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 Pure and Applied Physics

Course Code	Title	Credits	Hours per Week		Level	Type
			Theory	Practicals		
SEMESTER I						
MG1DSCUPH101	Principles of Physics	4			Foundation (100-199)	Major
MG1DSCUSP121	Foundations of Physics	4			"	Minor A
MG1DSCUSP141	Elements of Modern Physics	4			"	Minor B
MG1MDCUSP101	Physics of Devices	3			"	MDC
	AEC (Eng)	3			"	
	AEC (Mal)	3			"	
SEMESTER II						
MG2DSCUPH101	Modern Physics	4			"	Major
MG2DSCUSP121	Electricity and Magnetism	4			"	Minor A
MG2DSCUSP141	Condensed Matter Physics	4			"	Minor B
MG2MDCUSP101	Physics and Environment	3			"	MDC
	AEC (Eng)	3			"	
	AEC (Mal)	3			"	
SEMESTER III						
MG3DSCUPH201	Mechanics	4			Intermediate (200-299)	Major
MG3DSCUPH202	Properties of Matter & Thermal Physics	4			"	Major
MG3DSCUPH203	Electromagnetics	4			"	Major
MG3DSCUSP221	Numerical Methods	4			"	Minor

						A
MG3MDCUSP201	Introduction to Astrophysics	3			"	MDC
MG3VACUSP201	Photometric Techniques	3			"	VAC
SEMESTER IV						
MG4DSCUPH201	Electronics	4			"	Major
MG4DSCUPH202	Classical Optics	4			"	Major
MG4DSCUPH203	Mathematical Physics I	4			"	Major
MG4DSCUSP241	Basics of Quantum Mechanics	4			"	Minor B
MG4SECUSP201	Electronic Devices and Circuits	3			"	SEC
MG4VACUSP201	Thin films and Applications	3			"	VAC
MG4INTUPH200	Internship/Fieldwork	2				
SEMESTER V						
MG5DSCUPH301	Classical Mechanics	4			Higher (300-399)	Major
MG5DSCUPH302	Electrodynamics	4			"	Major
MG5DSCUPH303	Statistical Physics	4			"	Major
MG5DSCUPH304	Quantum Mechanics I	4			"	Major
MG5SECUSP301	Crystal Structure Analysis	3			"	SEC
MG5VACUSP301	Solar Cell Technology	3			"	VAC
SEMESTER VI						
MG6DSCUPH301	Mathematical Physics II	4			"	Major
MG6DSCUPH302	Solid State Physics	4			"	Major
MG6DSCUPH303	Quantum Mechanics II	4			"	Major
MG6DSEUPH304	Atomic and Molecular Physics	4			"	Major (E)

MG6DSEUPH305	Physics of Nanomaterials					
MG6DSEUPH306	Laser Physics					
MG6DSEUPH307	Basic Astrophysics	4			“	Major (E)
MG6DSEUPH308	Foundations of Theoretical Physics					
MG6DSEUPH309	Materials Science					
MG6SECUSP301	Instrumentation	3			“	SEC
Total Credits		**133**				

SEMESTER VII						
MG7DSCUPH401	Nuclear and Particle Physics	4			Advanced (400-499)	Major
MG7DSEUPH402	Quantum Field Theory	4			“	Major (E)
MG7DSEUPH403	Materials Physics					
MG7DSEUPH404	Photonics					
MG7DSEUPH405	Solar Physics	4			“	Major (E)
MG7DSEUPH406	Semiconductor Physics					
MG7DSEUPH407	Nanoscience and Nanotechnology					
MG7DSCUSP421	Nuclear and Particle Physics	4			“	Minor A
MG7DSEUSP422	Spectroscopic Characterization Techniques	4			“	Minor A (E)
MG7DSEUSP441	Basic Crystallography	4			“	Minor A/B (E)
SEMESTER VIII						
MG8DSCUPH401	Research Methodology	4			“	Major
MG8DSEUPH402	Introduction to Plasma Physics	4			“	Major (E)

MG8DSEUPH403	General Relativity and Cosmology					
MG8DSEUPH404	Material Characterization Methods					
MG8RPHUPH400	Research Project	12			“	
	Major*	4			“	Major*
	Major*	4			“	Major*
	Major*	4			“	Major*
Total Credits		**44**				
SEMESTER IX						
MG09DSEUPH501	Space Physics	4			PG Level (500-599)	Major (E)
MG09DSEUPH502	Applied Photonics					
MG09DSEUPH503	Nanophotonics					
MG09DSEUPH504	Atmospheric Physics	4			“	Major (E)
MG09DSEUPH505	Nanoscience and Nanotechnology					
MG09DSEUPH506	Semiconductor Devices					
MG09DSEUPH507	Theory of Relativity	4			“	Major (E)
MG09DSEUPH508	Functional Materials					
MG09DSEUPH509	Statistical Field Theory					
MG09DSEUPH510	Computational Methods for Theoretical Physics	4			“	Major (E)
MG09DSEUPH511	Computational Methods for Materials Physics					
MG09DSEUPH512	Elective based Extended Practical	4			“	Major (E)
SEMESTER X						
MG10RPHUPH500	Research Project	20			“	
	Major**	4			“	

	Major**	4			“	
	Major**	4			“	
	Major**	4			“	
	Major**	4			“	
Total Credits		**40**				

*Only for 4-Years Honours Students
**Only for students who opt for theory courses instead of Research Project

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

School	School of Pure and Applied Physics
Programme	4 year Integrated UG (Physics Major)
Course Title	Principles of Physics
Course Type	Major
Course Level	100-199
Course Code	MG1DSCUPH101
Course Overview	This foundational course provides a comprehensive exploration of fundamental physical theories and phenomena. It covers classical mechanics, including Newton's Laws and central force motion, as well as modern concepts like Special Relativity. Students will delve into thermodynamics, studying energy transformations and statistical mechanics, essential for understanding complex systems. Electromagnetism topics include electrostatics, magnetostatics, and Maxwell's equations, crucial for applications in various technological fields. The course also introduces quantum mechanics, covering wave functions, quantum dynamics, and the Schrödinger equation, offering insights into atomic and molecular behavior. Through theoretical study and practical exercises, students develop a deep understanding of foundational physics principles and their applications in scientific and engineering contexts.

Semester	1	**Credit**	4

<table>
<tr><td rowspan="2">Total Student Learning Time</td><td>Instructional hours for theory</td><td>Instructional hours for practical/lab work/field work</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="2">None</td></tr>
</table>

COURSE OUTCOMES (CO)

<table>
<tr><td rowspan="2">CO No.</td><td>Expected Course Outcome</td><td rowspan="2">Learning Domains</td><td rowspan="2">PSO No.</td></tr>
<tr><td>Upon completion of this course, students will be able to;</td></tr>
<tr><td>1</td><td>Recall and apply Newton’s Laws to analyze complex mechanical systems, including central force motion and harmonic oscillators.</td><td>R, An, A</td><td>1, 2</td></tr>
<tr><td>2</td><td>Evaluate the implications of Lorentz transformations in Special Relativity, demonstrating understanding of length contraction and time dilation.</td><td>E, U</td><td>1, 2</td></tr>
<tr><td>3</td><td>Recall and apply the principles of thermodynamics, including the first and second laws, to predict the performance of Carnot engines and analyze entropy changes in various physical systems.</td><td>R, A, An</td><td>1, 2</td></tr>
<tr><td>4</td><td>Analyze electrostatic and magnetostatic phenomena using Maxwell's equations, including solving problems involving charge distributions and magnetic fields.</td><td>A, An</td><td>1, 2</td></tr>
<tr><td>5</td><td>Compare classical and quantum mechanical descriptions of physical phenomena, demonstrating understanding of the probabilistic nature of quantum states and the uncertainty principle.</td><td>E, U</td><td>1, 2</td></tr>
</table>

6	Design experiments to explore quantum mechanical concepts such as wave function solutions and time evolution, applying the Schrödinger equation to different physical scenarios.	C, A	1, 2

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

COURSE CONTENT

Module 1	**Hours**	**CO No**
Mechanics and Relativity Kinematics and Dynamics, Newton's Laws, Central force motion - reduction to one-body problem, equations of motion, energy and angular momentum as constants of motion, classification of orbits, Kepler problem, Harmonic oscillator - Equation of motion, solutions, damped oscillator, forced harmonic oscillator, Relativity : Galilean relativity, Special relativity-Lorentz transformation, length contraction, time dilation, velocity addition.		1, 2
Module 2	**Hours**	
Thermodynamics and statistical mechanics Thermodynamics - Zeroth law, first law, second law, Carnot engine, Entropy, thermodynamic potentials, Classical statistical mechanics - microcanonical ensemble, two-level systems, ideal gas, entropy of mixing and Gibbs paradox, canonical ensemble, examples.		3
Module 3	**Hours**	
Electromagnetism Electrostatics - Coulomb's law, Electric field, Continuous charge distribution, divergence and curl of electrostatic fields, electric potential, Poisson's equation and Laplace's equation, Magnetostatics - Lorentz force, Biot-Savart law - divergence and curl of magnetic field		4
Module 4	**Hours**	

Quantum Mechanics Origin: Double slit experiment, Photoelectric effect, Compton effect - Heisenberg uncertainty principle - Wave function : probability in classical and quantum mechanics, mean and uncertainty - Quantization and Measurement : Single-valuedness and quantization of momentum, measurement postulate - States of definite energy : Free particle on a ring, Particle in a well - Quantum dynamics : A solution of time-dependent Schrödinger equation - General solution for time evolution.		5, 6

Mode of Transaction	**Classroom activities:** **Field activities:** **Lab based activities:**
Mode of Assessment	

Learning Resources

1. Fundamentals of Physics - Mechanics, Relativity and Thermodynamics by R. Shankar

2. Fundamentals of Physics - Electromagnetism, Optics and Quantum Mechanics by R. Shankar

3. Kleppner, D., & Kolenkow, R. (2013). An Introduction to Mechanics (2nd ed.). Cambridge: Cambridge University Press.

4. Griffiths, David J. (David Jeffery), Introduction to Electrodynamics. Boston :Pearson, 2013.

5. Griffiths, D. J., Introduction to Quantum Mechanics (3rd ed.). Pearson Prentice Hall, 2nd edition, 2015.

Relevance of Learning the Course/ Employability of the Course

This course is highly relevant in today's world as it equips students with essential analytical and problem-solving skills that are sought after in various industries.

Understanding physics principles is crucial for careers in engineering, technology, and research, where knowledge of mechanics, thermodynamics, electromagnetism, and quantum mechanics is fundamental. Employers value candidates who can apply theoretical concepts to practical situations, making physics graduates highly desirable in fields such as aerospace, renewable energy, and telecommunications. Moreover, the interdisciplinary nature of physics allows graduates to adapt to diverse work environments and tackle complex challenges across different sectors. Overall, mastering the principles of physics enhances employability by fostering critical thinking, innovation, and adaptability,

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

School	School of Pure and Applied Physics		
Programme	4 year Integrated UG (Physics Minor)		
Course Title	Foundations of Physics		
Course Type	Minor		
Course Level	100-199		
Course Code	MG1DSCUSP121		
Course Overview	This foundational course provides a comprehensive study of essential physical principles across diverse disciplines. It covers mechanics, including kinematics, dynamics, and central force motion, fundamental for understanding motion and forces. Thermodynamics and statistical mechanics are explored, emphasizing the laws of thermodynamics, entropy, and their application in energy transformations and complex systems. Electromagnetism topics include electrostatics, magnetostatics, and Maxwell's equations, crucial for technological and biological applications. Quantum mechanics introduces wave functions, quantization, and the probabilistic nature of quantum states, pivotal for atomic and subatomic phenomena. This course equips students with foundational knowledge and analytical skills relevant to careers in physics, engineering, chemistry, biology, and related scientific fields.		
Semester	1	**Credit**	4
Total Student	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	

Learning Time		
Pre-requisite	None	

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	Upon completion of this course, students will be able to;		
1	Apply Newton's Laws to analyze mechanical systems, including central force motion and harmonic oscillators, integrating energy and angular momentum conservation.	R, A, An	1, 5
2	Explain thermodynamic principles and laws, apply them to Carnot engines, and evaluate entropy using statistical mechanics formulations.	U, An, E	1, 5
3	Analyze electrostatic and magnetostatic fields using Coulomb's law and Biot-Savart law, and evaluate electric potentials and magnetic fields with divergence and curl concepts.	An, E	1, 5
4	Compare classical and quantum descriptions of physical phenomena (e.g., double slit experiment, photoelectric effect), understanding the probabilistic nature of quantum states and the Heisenberg uncertainty principle.	E, U	1, 5
5	Apply quantum mechanics to solve problems with wave functions, momentum quantization, and states of definite energy, demonstrating understanding of the measurement postulate and quantum outcomes.	A, C	1, 5

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

COURSE CONTENT

Module 1	**Hours**	**CO No**
Mechanics Kinematics and Dynamics, Newton's Laws, Central force motion - reduction to one-body problem, equations of motion, energy and angular momentum as constants of motion, Kepler problem, Harmonic oscillator - Equation of motion, solutions, damped oscillator, forced harmonic oscillator.		1
Module 2	**Hours**	
Thermodynamics and statistical mechanics Thermodynamics - Zeroth law, first law, second law, Carnot engine, Entropy, thermodynamic potentials, Classical statistical mechanics - microcanonical ensemble, two-level systems, ideal gas, entropy of mixing and Gibbs paradox.		2
Module 3	**Hours**	
Electromagnetism Electrostatics - Coulomb's law, Electric field, Continuous charge distribution, divergence and curl of electrostatic fields, electric potential, Magnetostatics - Lorentz force, Biot-Savart law - divergence and curl of magnetic field		3
Module 4	**Hours**	
Quantum Mechanics Origin: Double slit experiment, Photoelectric effect, Compton effect - Heisenberg uncertainty principle - Wave function : probability in classical and quantum mechanics, mean and uncertainty - Quantization and Measurement : Single-valuedness and quantization of momentum, measurement postulate - States of definite energy.		4, 5

Mode of Transaction	**Classroom** **Field** **Lab based**

Mode of Assessment	

Learning Resources

1. Kleppner, D., & Kolenkow, R. (2013). An Introduction to Mechanics (2nd ed.). Cambridge: Cambridge University Press.

2. Griffiths, David J. (David Jeffery), Introduction to Electrodynamics. Boston :Pearson, 2013.

3. Griffiths, D. J., Introduction to Quantum Mechanics (3rd ed.). Pearson Prentice Hall, 2nd edition, 2015.

Relevance of Learning the Course/ Employability of the Course
This course is a basic and foundational offering that can hold enormous value to students interested in various fields such as biology, chemistry, mathematics etc. by offering essential insights into the fundamental physical principles. For chemists, it provides a deep understanding of thermodynamics and quantum mechanics, crucial for studying reaction kinetics, molecular structures, and energy transformations. Biologists benefit from electromagnetism concepts, aiding in the understanding of biological processes like nerve signaling and cellular dynamics. Furthermore, the course enhances mathematical proficiency through applications of calculus, differential equations, and vector analysis in physics contexts, enriching quantitative analysis and modeling skills across disciplines. This interdisciplinary approach equips individuals to tackle complex challenges, innovate in technology and materials science, and contribute to

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

School	School of Pure and Applied Physics		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	**Elements of Modern Physics**		
Course Type	Major/**Minor**/MDC/AEC/SEC/VAC		
Course Level	**100-199**/200-299/300-399/400-499/500-599		
Course Code	MG1DSCUSP141		
Course Overview	This course mainly involves the descriptions of nature through some theories which are different from classical physics. Modern physics presents the foundations and frontiers of today's physics. It quantum mechanically focusses on the domains of atomic, nuclear, particle, and condensed-matter physics.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60	30	
Pre-requisite	Fundamental of Physics		

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 particle properties of waves and wave properties of particles.		
2	Understand the comprehensive structure of atoms and related topics.		
3	Understand the basic physics of semiconductor materials		
4	Gain conceptual understanding about the universe		
5	Understand, analyse, evaluate, and interpret the world around in a scientific way		
6	Pursue advanced levels of the subject		

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

COURSE CONTENT

Module 1	**Hours**	**CO No**
Quantum theory of light Electromagnetic waves, Blackbody radiation, Photoelectric effect, Nature of light, X-Ray diffraction, Compton effect, Pair production, Photons and gravity, De Broglie waves, Phase and group velocities, Particle diffraction, Particle in a box, Uncertainty principles.		
Module 2	**Hours**	
Atomic physics The Nuclear Atom, Electron Orbits, Atomic Spectra, The Bohr Atom, Energy Levels and Spectra, Correspondence Principle, Nuclear Motion, Atomic Excitation, Electron Spin, Exclusion Principle, Fermions and bosons, Periodic Table, Atomic Structures, Explaining the Periodic Table.		
Module 3	**Hours**	
Semiconductor physics Energy bands, Charge carriers in semiconductors, Intrinsic and extrinsic semiconductors, Energy bands of n-type and p-type semiconductors, Elemental and		

compound semiconductors, Carrier concentration at thermal equilibrium, Fermi level, Temperature dependence of carrier concentration.		
Module 4	**Hours**	
Introductory astrophysics Stellar structure - M-L relation, HR diagram, Physical state, Hydrostatic equilibrium, Stellar evolution – H burning, CNO cycle, Helium burning, Structure of main sequence stars, Qualitative account of pre-main sequence evolution, Early post main sequence evolution.		

Mode of Transaction	**Classroom activities:** **Field activities:** **Lab based activities:**
Mode of Assessment	

Learning Resources

1

2

3

Relevance of Learning the Course / Employability of the Course

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

School	School of Pure and Applied Physics		
Programme	4 + 1 Integrated UG and PG Programme		
Course Title	Modern Physics		
Course Type	Major		
Course Level	200-299		
Course Code	MG2DSCUPH101		
Course Overview	This course is a comprehensive study of modern physics which began in 1900 with Max Planck's discovery of energy quantization in black body radiation. This mainly involves the advanced description of nature through some theories which are different from classical physics. Modern physics presents the foundations and frontiers of today's physics. It quantum mechanically focusses on the domains like atomic, nuclear, particle, semiconductor and astro physics.		
Semester	2	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60	30	
Pre-requisite	Basic physics, calculus		

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 structure of atoms and subsequent developments in the field.		
2	Understand the comprehensive structure of nucleus and fundamentals of particle physics		
3	Understand the basic physics of semiconductor materials and P-N junction		
4	Gain conceptual understanding about the universe		
5	Understand, analyse, evaluate, and interpret the world around in a scientific way		
6	Pursue advanced levels of the subject.		

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

COURSE CONTENT

Module 1: Atomic structure	**Hours**	**CO No**
Early models of atom, Atomic spectra, Bohr model, Origin of line spectra, Correspondence principle, Quantum mechanics of hydrogen atom, Exclusion principle, Periodic table of elements, X-Ray Spectra, Fluorescence and phosphorescence.	**15**	
Module 2: Nuclear and particle physics	**Hours**	
Structure and properties of the nucleus, Binding energy, Magic numbers, Nuclear forces, Radioactivity– Alpha, beta and gamma decays, Half-life, Radioactive decay law, Nuclear reactions, Nuclear reactors, elementary particles, quarks, fundamental interactions.	**15**	
Module 3: Semiconductor physics	**Hours**	
Energy bands, Charge carriers in semiconductors, Energy bands of n-type and p-type semiconductors, Fermi level, Drift of carriers in electric and magnetic	**15**	

fields, Carrier mobility, Mean free time of carriers, Current density, Conductivity and Resistivity of semiconductors, P-N junction under forward and reverse biases.		
Module 4: Introductory astrophysics Stellar structure - M-L relation, HR diagram, Physical state, Hydrostatic equilibrium, Stellar evolution – H burning, CNO cycle, Helium burning, Structure of main sequence stars, Qualitative account of pre-main sequence evolution, Early post main sequence evolution.	**Hours** **15**	

Mode of Transaction	**Classroom activities:** **Field activities:** **Lab based activities:**
Mode of Assessment	

Learning Resources

1

2

3

Relevance of Learning the Course / Employability of the Course

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Programme	**4 + 1 Integrated UG and PG Programme- PHYSICS**		
Course Title	**CONDENSED MATTER PHYSICS**		
Course Type	Major/**Minor**/MDC/AEC/SEC/VAC		
Course Level	**100-199**/200-299/300-399/400-499/500-599		
Course Code	MG2DSCUSP141		
Course Overview	This course explores the fundamental principles governing the behavior of condensed matter, focusing on solids. Topics covered include crystal structures, symmetry operations, different crystal structures, crystal bonding, lattice dynamics, electronic properties of solids, semiconductor, superconductivity, and nanomaterials.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60	30	
Pre-requisite			

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Learning Outcomes: By the end of this course, students should be able to:		
1	Understand the basic concepts of crystal structures.		
2	Understand the basic concept of crystal symmetry and type of crystals		
3	Explain the electronic band structure of solids, including metals, insulators, and semiconductors.		
4	Analyze semiconductor properties, such as carrier concentration, mobility, and conductivity.		
5	Apply theoretical models and experimental techniques to study the properties of condensed matter systems.		
6			

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

COURSE CONTENT

Module 1	**Hours**	**CO No**
Crystal Structure, Crystalline and amorphous solids, Crystal lattices and unit cells, symmetry operations. Crystallographic notation and crystal systems	**15**	
Module 2	**Hours**	
Bravais lattice in two and three dimensions, miller indices, metallic crystal structures, coordination number, Atomic packing factor, Structure of NaCl, Diamond, Zinc blend etc. Braggs' law. X-ray diffraction and crystal structure determination	**15**	
Module 3	**Hours**	

Bonding in Solids, type of bonding, classification of crystals, ionic bonding, covalent bonding, metallic bonding, Vander Wall bonding and hydrogen bonding.	**15**	
Module 4	**Hours**	
Energy bands and band structure in solids, Metal, insulator, and semiconducting materials, Intrinsic and extrinsic semiconductors, n and p type materials, Semiconductor devices, Diode, transistors and Light emitting diodes.	**15**	

Mode of Transaction	**Classroom activities:** **Lab based activities:**
Mode of Assessment	

Learning Resources

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition
2. Solid State Physics, A J Dekker, Pan Macmillon 3.

Relevance of Learning the Course/ Employability of the Course

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Programme	**4 + 1 Integrated UG and PG Programme- PHYSICS**		
Course Title	**ELECTRICITY AND MAGNETISM**		
Course Type	Major/**Minor**/MDC/AEC/SEC/VAC		
Course Level	**100-199**/200-299/300-399/400-499/500-599		
Course Code	MG2DSCUSP121		
Course Overview	**Course Description:** This course provides an introduction to the fundamental principles of electricity and magnetism. Topics covered include electrostatics, electric circuits, magnetostatics, electromagnetic induction, Maxwell's equations, and electromagnetic waves. The course emphasizes both theoretical concepts and practical applications.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60	**30**	
Pre-requisite			

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Learning Outcomes: By the end of this course, students should be able to:		
1	Understand the fundamental concepts of electrostatics, including Coulomb's law, electric fields, electric potential, and Gauss's law.		
2	Analyze simple electric circuits, including series and parallel circuits, using Ohm's law and Kirchhoff's laws.		
3	Describe the behavior of magnetic fields, including magnetic forces and magnetic materials.		
4	Apply the laws of magnetostatics to analyze simple magnetic systems and devices.		
5	Explain electromagnetic induction and Faraday's law, and analyze the behavior of inductors and transformers.		
6	Apply the principles of electricity and magnetism to solve problems and design simple circuits and devices.		

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

COURSE CONTENT

Module 1	Hours	CO No
Electrostatics:- Coulomb's law, Electric field, distribution of charges, Field lines and Gauss's Law, Electric potential and potential difference, Gauss's law, application of Gauss's law,	**15**	
Module 2	**Hours**	
Work and energy in Electrostatics, Conductors, Electric Circuits, Ohm's law, Series and parallel circuits, Kirchhoff's laws, Capacitors and capacitance.	**15**	
Module 3	**Hours**	
Magnetostatics:- Magnetic fields and magnetic field lines, Magnetic forces on moving charges, Magnetic materials, Electromagnetic Induction, Faraday's law,	**15**	

Lenz's law, Inductors and inductance, Principles of Transformers, Generators.		
Module 4: Thermal and Chemical Effects of Electric Current.	**Hours**	
Thermoelectricity – Seebeck effect, laws of thermo- e.m.f, Measurement of thermo-e.m.f using potentiometer, Peltier effect and Peltier coefficient, Thomson effect and Thomson coefficient, AC and DC circuits, principle of AC/DC motors, Peak, average and RMS values of AC voltage and current, Impedence in an AC Circuit-Inductance in an AC circuit. Capacitance in an AC circuit, AC through an inductance and capacitance in series, AC through capacitance and resistance in series	**15**	

Mode of Transaction	**Classroom activities:** **Field activities:** **Lab based activities:**
Mode of Assessment	

Learning Resources

1. Text book of Electricity and Magnetism, Brij Lal and N Subramanyam. 2.

Relevance of Learning the Course/ Employability of the Course

<table>
<tr><td rowspan="2"></td><td>MAHATMA GANDHI UNIVERSITY
Graduate School</td></tr>
<tr><td>4 + 1 Integrated UG and PG Program</td></tr>
</table>

<table>
<tr><td>School</td><td colspan="3">SCHOOL OF PURE & APPLIED PHYSICS</td></tr>
<tr><td>Program</td><td colspan="3">4 + 1 Integrated UG and PG Program-PHYSICS</td></tr>
<tr><td>Course Title</td><td colspan="3">MECHANICS</td></tr>
<tr><td>Course Type</td><td colspan="3">Major/Minor/MDC/AEC/SEC/VAC</td></tr>
<tr><td>Course Level</td><td colspan="3">100-199/200-299/300-399/400-499/500-599</td></tr>
<tr><td>Course Code</td><td colspan="3">MG3DSCUPH201</td></tr>
<tr><td>Course Overview</td><td colspan="3">This course provides a comprehensive introduction to classical and modern physics. It begins with Newtonian Mechanics, covering Newton’s laws, reference frames, conservation laws, and potential energy. Rigid Body Dynamics explores rotational motion, torque, and moment of inertia for various shapes. The course also covers Waves and Oscillations, including SHM, resonance, and wave interference, and concludes with the Special Theory of Relativity, introducing Lorentz transformations, time dilation, and mass-energy equivalence.</td></tr>
<tr><td>Semester</td><td>3</td><td>credit</td><td>4</td></tr>
<tr><td rowspan="2">Total Student Learning Time</td><td>Instructional hours for theory</td><td colspan="2">Instructional hours for practical/lab work/field work</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Pre-requisite</td><td colspan="3">Students taking this course should have a foundational understanding of basic mechanics, including Newton’s laws and</td></tr>
</table>

	simple kinematics. Familiarity with elementary algebra, trigonometry, and calculus (especially differentiation and integration) is essential for following derivations and solving problems. A basic grasp of energy concepts and wave phenomena from high school physics will also be helpful. Prior exposure to vector operations and coordinate systems is recommended.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Recall and explain the fundamental laws of motion, conservation principles, and reference frames.	(U, R)	
2	Apply Newtonian mechanics and energy principles to solve problems involving particles and rigid bodies.	(A)	
3	Analyze rotational motion and compute moments of inertia for various geometries.	(**An**)	
4	Interpret and evaluate oscillatory and wave phenomena including resonance, interference, and Doppler effect	(**E**)	
5	Apply Lorentz transformations to physical scenarios and demonstrate understanding of relativistic effects	(**A,U**)	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Newtonian Mechanics Review of Newton's Laws of Motion and Applications, Inertial and non- inertial frame of reference. Dynamics of a System of Particles: Center of Mass, Conservation of Momentum, Work-Energy Theorem, Conservative and Non-Conservative Forces, Potential Energy and Stability of Equilibrium.	**( )**	
Module II	**()**	
Rigid Body Dynamics Angular velocity- angular momentum- torque- conservation of angular momentum- angular acceleration, Moment of inertia- parallel and perpendicular axes theorems, Moment of inertia of rod, ring, disc, cylinder and sphere, Flywheel.		
Module III	**()**	
Waves and Oscillations Simple Harmonic Motion (SHM): Damped and Forced Oscillations, Coupled		

Oscillations and Normal Modes, Theory of forced oscillator, resonance, applications, Waves and Superposition: Types of Waves, Wave Equation, Superposition of Waves, Interference, and Beats, Velocity of sound, Doppler effect.		
Module IV	**( )**	
Special Theory of Relativity Inertial and non-inertial frames of reference – Galilean transformation – Significance of Michelson – Morley experiment – postulates of STR- Lorentz transformation – length contraction - time dilation – composition of velocities – Equivalence of mass and energy.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References:

1. An Introduction to mechanics , Daniel Kleppner & Robert J. Kolenkow, McGraw-Hill A Division of The McGraw·HiU Companies
2. University Physics with Modern Physics 15th Edition By Hugh D. Young & Freedman Roger A.
3. Mechanics- H.S.Hans and S.P.Puri. (Tata McGraw-Hill)

Learning Resources

1. Fundamentals of Physics, Resnick, Halliday and Walker, 6th edition, Wiley
2. Mechanics, D S Mathur, S.Chand & Co. (2007)
3. University Physics, Sears and Zemansky, 10th edition, Addison – Wesley Series
4. Concepts of Physics, H.C. Verma, TMH

Relevance of Learning the Course & Employability
Learning this course builds a strong foundation in classical and modern physics, which is essential for advanced studies in physical sciences and engineering. The analytical and problem-solving skills developed are highly relevant in fields like aerospace, mechanical engineering, data science, and research. A solid grasp of mechanics and relativity also prepares students for competitive exams and careers in

academia, R&D, and technical industries.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**PROPERTIES OF MATTER & THERMAL PHYSICS**		
Course Type	**Major**/Minor/MDC/AEC/SEC/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG3DSCUPH202**		
Course Overview	This course offers a detailed study of classical and thermal physics, starting with elasticity, including stress-strain relationships, bending of beams, and torsion. It then explores surface tension, fluid dynamics, and the kinetic theory of gases to understand fluid behavior and molecular motion. The thermodynamics section covers all four laws, focusing on energy transfer, entropy, and the functioning of heat engines like Otto and Diesel engines. The course concludes with entropy in irreversible processes and the theory of black-body radiation, introducing key laws such as Stefan–Boltzmann and Planck's law. Together, these topics build a strong foundation in understanding physical systems and energy transformations.		
Semester	3	credit	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	

Pre-requisite	A basic understanding of high school-level physics and mathematics is essential for this course. Students should be familiar with concepts such as force, energy, pressure, and temperature, as well as basic algebra, calculus (differentiation and integration),and trigonometry. Prior exposure to topics like heat, motion, and properties of matter will help in grasping the core principles more effectively.	

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Recall and explain the fundamental principles of elasticity, fluid dynamics, and thermodynamics.	(R,U)	
2	Apply the laws of elasticity and fluid mechanics to solve problems involving beam bending, torsion, and viscous flow.	(A, S)	
3	Analyze thermodynamic processes and evaluate the efficiency of different heat engines.	(An, E)	
4	Understand entropy changes in reversible and irreversible processes and interpret S-T diagrams and thermodynamic potentials.	(U, An)	
5	Apply radiation laws to analyze black-body spectra and energy distribution.	(A)	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Elasticity Modulus of elasticity, Relations connecting the three elastic moduli-Poisson's ratio- bending of beams- bending moment-cantilever-centrally loaded beams and uniformly bent beams-I section girders-torsion of a cylinder-expression for torsional couple -work done in twisting a wire-torsion pendulum-.		
Module II		
Surface Tension & Fluid Dynamics Molecular explanation of ST.-angle of contact shapes of drops -expression for excess of pressure on a curved liquid surface-variation of ST. with		

temperature. Viscosity, Newton's formula, equation of continuity-Bernoulli's theorem- venturimeter - Stoke's formula, critical velocity- derivation of Poiseuille's formula. Kinetic theory of gases, Gas equations.		
Module III		
Laws of Thermodynamics: Zeroth law, First law- internal energy, Work done during isothermal and adiabatic process, cooling due to Adiabatic reversible processes. Reversible and irreversible processes, Second law- Entropy, Heat Engines, Carnot cycle and theorem, Efficiency, Otto Engine, Petrol engine, Diesel Engine, Third law of thermodynamics- absolute zero of temperature.		
Module IV		
Entropy and Black body radiation Entropy in reversible and irreversible processes, S-T diagrams. Clausius Clepeyron Equation. Thermodynamic potentials: Enthalpy, Gibbs and Helmholtz functions, Maxwell's relations and applications. Black body radiation, Stefan Boltzmann Law, Wein's displacement law, Rayleigh -Jean's Law, Planck's law (Qualitative).		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References:

1. Elements of Properties of Matter: D.S. Mathur, S. Chand Publications,2008
2. Fundamentals of Physics: Halliday and Resnick, Wiley India Pvt. Ltd.,2006
3. Thermal and Statistical Mechanics: S.K. Roy, NewAge International
4. Heat and Thermodynamics: D. S. Mathur, S. Chand &Co
5. Heat and Thermodynamics: Brijlal &Subramaniam, S. Chand &Co

Relevance of Learning the Course & Employability
This Honors-level course in Properties of Matter & Thermal Physics equips students with essential knowledge of elasticity, fluid dynamics, and thermodynamics, which are crucial for engineering, research, and industry. Key applications include structural analysis in civil and

mechanical engineering, aerodynamics in aviation and automotive design, and thermodynamic principles in energy systems and sustainability. Understanding phase transitions and entropy is vital for materials science, nanotechnology, and metallurgy. Graduates can pursue careers in mechanical and aerospace engineering, energy and power industries, R&D, biomedical and environmental sciences, or academia, contributing to advancements in technology and applied physics.

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

<table>
<tr><td>School</td><td colspan="3">SCHOOL OF PURE & APPLIED PHYSICS</td></tr>
<tr><td>Program</td><td colspan="3">4 + 1 Integrated UG and PG Program-PHYSICS</td></tr>
<tr><td>Course Title</td><td colspan="3">ELECTROMAGNETICS</td></tr>
<tr><td>Course Type</td><td colspan="3">Major/Minor/MDC/AEC/SEC/VAC</td></tr>
<tr><td>Course Level</td><td colspan="3">100-199/200-299/300-399/400-499/500-599</td></tr>
<tr><td>Course Code</td><td colspan="3">MG3DSCUPH203</td></tr>
<tr><td>Course Overview</td><td colspan="3">Electromagnetics have the key role in the development of modern technological world. Without electric power and communication facilities, life on earth stands still. A course in electromagnetics is thus an essential component of physics programme at honors level. This course is expected to provide a sound foundation in electricity and magnetism.</td></tr>
<tr><td>Semester</td><td>3</td><td>credit</td><td>4</td></tr>
<tr><td rowspan="2">Total Student Learning Time</td><td>Instructional hours for theory</td><td colspan="2">Instructional hours for practical/lab work/field work</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Pre-requisite</td><td colspan="3">A solid understanding of electricity and magnetism, including Coulomb’s law, electric fields, and basic circuits, is essential. Knowledge of vector calculus and differential equations, particularly Poisson’s and Laplace’s equations, is crucial for analyzing electromagnetic fields. Familiarity with mechanics and wave theory supports the study of charge motion and electromagnetic wave propagation.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	**Analyze and Solve Advanced Electrostatics Problems-**Derive and apply Poisson's and Laplace's equations to compute electric potential and energy distributions in electrostatic systems.	(An, A, E)	
2	**Evaluate the Behavior of Dielectric Materials in Electric Fields-** Understand and analyze polarization, bound charges, and electric displacement, applying Gauss's law in dielectrics to real-world materials.	(U, An, E)	
3	**Apply and Extend Principles of Magnetostatics-**Use Biot-Savart law, Ampère's circuital theorem, and vector potentials to determine magnetic fields in different configurations, optimizing solutions for practical applications.	(A, An, E, C)	
4	**Develop a Deep Understanding of Electromagnetic Induction and Maxwell's Equations-**Interpret and derive Faraday's law, Lenz's law, and Maxwell's equations, extending their applications to wave propagation and modern electromagnetic systems.	(U, An, A, E,C)	
5	**Formulate and Solve Problems in Electromagnetic Wave Propagation-**Analyze the wave equation for EM waves in vacuum and dielectric media, evaluate energy and momentum transfer, and apply concepts to telecommunications, optics, and modern physics research.	(An, E, C, S)	

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

COURSE CONTENT

Module I	Hours	CO No
Electrostatics: Coulomb's law, Electric field- Continuous charge distribution-Divergence and curl of electrostatic fields, Gauss' Law and Applications. Work and Energy in electrostatics-The work done to move a charge - Energy of a point charge distribution and continuous charge distribution. The potential of a localized charge distribution. Electric potential-Poisson's equation and Laplace's equation. Conductors - Basic properties-induced charges, Surface charge and force on a conductor-Capacitors.	()	
Module II		
Magnetostatics The Lorentz Force, The Biot-Savart Law, Amperes circuital law and	()	

applications, Gausses law in magnetism, Faraday's and Lenz's law.		
Module III		
Dielectrics; Polarization – the electric field inside a dielectric medium – Gauss law in dielectric and the electric displacement – Electric susceptibility and dielectric constant – Boundary conditions on the field vectors – Dielectric sphere in a uniform electric field– Force on a point charge embedded in a dielectric.	**()**	
Module IV		
Maxwell's equations and Electromagnetic Waves: Maxwell's equations and magnetic charge - Maxwell's equations inside matter – Boundary conditions – Scalar and vector potentials –Poynting theorem. Hertz Experiment- The wave equation in one dimension – Plane waves-Boundary conditions- Reflection and transmission - Monochromatic plane waves in vacuum - Energy and momentum of electromagnetic waves – Propagation through linear media – Modified wave equation in conductors - Monochromatic plane waves in conducting media	**( )**	

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References:

1. Electricity and Magnetism- J.H.Fewkes & John Yarwood
2. Fundaments of Magnetism and Electricity D N Vasudeva
3. Introduction to Electrodynamics- David J Griffiths
4. Foundation of EMT – Third edition –John R. Reity, Frederick J. Milford and Robert W. Christy.
5. Electromagnetic theory – Prabir K. Basu and HrishikeshDhasmana.

Learning Resources

1. Electricity and Magnetism A S Mahajan and AA Rangwala -TMH
2. Electromagnetics Matthew N Sadiku- Oxford 4th Edn
3. Electromagnetics with applications Kraus/Fleish 5th Edn – TMH

4. Electromagnetics J A Edminister 2nd Edn - TMH
5. Electromagnetic Fields TVS Arunmurthi – S. Chand

Relevance of Learning the Course & Employability
The study of Electromagnetics is vital for modern technology, providing a foundation in electrostatics, magnetostatics, electromagnetic induction, and wave propagation. It is essential for electrical and electronics engineering (circuit design, transformers), telecommunications (wireless communication, antennas, fiber optics), and wave propagation applications (satellites, lasers). It supports research in quantum electrodynamics, plasma physics, and medical applications like MRI and electromagnetic shielding. Career opportunities include electrical and electronics industries (power systems, motors), aerospace and defense (radar, navigation, EMI shielding), telecommunications (RF engineering, networking), renewable energy (solar, wind power), and research in electromagnetics and photonics, enhancing employability in cutting-edge industries.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**NUMERICAL METHODS**		
Course Type	Major/**Minor**/MDC/AEC/SEC/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG3DSCUPH203**		
Course Overview	This course provides a foundational understanding of computational methods and numerical analysis techniques essential in physics and engineering. It begins with an introduction to **Number Systems**, covering binary, decimal, octal, and hexadecimal systems, along with their conversions, arithmetic operations, and floating-point representations based on IEEE standards, with a focus on their applications in scientific computing. The **Errors and Significant Figures** module familiarizes students with different types of errors, methods of error propagation, and the importance of accuracy and precision in measurements. In **Curve Fitting**, students learn basic data analysis techniques including least squares fitting, interpolation, and extrapolation using Newton's methods. The course concludes with an **Introduction to Computational Physics**, offering hands-on experience with programming tools such as MATLAB or Python to solve physical problems numerically.		
Semester	3	credit	4
Total Student Learning Time	**Instructional**	**Instructional hours for**	

	hours for theory	**practical/lab work/field work**
Pre-requisite	A basic understanding of high school mathematics, including algebra and functions, is essential for this course. Familiarity with scientific notation, simple arithmetic operations, and basic concepts in physics such as measurement and units will be helpful. No prior programming experience is required, but a willingness to learn computational tools like MATLAB or Python is expected.	

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Understand and convert between different number systems used in scientific computing.	(U)	
2	Perform binary arithmetic operations and interpret floating-point representations based on IEEE standards	(A)	
3	Identify and analyze different types of errors in measurements and apply error propagation techniques.	(A, E)	
4	Use curve fitting, interpolation, and extrapolation methods to analyze data sets.	(A, U)	
5	Utilize basic programming tools like MATLAB or Python to implement computational methods in physics.	(A,S)	

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

COURSE CONTENT

Module I	Hours	CO No
Number system's: Introduction to Number Systems: Decimal, Binary, Octal, and Hexadecimal, Conversion between Different Number Systems, Binary Arithmetic: Addition, Subtraction, Multiplication, and Division, Floating-Point Representation and IEEE Standards, Applications of Number Systems in Scientific Computing.		
Module II		
Errors and significant figures: Types of Errors: Systematic, Random, and Instrumental Errors, Absolute, Relative, and Percentage Errors, Propagation of Errors in Mathematical Operations, Significant Figures: Rules for Identifying and Rounding,		

Precision, Accuracy, and Uncertainty in Measurements, Error Analysis in Experimental Physics		
Module III		
Curve fitting: Method of group average-Least square fit method (equation only)-fitting a straight line. Interpolation and extrapolation. Newton’s forward difference and backward difference and interpolation-Newton’s divided difference.		
Module IV		
Introduction to Computational Physics (Programing Tools)- MATLAB/Python etc.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. Numerical Methods, Balagurusamy, TMH
2. Numerical Methods for Scientists and Engineers- K Sankara Rao- PHI
3. Introductory Numerical Methods, S S Sastry, PHI.

Learning Resources

Relevance of Learning the Course & Employability
This course equips students with essential computational and analytical skills widely used in physics, engineering, and data-driven fields. Understanding number systems, error analysis, and data fitting techniques is crucial for accurate scientific computation and experimentation. Proficiency in tools like MATLAB or Python enhances employability in research, software development, data analysis, and technical industries, where numerical accuracy and computational modeling are vital.

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

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<tr><td>School</td><td colspan="3">SCHOOL OF PURE & APPLIED PHYSICS</td></tr>
<tr><td>Program</td><td colspan="3">4 + 1 Integrated UG and PG Program-PHYSICS</td></tr>
<tr><td>Course Title</td><td colspan="3">Introduction to Astrophysics</td></tr>
<tr><td>Course Type</td><td colspan="3">Major/Minor/MDC/AEC/SEC/VAC</td></tr>
<tr><td>Course Level</td><td colspan="3">100-199/200-299/300-399/400-499/500-599</td></tr>
<tr><td>Course Code</td><td colspan="3">MG3MDCUSP201</td></tr>
<tr><td>Course Overview</td><td colspan="3">This multidisciplinary course offers undergraduate students a foundational exploration into the physics of the universe. Covering a wide range of topics—from planetary motion and stellar evolution to galaxies, cosmology, and the search for exoplanets—the course blends concepts from classical mechanics, optics, thermodynamics, and modern physics. Students will gain insight into how astronomical observations are made and interpreted, and how physical laws operate on cosmic scales. Whether you're physics major or a science enthusiast, this course aims to spark curiosity about the cosmos while building analytical and problem-solving skills.</td></tr>
<tr><td>Semester</td><td>3</td><td>credit</td><td>3</td></tr>
<tr><td rowspan="2">Total Student Learning Time</td><td>Instructional hours for theory</td><td colspan="2">Instructional hours for practical/lab work/field work</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Pre-requisite</td><td colspan="3">An interest in space, science, and understanding how the universe works. Basic familiarity with high</td></tr>
</table>

	school-level physics and mathematics (algebra and simple formulas) is sufficient. No prior background in astronomy or programming is required—concepts will be introduced in an accessible, interdisciplinary manner suitable for students from all academic streams.

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 celestial motion, coordinate systems, and observational astronomy	(R,U)	
2	Explain the nature of light and radiation, and interpret stellar spectra and blackbody curves.	(U,A)	
3	Analyze the life cycle of stars using H-R diagrams and stellar properties	(An, U)	
4	Apply physical laws to explore galactic structures and cosmological models.	(A, E)	
5	Use basic data analysis tools and simulations to explore real astronomical data and present scientific findings.	(S,C, A)	

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

COURSE CONTENT

Module I	Hours	CO No
Celestial Mechanics and Observational Foundations: Overview of Astronomy: History, Importance & Tools, Celestial sphere, coordinate systems. Newtonian mechanics and Kepler's laws, Orbital motion: Planets, satellites, and escape velocity. Telescopes: Optical, radio, and space-based instruments.		
Module II		
Light, Matter, and Radiation in the Universe: Nature of light and electromagnetic spectrum, Spectroscopy: Emission/absorption lines, redshift, Blackbody radiation, Planck's law, Wien's law, Doppler effect and distance measurements.		
Module III		
Stars and Stellar Evolution: Stellar formation and classification, Hertzsprung–Russell (H-R) diagram, Nuclear fusion, stellar equilibrium, Stellar endpoints: White dwarfs, neutron stars, black holes		

Module IV		
Galaxies, Cosmology & Astrophysical Frontiers: Galaxy types, structure, and distribution, Expansion of the Universe and Hubble's Law, Big Bang theory and cosmic background radiation, Exoplanets and astrobiology, Introduction to data science in astrophysics (e.g., Astropy)		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. "An Introduction to Modern Astrophysics" by Carroll & Ostlie
2. "Astrophysics for Physicists" by Arnab Rai Choudhuri
3. Open resources: NASA Education, ESA, SDSS, Stellarium
4. Programming: Python (Astropy, Matplotlib), Excel-based data plots

Learning Resources

Relevance of Learning the Course & Employability
Aligned with the multidisciplinary and skill-oriented vision, this course on Introduction to Astrophysics encourages experiential and conceptual learning across scientific domains. It helps students develop core competencies in physics, scientific reasoning, and data interpretation, while also promoting digital literacy through the use of computational tools and sky simulation software. The course fosters critical thinking and creativity, preparing learners for diverse academic and professional trajectories.

	MAHATMA GANDHI UNIVERSITY **Graduate School**

	4 + 1 Integrated UG and PG Program

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<tr><td>Program</td><td colspan="3">4 + 1 Integrated UG and PG Program-PHYSICS</td></tr>
<tr><td>Course Title</td><td colspan="3">Photometric Techniques</td></tr>
<tr><td>Course Type</td><td colspan="3">Major/Minor/MDC/AEC/SEC/VAC</td></tr>
<tr><td>Course Level</td><td colspan="3">100-199/200-299/300-399/400-499/500-599</td></tr>
<tr><td>Course Code</td><td colspan="3">MG3VACUSP201</td></tr>
<tr><td>Course Overview</td><td colspan="3">This value-added course offers a practical and interdisciplinary introduction to photometric techniques, focusing on the measurement and analysis of light. Students will learn the principles behind photometry, explore various instruments such as spectrophotometers and colorimeters, and apply these techniques to real-world problems in physics, chemistry, environmental science, and materials research. Emphasizing hands-on learning and data interpretation, the course equips students with skills relevant to research, industry, and higher studies. Designed to complement core subjects, it supports the development of scientific thinking, precision, and technical competence.</td></tr>
<tr><td>Semester</td><td>3</td><td>credit</td><td>3</td></tr>
<tr><td rowspan="2">Total Student Learning Time</td><td>Instructional hours for theory</td><td colspan="2">Instructional hours for practical/lab work/field work</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Pre-requisite</td><td colspan="3">Basic understanding of science at higher secondary level; open to students from all disciplines with an interest in scientific tools and measurements.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Understand key photometric concepts and measurement principles	(R,U)	
2	Operate basic photometric instruments and record data	(S,A)	
3	Apply photometric techniques to real-world problem	(An, A)	
4	Analyze data from photometric experiments and draw conclusions	(An, E)	
5	Connect photometric methods to broader scientific research and industry.	(S,C, U)	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Principles of Photometry and Light Measurement: Basics of photometry and radiometry, Units and concepts: lumen, lux, candela, irradiance, Visual vs instrumental photometry, Introduction to light sources (LEDs, lasers)		
Module II		
Photometric Devices and Instrumentation: Photodetectors: Photodiodes, PMTs, CCDs, Working principles of UV-Vis spectrophotometers, fluorimeters, colorimeters, Calibration and characteristics of instruments, Demonstration: Operating a UV-Vis spectrophotometer		
Module III		
Analytical Photometric Techniques and Applications: Absorbance and transmittance principles, Photometric titrations, colorimetry, turbidity, Applications in environmental testing (e.g., water analysis), Materials characterization (e.g., optical bandgap, luminescence), Case study: photometry in phosphor research.		
Module IV		
Data Handling, Research Integration & Interdisciplinary Relevance: Plotting calibration curves and data interpretation, Error estimation and sensitivity analysis, Simulated mini-project: Determining unknown concentrations, Application in astronomy: Stellar brightness measurement basics, Group presentations on cross-disciplinary uses of photometry.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA)

	Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. Principles of Instrumental Analysis – Cengage Learning
2. Banwell, C. N., & McCash, E. M. Fundamentals of Molecular Spectroscopy – McGraw-Hill
3. Sharma, Y. R. Elementary Organic Spectroscopy – S. Chand Publishing
4. Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. Instrumental Methods of Analysis – CBS Publishers
5. Keller, C. Radiometry and Photometry – Springer (for advanced students)
6. NPTEL Video Lectures – Analytical Chemistry and Spectroscopic Techniques

Learning Resources

Relevance of Learning the Course & Employability
This course enhances students' technical and analytical skills in light-based measurement techniques, which are foundational in research and industry. Photometric techniques are widely used in environmental monitoring, medical diagnostics, material science, quality control, and space science, making the course highly relevant to diverse career paths. By integrating hands-on training with real-world applications, the course improves employability in scientific research, industrial labs, teaching, and instrumentation sectors, while also preparing students for postgraduate studies and competitive fellowships.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**ELECTRONICS**		
Course Type	**Major**/Minor/MDC/AEC/SEC/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG4DSCUPH201**		
Course Overview	We are living in a wonder world of Electronics. To know the physical principles and applications of Electronics is most necessary for a Physics student. This course is intended to provide this know-how.		
Semester	3	credit	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	A basic knowledge of semiconductors, circuit fundamentals, current laws, network theorems, passive elements etc. is a must for the deeper understanding of the topics.		

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 working principles of semiconductor devices and analyze rectifier circuits with filters and voltage regulation.	(U, A)	
2	Explain the characteristics and configurations of BJTs and FETs, and analyze transistor biasing and amplifier operation using h-parameters.	(U, An)	
3	Design and evaluate various amplifier circuits, feedback systems, and sinusoidal oscillators.	(A,E)	
4	Understand the principles of modulation and demodulation and apply them in analyzing AM and FM signals.	(U, A)	
5	Apply Boolean algebra to simplify logic circuits and design basic combinational logic systems using logic gates.	(A, C)	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Basic concepts of semiconductors: P-N junction Diode-Diode Characteristics-Expression for Diode current (Expression without derivation)-Static and Dynamic resistances-Junction capacitance-Equivalent circuit-Avalanche and Zener breakdown-PIV. Rectifiers-Half wave-Centre tapped full wave and Bridge rectifiers-Derivation of efficiency and ripple factor of half wave and full wave rectifiers Filter circuits- Shunt capacitor filter-Series inductor filter-LC filter- π section filter Voltage regulation-Line regulation and load regulation- Zener diode shunt regulator. Design of circuit-Optimum value of current limiting resistor. Wave shaping circuits-Clipper-Positive, negative and biased clipping circuits Clampers-Biased clampers-Voltage multipliers- Doubler-Tripler & Quadrupler.		
Module II		
Transistors: Bipolar junction transistors-Mechanism of amplification in a transistor Common base, common emitter and common collector configurations and their characteristics-Active, saturation and Cut-off regions-Current gain α , β , γ and their relationships-Experiment to draw the characteristics of transistor in the CB and CE modes-Leakage currents-Expressions for output currents in the three modes Thermal runaway Load line, Q-Point- Classification of amplifiers-Class A,B,AB and C amplifiers Need for biasing-Stabilization-Transistor biasing-Fixed bias-Collector to base bias-Self bias(emitter bias)-Voltage divider bias-Transistor as a switch. AC equivalent circuit using h-parameters-Analysis of a transistor amplifier using h parameters-Performance of CE,CC and CC amplifiers Basic ideas of FET & MOSFET		
Module III		
Amplifiers: Feedback amplifiers-Principle of feedback amplifiers-Positive and negative feedback and its effects - Different types of feedback (Block diagrams only)-		

Emitter follower. Sinusoidal oscillators-Principle of oscillators-Barkhausen criterion-Tuned collector oscillator-Hartley and Colpitt's Oscillators – RC Phase shift oscillators - Crystal oscillator. Operational amplifiers - Ideal Op-amp - Virtual ground and summing point Applications-Inverting amplifier - Non inverting amplifier-Unity follower - Summing amplifier (adder).		
Module IV		
Logic Gates and Boolean Algebra: Positive and Negative logic- Basic Logic gates (OR, AND and NOT) only), De Morgan's theorem, Bubbled gates, Universal gates and XOR gates, Laws of Boolean Algebra-Equivalent circuits (Solving simple circuits only), Adders and subtractors.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

Reference

1. A Text Book of Applied Electronics-R.S.Sedha: S.Chand Co. Multi Colour Edn.
2. Basic Electronics-B.L.Theraja: S.Chand Co.

Learning Resources

1. Principles of Electronics: V. K. Mehta and Rohit Mehta, S. Chand Ltd.,2020 Edition
2. Basic Electronics: Devices, circuits and IT fundamentals: Santiram Kal, PHI, 2010

Relevance of Learning the Course & Employability
This course provides essential knowledge of semiconductor electronics, amplifiers, and digital logic circuits, forming the backbone of modern electronic systems. Understanding these concepts is crucial for careers in electronics, communication, instrumentation, and embedded systems. It enhances employability in industries such as consumer electronics, telecommunications, automotive electronics, and IT hardware, while also laying a strong foundation for further studies or research in applied electronics and circuit design.

	MAHATMA GANDHI UNIVERSITY

	Graduate School
	4 + 1 Integrated UG and PG Program

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**CLASSICAL OPTICS**		
Course Type	**Major**/Minor/MDC/AEC/SEC/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG4DSCUPH202**		
Course Overview	This course offers a comprehensive introduction to wave optics and optical communication. It begins with the study of interference phenomena, covering Young's double slit experiment, thin film interference, and Newton's rings. The diffraction module explores patterns from single and multiple slits, circular apertures, and diffraction gratings, including resolution and Rayleigh's criterion. Polarization is discussed through concepts like Malus' law, Nicol prism, and wave plates, along with the analysis of different types of polarized light and dispersion. The course concludes with fiber optics, emphasizing light propagation in optical fibers, transmission characteristics, and the basics of optical communication systems.		
Semester	3	credit	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	A basic understanding of wave phenomena, reflection, refraction, and general physics at the high school level is sufficient 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	Understand the principles of interference and apply them to thin films and Newton's rings.	(A, U)	
2	Analyze diffraction patterns from single slits, multiple slits, and gratings.	(An, A)	
3	Explain the concepts of polarization and identify different types of polarized light.	(U)	
4	Apply the principles of fiber optics in understanding light transmission and losses in optical fibers.	(U,A)	
5	Evaluate the resolving power of optical instruments and explain dispersion phenomena	(E, U)	

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

COURSE CONTENT

Module I	Hours	CO No
Interference-The principle of superposition - coherent sources –superposition of waves from coherent and incoherent sources, Young's double slit experiment, Interference by division of wave front-Fresnel's biprism, Interference by division of amplitude -interference in thin films (reflection only), colours in thin films, air wedge testing of optical flatness Newton's rings (reflected system)-refractive index of a liquid.		
Module II		
Diffraction-Introduction, Diffraction at a single slit , Diffraction through a circular aperture , Diffraction through double slits and N-slits, Diffraction grating, Limit of resolution, Rayleigh's criterion for resolution, resolving power of microscope and grating.		
Module III		
Polarization -Polarization, Plane polarized light, Malu's law, Polarization by reflection, Brewster's law 1 Double refraction, positive and negative crystals, Nicol prism-construction, Nicol prism as a polarizer and analyzer, Quarter and half wave plates. Theory- production and analysis of plane, circularly and elliptically polarized light. Dispersion: Normal and anomalous dispersion-Cauchy's relation (Qualitative ideas only).		
Module IV		
Fiber Optics- Introduction to optical fibre, advantages, disadvantages, and applications of optical fibre communication, principle of light propagation in		

optical fibre, optical fibre fabrication, types of optical fibres: single mode and multimode fibres. Transmission characteristics of optical fibre: attenuation, absorption, scattering losses, bending loss, dispersion, intra modal dispersion, inter modal dispersion. Fundamentals of optical fiber communication systems.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. Optics by Subramanayam, Brijlal, MN Avadhanalu, S.Chand
2. An Introduction to Fiber Optics, Ajoy K. Ghatak, K. Thyagarajan, Cambridge University Press, 2012

Learning Resources

1. Basic optics: principles and concepts: Avijit Lahiri, Elsvier
2. Optics: Eugene Hecht, Addison-Wesley 2002
3. Lasers-Principles, types and applications, K R Nambiar
4. A Text book of Optics, N.Subramanayam, Brijlal, M.N.Avadhanulu, S. Chand & Co.
5. Fundamentals of physics:- Resnuk, Halliday, Krane, JohnWiley and Sons, 5th Ed.
6. Textbook of Optics, Ajoy Ghatak, Tata McGrowHills.
7. Optics, S K Srivastava, CBS Pub. N Delhi 6. A Text book of Optics, S L Kakani, K L Bhandari, S Chand.

Relevance of Learning the Course & Employability
This course equips students with a strong foundation in optical physics, which is essential in fields like photonics, optical engineering, and telecommunications. Understanding interference, diffraction, polarization, and fiber optics is crucial for careers in fiber optic communication, laser technology, imaging systems, and optical instrumentation. The knowledge gained also supports employability in research labs, medical diagnostics (like endoscopy), and advanced manufacturing industries using optical technologies.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**MATHEMATICAL PHYSICS I**		
Course Type	**Major**/Minor/MDC/AEC/SEC/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG4DSCUPH203**		
Course Overview	This course provides essential mathematical tools for physics, starting with vector analysis including gradient, divergence, curl, and key theorems like Gauss's and Stokes'. It then introduces matrix theory and systems of linear equations, focusing on methods like Cramer's rule and the Cayley-Hamilton theorem. Finally, it covers special functions such as Fourier series, Legendre polynomials, and Bessel functions, which are fundamental in solving physical problems involving differential equations.		
Semester	3	credit	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	A basic understanding of calculus, linear algebra, and differential equations is essential to follow the concepts in this course effectively.		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Understand and apply concepts of vector calculus in physical contexts.	*(U, A)*	
2	Solve systems of linear equations using matrix methods.	*(A, S)*	
3	Analyze properties of matrices including eigenvalues and eigenvectors.	*(An)*	
4	Develop Fourier series representations for periodic functions.	*(A, C)*	
5	Apply special functions like Legendre and Bessel functions in solving differential equations.	*(A, U)*	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Vector Analysis Basics of Vector Algebra and its physical concepts, Gradient, Divergence and Curl, vector integration, Gauss's theorem, Green's theorem and Stokes theorem, Potential theory, Gauss's Law and Poisson's Equation, Dirac Delta function and its properties, Orthogonal curvilinear coordinates Gradient, Divergence, Curl and Laplacian. Evaluation of line, surface and volume.		
Module II		
Matrices - Rank of a Matrix, Non-Singular and Singular matrices, Elementary Transformations, Inverse of an elementary Transformations, Equivalent matrices, Row Canonical form, Normal form, Elementary matrices only. Systems of Linear equations: System of non-homogeneous, solution using matrices, Cramer's rule, system of homogeneous equations, Characteristic equation of a matrix; Characteristic roots and characteristic vectors. Cayley-Hamilton theorem (statement only) and simple applications		
Module III		
Special Functions *Fourier Series* : Periodic Functions, Trigonometric Series, Fourier Series, Even and Odd functions, Half-range Expansion.		
Module IV		
Legendre Polynomials – A brief introduction to power series and power series method solving Differential equations. Legendre equation and Legendre Polynomials, Rodrigues' Formula, Bessel's Equation .Bessel's Functions.		

Mode of Transaction	Classroom activities: Seminars, Quiz Field activities: Lab based activities:
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

Learning Resources

1. Mathematical Methods for Physicists, George B. Arfken & Hans J. Weber Academic Press, Elsevier, 2005
2. Introduction to Mathematical Physics, Charlie Harper, PHI Learning Private Limited, New Delhi, 2012.
3. Applied Mathematics for Engineers and Physicists, Louis A. Pipes & Lawrence R. Harvill, McGraw Hill international Book edition, 1981

Relevance of Learning the Course & Employability
This course equips students with essential mathematical tools widely used in physics, engineering, and computational sciences. Mastery of vector calculus, matrix theory, and special functions is fundamental for modeling physical systems, solving complex equations, and analyzing data. These skills are highly valued in fields such as data science, electronics, aerospace, and research, enhancing both academic and industry employability.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**BASICS OF QUATUM MECHANICS**		
Course Type	Major/**Minor**/MDC/AEC/SEC/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG4DSCUSP241**		
Course Overview	This course provides a foundational understanding of quantum mechanics, beginning with its historical development through blackbody radiation, the photoelectric effect, and the wave-particle duality. It introduces the formalism of quantum mechanics, including wave functions, operators, and the postulates that govern quantum systems. Students will explore the Schrödinger equation and its applications to various potential problems such as the particle in a box and the harmonic oscillator. The course also covers essential concepts like expectation values, probability densities, angular momentum, and energy quantization in simple quantum systems.		
Semester	3	credit	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	Students should know basic physics like waves		

	and motion, and be comfortable with simple math and equations.

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 historical development of quantum theory and key experiments.	(U)	
2	Apply the postulates of quantum mechanics to analyze simple systems.	(A)	
3	Solve the Schrödinger equation for basic potential problems.	(A)	
4	Analyze quantum mechanical operators and their physical significance.	(An)	
5	Interpret the mathematical and physical meaning of wave functions and probability densities.	(E)	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Historical Perspective : The Blackbody radiation and Planck's hypothesis, Particle nature of radiation- The photoelectric effect, The Compton effect, Bohr's theory of hydrogen atom, Somerfield's modification, De-Broglie hypothesis-Wave particle duality, Davisson and Germer's electron diffraction experiment,– Uncertainty principle, Quantum numbers		
Module II		
General formalism of Quantum Mechanics Wave function, Eigen functions and Eigen values, Postulates of Quantum Mechanics, Orthogonality, Normalization, Operators- position, momentum, energy and angular momentum, Expectation value, Hermitian operators: properties, Probability Density & Probability current density.		
Module III		
The Schrodinger equation – Operators - The commutator - Physical Interpretation of wave function – Normalization probability current density, expectation value – General Eigen value equation – Eigen value for momentum operator.		

Module IV		
General solution of one dimensional Schrodinger equation for a free particle – group velocity and phase velocity. Stationary state - Time independent Schrodinger equation – boundary and continuity condition for wave functions – degeneracy – orthogonality of wave function – particle in a box (one dimensional) – One dimensional harmonic oscillator – energy eigen value and zero point energy – Orbital angular momentum – commutation relations – Eigen values of L2 , Lz - Energy eigen values of rigid rotator.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. Introduction to Quantum Mechanics, Ajoy Ghatak, Macmillan India Ltd
2. Quantum Physics – Stephen Gasirowicz Pub. Pearson Education (Indian Edn.)
3. Quantum Mechanics - Greiner, 4th Edition, Springer International Edn.
4. Quantum Mechanics G. Aruldhas, Premtice Hall of India.
5. Concepts of Modern Physics - Arthur Beiser, Tata Mc Graw Hill.
6. Applied Quantum Mechanics, A F J Levi, Cambridge Univ. Press.

Learning Resources

1. Introduction to Modern Physics, H.S. Mani and G.K. Mehta
2. Quantum Mechanics, A Konar, Decca students Library Publication Ist Ed.
3. Quantum Mechnics, Mathews and Venkitesan, Tata McGrawHills (2006)

Relevance of Learning the Course & Employability
Understanding quantum mechanics is essential for careers in physics, engineering, and emerging technologies like quantum computing and nanotechnology. This course builds the foundation for analyzing atomic and subatomic systems, equipping students with critical thinking and problem-solving skills applicable in research, electronics, and advanced materials industries. The knowledge gained is highly relevant for roles in R&D, defense, and higher studies in physical sciences.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program- PHYSICS**		
Course Title	**Electronic Devices and Circuits**		
Course Type	Major/Minor/MDC/AEC/**SEC**/VAC		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG4SECUSP201**		
Course Overview	This Skill Enhancement Course introduces undergraduate students to the fundamentals of electronic components, analog and digital circuits, and practical circuit design. It covers key topics such as diodes, transistors, amplifiers, operational amplifiers, and logic gates, blending theory with hands-on lab experience. Students will gain essential skills in analyzing, assembling, and troubleshooting basic electronic circuits. The course is designed to build technical proficiency for future applications in physics, engineering, and industry-aligned careers, supporting the multidisciplinary and employability		
Semester	4	credit	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	Basic knowledge of electricity and simple circuits from higher secondary science.		

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 principles of semiconductor devices and their characteristics	(R,U)	
2	Apply basic concepts to build rectifiers and amplifier circuits	(S,A)	
3	Analyze transistor and Op-Amp based circuits	(An, E)	
4	Develop and troubleshoot digital logic circuits	(A, C)	
5	Gain practical skills in electronic circuit assembly and simulation	(S,C)	

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

COURSE CONTENT

Module I	Hours	CO No
Semiconductor Fundamentals and Diodes: Basic concepts: Intrinsic and extrinsic semiconductors, p-n junction diode, Zener diode – characteristics and applications, Rectifiers (half wave, full wave) and filters.		
Module II		
Transistors and Amplifiers: Bipolar Junction Transistor (BJT) – working and configurations (CE, CB, CC), Load line analysis and biasing, Basic amplifier circuits and frequency response.		
Module III		
Operational Amplifiers and Applications: Ideal and real Op-Amps – characteristics, Inverting, non-inverting amplifiers, Applications: summing amplifier, comparator, integrator, and differentiator.		
Module IV		
Digital Electronics Basics: Logic gates, truth tables, Boolean algebra, Combinational logic circuits (adders, multiplexers), Sequential circuits (flip-flops, counters, registers).		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:** **Lab based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA)

	Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. Boylestad & Nashelsky, Electronic Devices and Circuit Theory, Pearson
2. David A. Bell, Electronic Devices and Circuits, Oxford
3. Thomas L. Floyd, Digital Fundamentals, Pearson
4. Malvino & Leach, Digital Principles and Applications, McGraw-Hill

Learning Resources

Relevance of Learning the Course & Employability
This SEC equips students with essential skills required for careers in electronics servicing, instrumentation labs, automation, and embedded systems development. The course supports hands-on learning and industry-relevant skill acquisition, making it ideal for internships, research projects, and higher studies in electronics, physics, and applied engineering fields.

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

School	SCHOOL OF PURE & APPLIED PHYSICS		
Program	**4 + 1 Integrated UG and PG Program-PHYSICS**		
Course Title	**Thin films and Applications**		
Course Type	Major/Minor/MDC/AEC/SEC/**VAC**		
Course Level	100-199/**200-299**/300-399/400-499/500-599		
Course Code	**MG4VACUSP201**		
Course Overview	This course introduces students to the fascinating world of **thin film materials**, their fabrication techniques, and their diverse technological applications. Emphasizing both theoretical understanding and practical skills, the course covers deposition methods like sputtering, sol-gel, and spin coating, along with basic characterization tools such as XRD and SEM. Students will explore how thin films are used in solar cells, sensors, and electronic devices. Designed for undergraduate science students, the course fosters interdisciplinary learning and skill development aligned with modern research and industrial demands.		
Semester	4	credit	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
Pre-requisite	Fundamental knowledge of Physics and Chemistry at the higher secondary level. Open to all science and engineering undergraduate students with an		

	interest in materials and their applications.

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 thin film science	(R,U)	
2	Identify various deposition techniques and their uses	(U,A)	
3	Apply basic characterization techniques to analyze thin films	(A, An)	
4	Relate the structure of thin films to their functionality in applications	(An, E)	
5	Demonstrate awareness of emerging technologies using thin film materials	(U,S,C)	

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

COURSE CONTENT

Module I	**Hours**	**CO No**
Introduction to Thin Films: Definition and significance of thin films, Distinction between thin and thick films, Historical development and modern relevance, Classification based on material and application		
Module II		
Thin Film Deposition Techniques: Physical Vapor Deposition (PVD): Pulsed Laser Deposition, Sputtering, Thermal evaporation, Chemical Vapor Deposition (CVD):Sol-gel technique, Spin coating, Dip coating, and Spray pyrolysis, Lab Demo: Spin coating and thin film formation on glass substrate.		
Module III		
Characterization of Thin Films: Structural analysis: XRD, Morphology: SEM, Film thickness measurement, Optical and electrical properties, Case study: Thin film transparency and conductivity.		
Module IV		
Applications of Thin Films: Solar cells, OLEDs, sensors, anti-reflection coatings, Superconducting and magnetic thin films, Lab Simulation/Demo: Thin film use in optoelectronic devices, Project presentation: A selected thin film application.		

Mode of Transaction	**Classroom activities: Seminars, Quiz** **Field activities:**

	Lab based activities:
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed within the class 3. Semester End Examination 4. Viva

References

1. Ohring, M. – Materials Science of Thin Films, Academic Press
2. Vossen, J. L., & Kern, W. – Thin Film Processes, Academic Press
3. K.L. Chopra – Thin Film Phenomena, McGraw-Hill

Learning Resources

Relevance of Learning the Course & Employability
This course builds essential skills in material processing and device fabrication, relevant for careers in nanotechnology, electronics, energy research, sensor development, and applied physics. Skill-based, multidisciplinary education prepares students for research internships, industry roles, and postgraduate programs.