ethical considerations, and practical applications, making them valuable assets in roles related to research and development. Additionally, the interdisciplinary nature of nanotechnology empowers graduates to adapt to diverse environments and collaborate across various fields, further enhancing their competitiveness in the job market.

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

School	School of Nanoscience and Nanotechnology		
Programme			
Course Title	Nanomaterials in Practice: Real-world Applications		
Course Type	MDC		
Course Level	100-199		
Course Code	MG2MDCUNN101		
Course Overview	This course explores the vast and transformative applications of nanomaterials in biomedical, agricultural, food, defense, and aerospace industries. Students will gain basic understanding of medical diagnostics, drug delivery, and therapeutic treatments. The course will also cover the agricultural practices and food safety through nanotechnology. In addition, students will learn about the critical role of nanotechnology in defense and aerospace applications, including detection and diagnostics of chemical and biological threats, satellite communications, and spacecraft thermal control.		
Semester	2	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	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 role of nanomaterials in real world applications.	U	
2	Explore the application of nanomaterials in biomedical field and their significance for human kind.	An	
3	Apply nanotechnology principles to enhance agricultural practices and food industry.	A	
4	Provide a discussion and critical thinking on interdisciplinary nature of nanoscience and nanotechnology.	E	
5	Exposure to various applications and case studies enables students to evaluate and analyse the role of nanotechnology in defence, satellite communication and aerospace applications.	An	
6	Promote research interest in students in the frontier areas of biomedical, agriculture, food packaging, defence and aerospace applications.	C	

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

COURSE CONTENT

Module 1	**Hours**	**CO No**
Biosensors- Biological imaging using nanomaterials – Biomarker Imaging – Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis – Tissue Engineering – Skin Tissue repairs, Vascular grafts – Nanosensors in Diagnosis – Drug delivery – Cancer therapy and other therapeutic applications.	15	1, 2, 4, 6
Module 2	**Hours**	
Nanotechnology in Agriculture -Precision farming, Smart	15	1, 3, 4,

delivery systems – Insecticides using nanotechnology – Potential of nano-fertilizers – Potential benefits in Nanotechnology in Food industry – Food processing - Packaging- Packing materials; physical properties. Sensors- RF identification- Food safety- Nanomaterial based Food diagnostics – Contaminant detection – Intelligent packaging.		6
Module 3	**Hours**	
Pathways to Physical protection- Detection and diagnostics of chemical and biological agents, Nanotechnology enabled biochemical weapons. Nanotechnology based satellite communication system- Guidance, Navigation and control. Spacecraft thermal control- mini, micro, nanosatellite concepts- Fiber optic and Chemical microsensors for space craft and launch support- Micro/Nano pressure and temperature sensors for space missions.	15	1, 4, 5, 6

Mode of Transaction	**Classroom activities:** Interactive lectures, discussions, and presentations. **Field activities:** NA **Lab based activities:** NA
Mode of Assessment	Attendance: 10% Assignment: 10% Internal Exam: 20% Final Exam: 60%

Learning Resources

1. Mark A. Ratner and Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Pearson, 2003.
2. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2004.
3. Neelina H. Malsch (Ed.), "Biomedical Nanotechnology", CRC Press, 2005.
4. Udo H. Brinker, Jean-Luc Mieusset (Eds.), "Molecular Encapsulation: Organic Reactions in Constrained Systems", Wiley Publishers, 2010.
5. Jennifer Kuzma and Peter Ver Hage, "Nanotechnology in Agriculture and Food Production", Woodrow Wilson International Center, 2006.

6. Lynn J. Frewer, Willem Norde, R. H. Fischer, and W. H. Kampers, "Nanotechnology in the Agri-Food Sector", Wiley-VCH Verlag, 2011.
7. P. J. Brown and K. Stevens, "Nanofibers and Nanotechnology in Textiles", Woodhead Publishing Limited, Cambridge, 2007.
8. Y.-W. Mai, "Polymer Nanocomposites", Woodhead Publishing, 2006.
9. W. N. Chang, "Nanofibers Fabrication, Performance and Applications", Nova Science Publishers Inc, 2009.
10. H. Helvajian and E. Y. Robinson, "Micro and Nanotechnology for Space Systems", The Aerospace Corporation, Micrograph, 1997.
11. Margaret E. Kosal, "Nanotechnology for Chemical and Biological Defense", Springer, 2009.
12. A. K. Alves (Ed.), "Technological Applications of Nanomaterials", Springer Cham, 2022.

Relevance of Learning the Course/ Employability of the Course
Understanding the applications of nanomaterials across diverse industries is crucial for today's professionals seeking to stay competitive in rapidly advancing fields. Proficiency in nanotechnology is essential for career opportunities in biomedical research and development, transforming diagnostics, drug delivery, and tissue engineering. Understanding nanotechnology in agriculture and food sectors fosters sustainable farming practices, ensures food safety, and drives product innovation on a global scale. In defense and aerospace, nanotechnology expertise supports the development of cutting-edge sensors, communication systems, and spacecraft technologies crucial for national security and exploration efforts. Mastering these applications enhances employability across research institutes, pharmaceutical companies, agricultural firms, and aerospace agencies, empowering individuals to lead innovation in a globally interconnected economy propelled by technological progress.