

NOAKHALI SCIENCE AND TECHNOLOGY UNIVERSITY

Institutional Quality Assurance Cell (IQAC)

Noakhali Science and Technology University, Noakhali-3814, Bangladesh

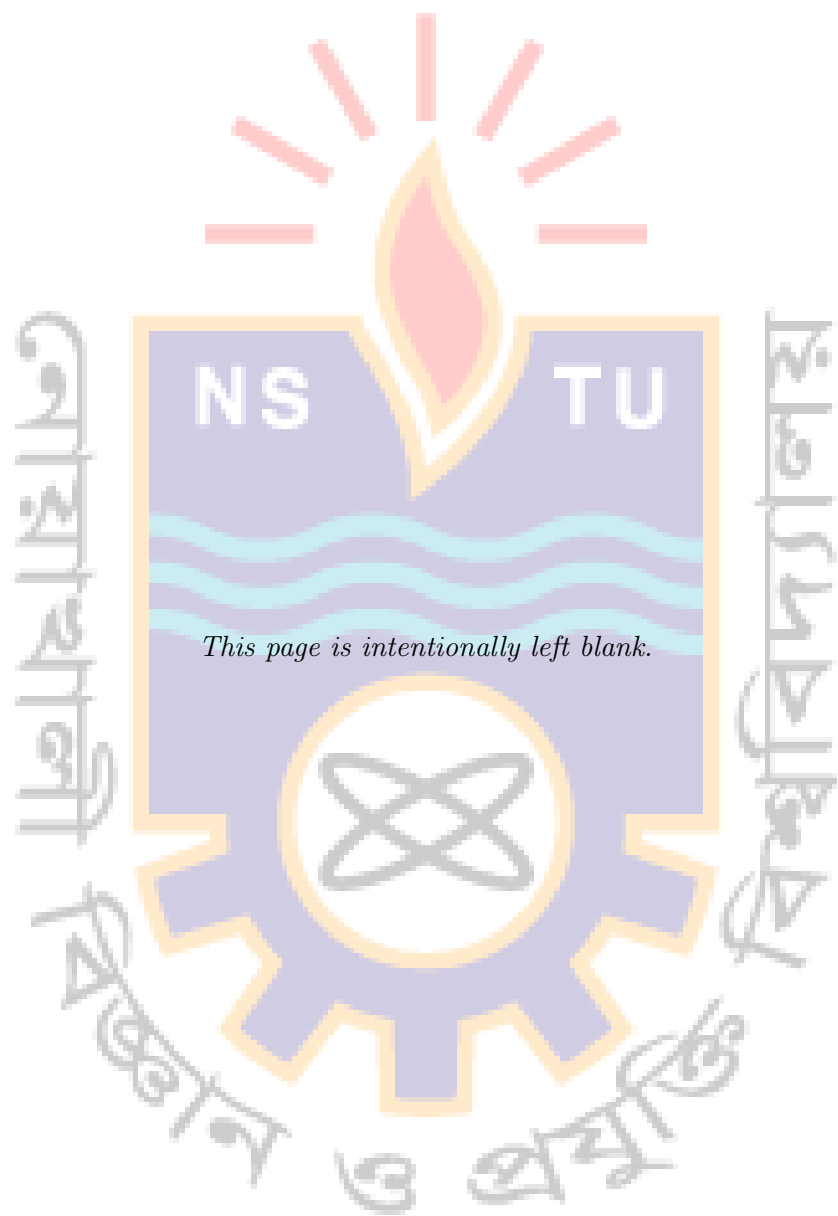


OUTCOME BASED EDUCATION (OBE) CURRICULUM

Bachelor of Science (Honours) in Physics

Department of Physics

Noakhali Science and Technology University

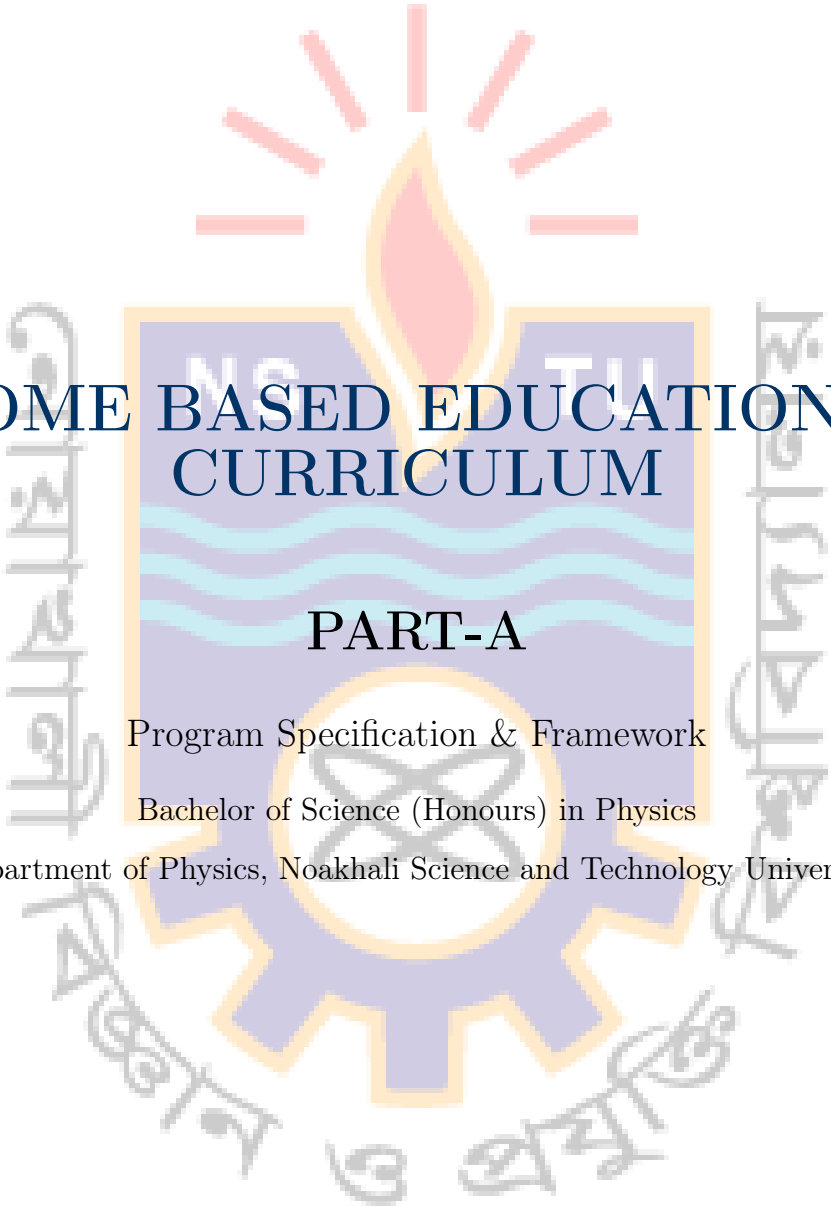


Contents

1 PART-A	6
1.1 Title of the Academic Program	6
1.2 Name of the University	6
1.3 Vision of the University	6
1.4 Mission of the University	6
1.5 Name of the Program Offering Entity (POE)	6
1.6 Vision of the Program Offering Entity	6
1.7 Mission of the Program Offering Entity	6
1.8 About this Department	7
1.9 Objectives of the Program Offering Entity	7
1.10 Name of the Degree	8
1.11 Description of the Program	8
1.12 Graduate Attributes	8
1.13 Program Educational Objectives (PEOs)	9
1.14 Program Learning Outcomes (PLOs)	10
1.15 Mapping of Program Educational Objectives (PEOs) with University Mission	10
1.16 Mapping PLOs with PEOs	11
1.17 Mapping Courses with PLOs	11
2 PART-B (Structure of the Curriculum)	17
2.1 Structure of the Curriculum	17
2.2 Year/Term-wise Distribution of Courses	17
3 PART-C (Course Descriptions)	21
3.1 First Year – Course Descriptions	21
Year I – Term I	21
0533 PHYS 1101: Mechanics	21
0533 PHYS 1102: Physics Lab-1A	23
0533 PHYS 1103: Waves and Oscillations	24
0533 PHYS 1104: Physics Lab-1B	26
0541 MATH 1101: Differential and Integral Calculus	28
0531 CHEM 1101: Fundamentals of Chemistry	29
0531 CHEM 1102: Chemistry Lab	31
0611 CSE 1101: Computer Fundamentals	33
0611 CSE 1102: Computer Fundamentals Lab	34
0533 PHYS 1106: Viva-voce	36
Year I – Term II	37
0533 PHYS 1201: Electricity and Magnetism	37
0533 PHYS 1202: Physics Lab-1C	39
0533 PHYS 1203: Properties of Matters	40
0533 PHYS 1204: Physics Lab-1D	42

0613 CSE 1201: Computer Programming	43
0613 CSE 1202: Computer Programming Lab	45
0541 MATH 1201: Differential Equations and Matrices	47
0533 PHYS 1206: Viva-voce	49
3.2 Second Year – Course Descriptions	50
Year II – Term I	50
0533 PHYS 2101: Optics	50
0533 PHYS 2102: Physics Lab-2A	52
0533 PHYS 2103: Basic Electronics	53
0533 PHYS 2104: Physics Lab-2B	55
0533 PHYS 2105: Mathematical Physics	56
0542 STAT 2101: Principles of Statistics-I	58
0231 ENG 2101: Functional English	60
0533 PHYS 2106: Viva-voce	62
Year II – Term II	63
0533 PHYS 2201: Thermal Physics	63
0533 PHYS 2202: Physics Lab-2C	65
0533 PHYS 2203: Atomic and Molecular Physics	66
0533 PHYS 2204: Physics Lab-2D	68
0533 PHYS 2205: Classical Mechanics and Relativity	70
0541 MATH 2201: Numerical Analysis and Applications	72
0542 STAT 2201: Principles of Statistics-II	74
0542 STAT 2202: Principles of Statistics Lab	76
0533 PHYS 2206: Viva-voce	78
3.3 Third Year – Course Descriptions	79
Year III – Term I	79
0533 PHYS 3101: Laser Physics	79
0533 PHYS 3102: Physics Lab-3A	81
0533 PHYS 3103: Electrodynamics	82
0533 PHYS 3104: Physics Lab-3B	85
0533 PHYS 3105: Solid State Physics-I	86
0533 PHYS 3107: Quantum Mechanics-I	88
0533 PHYS 3109: Statistical Mechanics	90
0533 PHYS 3106: Viva-voce	92
Year III – Term II	93
0533 PHYS 3201: Nuclear Physics-I	93
0533 PHYS 3202: Physics Lab-3C	95
0533 PHYS 3203: Electronic Devices and Circuits	96
0533 PHYS 3204: Physics Lab-3D	98
0533 PHYS 3205: Computational Physics	99
0533 PHYS 3206: Computational Physics Lab	101
0533 PHYS 3207: Introduction to Astrophysics	103

0533 PHYS 3209: Geophysics	105
0533 PHYS 3208: Viva-voce	107
3.4 Fourth Year – Course Descriptions	108
Year IV – Term I	108
0533 PHYS 4101: Nuclear Physics-II	108
0533 PHYS 4102: Physics Lab-4A	110
0533 PHYS 4103: Solid State Physics-II	112
0533 PHYS 4104: Physics Lab-4B	114
0533 PHYS 4105: Digital Electronics and Pulse Techniques	115
0533 PHYS 4107: Experimental and Computational Methods in Physics	117
0533 PHYS 4106: Honors Project-I	120
0533 PHYS 4108: Viva-voce	122
Year IV – Term II	123
0533 PHYS 4201: Introduction to Material Science and Nanotechnology	123
0533 PHYS 4202: Physics Lab-4C	125
0533 PHYS 4203: Medical and Radiation Physics	127
0533 PHYS 4204: Physics Lab-4D	129
0533 PHYS 4205: Quantum Mechanics-II	131
0533 PHYS 4207: Reactor Physics	133
0533 PHYS 4209: Plasma Physics	135
0533 PHYS 4206: Honors Project-II	137
0533 PHYS 4208: Viva-voce	139
4 PART-D (Grading / Evaluation)	142
4.1 Grading / Evaluation	142
4.1.1 Grading Scale	142
4.1.2 Grades	143
4.1.3 Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)	143
4.1.4 Course / Term Withdrawal	144
4.1.5 Backlog and Special Term	144



OUTCOME BASED EDUCATION (OBE) CURRICULUM

PART-A

Program Specification & Framework

Bachelor of Science (Honours) in Physics

Department of Physics, Noakhali Science and Technology University

1 PART-A

1.1 Title of the Academic Program

Bachelor of Science (Honours) in Physics

1.2 Name of the University

Noakhali Science and Technology University

1.3 Vision of the University

To become the center of excellence for advanced research and technology to achieve sustainable development.

1.4 Mission of the University

	Mission Statement
M1	To create precious manpower with intellectual, creative, technical and practical skills to contribute with moral, industry, community and caring relationship among all stakeholders.
M2	To provide outcome based standard education as preparation for advanced studies, entrepreneurship or future employment across a global range of ICT, business, research organization along with social and public institution.
M3	To ensure the delivery of high-quality learning combining with hands-on training through qualified, dedicated and experienced facilitators.
M4	To deliver research and innovative opportunities at all levels to promote local and global networking for students and staff.
M5	To engage in partnerships with local and global communities, government agencies, industries and universities aspiring for sustainable society and economy.

1.5 Name of the Program Offering Entity (POE)

Physics

1.6 Vision of the Program Offering Entity

To establish the Department of Physics as a center of excellence in teaching, research, and innovation by inspiring and nurturing students' curiosity, critical thinking, and passion for the creation and dissemination of scientific knowledge. The department is committed to producing competent graduates with strong professional and ethical values while fostering a scientifically literate society that promotes logical reasoning, innovation, and sustainable development.

1.7 Mission of the Program Offering Entity

	Mission Statement
M1	Excellence in Physics Education: To become a nationally and internationally recognized center of excellence in physics education, known for producing highly skilled graduates with a strong foundation in both theoretical and applied physics.

	Mission Statement
M2	Innovative Learning Environment: To provide an engaging, student-focused learning environment that integrates modern pedagogical techniques, advanced laboratory experiences, and interdisciplinary collaboration.
M3	Global Competence: To nurture students who are prepared to excel in a globally competitive environment, capable of addressing scientific and technological challenges across diverse industries and research fields.
M4	Leadership in Research and Technology: To advance the frontiers of physics by fostering a research culture that promotes innovation, critical thinking, and breakthroughs in cutting-edge scientific areas, contributing to societal and technological progress.
M5	Commitment to Sustainability and Ethical Responsibility: To produce graduates who understand the societal and environmental impact of scientific advancements, committed to ethical practice, sustainability, and responsible scientific leadership.
M6	Lifelong Learning and Adaptability: To empower students with the skills for lifelong learning and adaptability in the rapidly evolving landscape of science and technology, ensuring they are equipped for continuous growth and contribution to interdisciplinary fields.

1.8 About this Department

The Department of Physics at Noakhali Science and Technology University (NSTU) stands as a beacon of academic excellence and innovation in the realm of physical sciences. Since its inception, the department has been dedicated to providing a comprehensive education that blends theoretical foundations with practical applications, equipping students to excel in both academia and industry.

Department of Physics started its journey from Session 2021-22 with three faculty members and twenty students. The Department is currently situated on the 2nd and 4th Floor of the beautiful Provost Building, Noakhali Science & Technology University. The Department boasts well-equipped laboratories, a modern seminar room, and advanced research facilities that support the academic and professional growth of students and faculty. The curriculum encompasses a wide range of topics, from classical mechanics and quantum physics to modern advancements in materials science, thermodynamics, and computational physics.

At present there are 6 faculty members (one Professor, one Associate Professor, one Assistant Professors and three Lecturers) who are involved in teaching and performing their research with brilliance and perseverance.

To enhance the learning experience, the department integrates fieldwork, individual projects, and industrial training into its academic programs. Students also engage in community-based science outreach and participate in conferences, workshops, and internships to broaden their practical knowledge and skillset.

The Physics Department is committed to fostering a collaborative and inclusive environment, where critical thinking, problem-solving, and ethical practices are emphasized. With a dedicated team of highly qualified faculty, the department is driving innovation and contributing to the advancement of knowledge, preparing students to meet the challenges of the global scientific community.

1.9 Objectives of the Program Offering Entity

	Objective
O1	Introduce students to fundamental and advanced principles of physics, building a solid foundation for critical thinking and scientific inquiry.
O2	Make students proficient in applying theoretical knowledge through hands-on experiments and problem-solving in real-world applications.

	Objective
O3	Familiarize students with modern scientific tools and techniques, preparing them for industry and research environments.
O4	Explain the ethical responsibilities of physicists and implant a strong sense of professional integrity in scientific practice.
O5	Prepare students for careers in academia and industry by enhancing their technical skills, communication abilities, and adaptability.
O6	Develop highly competitive professionals who excel in both national and international scientific and technological arenas.

1.10 Name of the Degree

Bachelor of Science (Honours) in Physics

1.11 Description of the Program

The Department of Physics at Noakhali Science and Technology University was established in 2022 with an average annual intake of about 17 undergraduates and from then it successfully engaged in teaching and research activities. A total of six teachers is conducting the department education activities. The department offers the four-year B.Sc. (Honours) degree where students are taught courses in Physics and other basic sciences (Mathematics, Chemistry, and Statistics), computer programming as well as English Language course. Sharing a strong tie with Bangladesh Atomic Energy Commission (BAEC), Bangladesh Council of Scientific and Industrial Research (BCSIR), Bangladesh University of Engineering and Technology (BUET), University of Dhaka (DU), Jahangirnagar University (JU), Shahjalal University of Science and Technology (SUST) and other major research institutions of the country, research students work to learn and explore experimental techniques and theoretical methods to investigate nature. The department conducts research on condensed matter physics, materials science, spintronics, plasma physics, nuclear physics, radiation and health physics, and photonics. Faculties of the department have authored numerous articles published in international peer-reviewed journals and preceded on international conferences and seminars.

1.12 Graduate Attributes

GA	Graduate Attribute	Description	Domain
GA1	Physics Knowledge	Demonstrate a comprehensive understanding of fundamental principles, theories, and concepts of physics and apply them to explain natural phenomena and solve scientific problems.	Fundamental Knowledge
GA2	Critical Thinking and Problem Solving	Apply logical reasoning, analytical thinking, and quantitative methods to identify, formulate, and solve complex scientific and technological problems.	Cognitive
GA3	Scientific Investigation	Design and conduct experiments, collect and analyze data, interpret results, and draw evidence-based conclusions using appropriate scientific methods.	Cognitive
GA4	Teamwork and Leadership	Work effectively and responsibly as an individual or as a member or leader of diverse and multidisciplinary teams to achieve common goals.	Social

GA	Graduate Attribute	Description	Domain
GA5	Communication	Communicate scientific concepts, experimental findings, and research outcomes effectively in oral, written, and digital forms to both scientific and non-scientific audiences.	Social
GA6	Adaptability	Demonstrate adaptability, resilience, and a commitment to continuous improvement in response to emerging scientific knowledge and technological advancements.	Personal
GA7	Technical Competence	Demonstrate proficiency in laboratory techniques, scientific instrumentation, computational tools, and modern technologies relevant to physics education and research.	Psychomotor
GA8	Ethics and Social Responsibility	Uphold ethical principles, professional integrity, and responsible conduct in scientific research while recognizing the societal, environmental, and global impacts of scientific practice.	Affective
GA9	Self-Management	Demonstrate personal responsibility, professionalism, effective time management, and independent learning in academic and professional activities.	Personal
GA10	Lifelong Learning	Recognize the importance of lifelong learning and actively pursue continuous professional development to remain current with advances in physics and related disciplines.	Affective

1.13 Program Educational Objectives (PEOs)

These are the statements that describe the expected accomplishments of graduates during their first few years after graduation. Once our students are out in the workforce, it is expected to:

PEO	Description	Category
PEO1	Graduates will demonstrate a strong foundation in physics principles and theories, enabling them to apply this knowledge effectively in their careers or further studies.	Fundamental Mastery
PEO2	Graduates will exhibit proficiency in the use of modern scientific tools and methodologies, allowing them to solve practical problems in various physics-related fields.	Professional Competence
PEO3	Graduates will engage in scientific inquiry and research, contributing to advancements in physics and related disciplines through innovative approaches.	Research and Innovation
PEO4	Graduates will effectively collaborate in multidisciplinary teams, showcasing their ability to contribute to group efforts and communicate effectively with peers.	Teamwork and Collaboration
PEO5	Graduates will demonstrate a commitment to continuous personal and professional development, adapting to new challenges and advancements in the field of physics.	Lifelong Learning
PEO6	Graduates will communicate complex scientific concepts clearly and effectively, both verbally and in writing, to diverse audiences, including peers and non-specialists.	Effective Communication

PEO	Description	Category
PEO7	Graduates will exhibit the ability to adapt to changing environments and tackle complex problems, applying critical thinking and analytical skills in various contexts.	Adaptability and Problem Solving

1.14 Program Learning Outcomes (PLOs)

After successful completion of the degree, the graduates will be able to:

PLO	Program Learning Outcome	Domain
PLO1	Demonstrate comprehensive knowledge of the fundamental principles, theories, and concepts of classical and modern physics and apply them to explain natural phenomena and solve scientific problems.	Fundamental
PLO2	Analyze, formulate, and solve complex physical problems using appropriate mathematical techniques, computational methods, and scientific reasoning.	Cognitive
PLO3	Design and conduct experiments, collect and analyze data, evaluate uncertainties, and draw evidence-based conclusions using established scientific methods.	Cognitive
PLO4	Apply modern laboratory techniques, scientific instrumentation, computational tools, and specialized software for experimentation, modeling, simulation, and data analysis.	Psychomotor
PLO5	Conduct scientific investigations by applying research methodologies, critical analysis, literature review, and evidence-based interpretation of experimental and theoretical results.	Cognitive
PLO6	Communicate scientific concepts, experimental results, and research findings effectively through technical reports, oral presentations, and digital media for both scientific and general audiences.	Social
PLO7	Function effectively as an individual and as a member or leader of multidisciplinary teams by demonstrating collaboration, leadership, and interpersonal skills.	Social
PLO8	Uphold ethical principles, academic integrity, professional responsibility, and environmental sustainability in scientific research and professional practice.	Affective
PLO9	Demonstrate self-management, professionalism, adaptability, and accountability in academic, research, and professional activities.	Personal
PLO10	Engage in lifelong learning and continuous professional development to adapt to emerging scientific knowledge, technologies, and interdisciplinary advances.	Affective
PLO11	Apply physics knowledge and technical skills to solve practical problems in research, industry, education, healthcare, energy, and other technology-driven sectors.	Fundamental
PLO12	Integrate knowledge of physics with mathematics, computing, and related disciplines to develop innovative and sustainable solutions to complex scientific problems.	Cognitive

1.15 Mapping of Program Educational Objectives (PEOs) with University Mission

Level of Correlation: 3 = High, 2 = Medium, 1 = Low

PEOs	M1	M2	M3	M4	M5
PEO1	3	3	2	1	1
PEO2	2	3	3	3	2
PEO3	3	2	2	2	3
PEO4	2	2	3	3	2
PEO5	3	2	1	2	3
PEO6	2	3	2	3	2

1.16 Mapping PLOs with PEOs

Mapping of Program Learning Outcomes (PLOs) with Program Educational Objectives (PEOs)

Level of Correlation: 3 = High, 2 = Medium, 1 = Low

PLOs	PEO1	PEO2	PEO3	PEO4	PEO5
PLO1	3	2	1	1	1
PLO2	3	3	1	2	1
PLO3	2	3	1	3	1
PLO4	2	3	1	3	1
PLO5	2	3	2	3	1
PLO6	1	2	3	2	2
PLO7	1	1	3	2	2
PLO8	1	1	3	2	3
PLO9	2	2	3	1	3
PLO10	1	2	2	2	3
PLO11	3	3	2	2	2
PLO12	2	3	2	3	3

1.17 Mapping Courses with PLOs

Year I Term I

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 1101	✓	✓							✓		✓	
0533 PHYS 1102			✓	✓	✓		✓		✓		✓	
0533 PHYS 1103	✓	✓									✓	✓
0533 PHYS 1104			✓	✓	✓		✓		✓		✓	
0541 MATH 1101		✓									✓	✓
0531 CHEM 1101	✓	✓										✓
0531 CHEM 1102			✓	✓	✓		✓		✓		✓	
0611 CSE 1101				✓					✓	✓		✓
0611 CSE 1102			✓	✓					✓	✓		✓

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 1106						✓	✓	✓	✓	✓		

Year I Term II

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 1201	✓	✓									✓	✓
0533 PHYS 1202			✓	✓	✓		✓		✓		✓	
0533 PHYS 1203	✓	✓									✓	
0533 PHYS 1204			✓	✓	✓		✓		✓		✓	
0613 CSE 1201		✓			✓				✓	✓		✓
0613 CSE 1202			✓	✓	✓				✓	✓		✓
0541 MATH 1201		✓									✓	✓
0533 PHYS 1206						✓	✓	✓	✓	✓		

Year II Term I

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 2101	✓	✓									✓	✓
0533 PHYS 2102			✓	✓	✓		✓		✓		✓	
0533 PHYS 2103	✓	✓		✓						✓	✓	
0533 PHYS 2104			✓	✓	✓		✓		✓		✓	
0533 PHYS 2105	✓	✓									✓	✓
0542 STAT 2101		✓	✓							✓	✓	
0231 ENG 2101						✓	✓	✓	✓	✓		
0533 PHYS 2106						✓	✓	✓	✓	✓		

Year II Term II

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 2201	✓	✓									✓	
0533 PHYS 2202			✓	✓	✓		✓		✓		✓	
0533 PHYS 2203	✓	✓									✓	
0533 PHYS 2204			✓	✓	✓		✓		✓		✓	
0533 PHYS 2205	✓	✓									✓	✓
0541 MATH 2201	✓	✓			✓				✓		✓	
0542 STAT 2201		✓	✓							✓	✓	
0542 STAT 2202			✓	✓	✓				✓	✓		
0533 PHYS 2206						✓	✓	✓	✓	✓		

Year III Term I

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 3101	✓	✓				✓					✓	
0533 PHYS 3102			✓	✓	✓		✓		✓		✓	
0533 PHYS 3103	✓	✓									✓	✓
0533 PHYS 3104			✓	✓	✓		✓		✓		✓	
0533 PHYS 3105	✓	✓			✓						✓	
0533 PHYS 3107	✓	✓			✓					✓	✓	
0533 PHYS 3109	✓	✓			✓					✓	✓	
0533 PHYS 3106						✓	✓	✓	✓	✓		

Year III Term II

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 3201	✓	✓			✓						✓	
0533 PHYS 3202			✓	✓	✓		✓		✓		✓	
0533 PHYS 3203	✓	✓		✓						✓	✓	

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 3204			✓	✓	✓		✓		✓		✓	
0533 PHYS 3205		✓		✓	✓				✓		✓	
0533 PHYS 3206			✓	✓	✓				✓		✓	
0533 PHYS 3207	✓	✓			✓					✓	✓	
0533 PHYS 3209	✓	✓			✓						✓	✓
0533 PHYS 3208						✓	✓	✓	✓	✓		

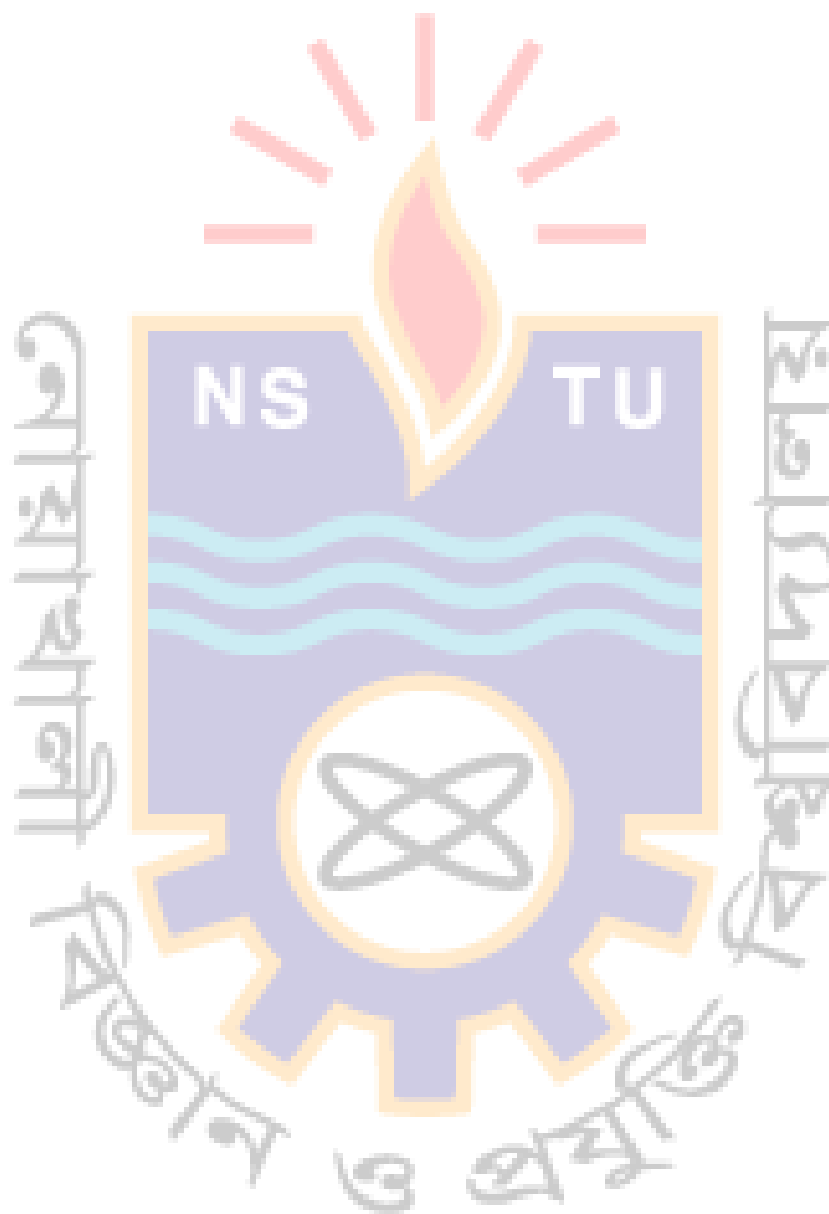
Year IV Term I

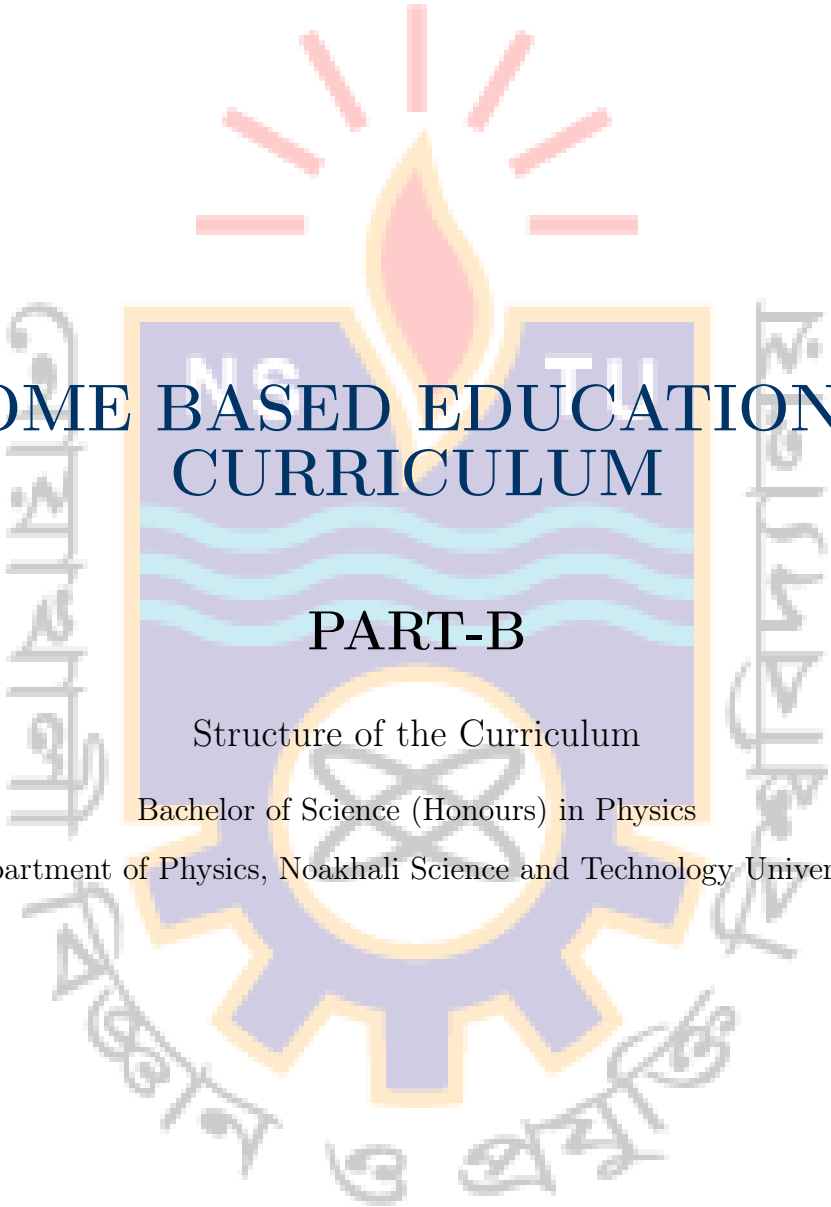
Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 4101	✓	✓			✓						✓	
0533 PHYS 4102			✓	✓	✓		✓		✓		✓	
0533 PHYS 4103	✓	✓			✓						✓	
0533 PHYS 4104			✓	✓	✓		✓		✓		✓	
0533 PHYS 4105	✓	✓		✓	✓						✓	
0533 PHYS 4107	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
0533 PHYS 4106	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
0533 PHYS 4108						✓	✓	✓	✓	✓	✓	✓

Year IV Term II

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 4201	✓	✓			✓						✓	✓
0533 PHYS 4202			✓	✓	✓		✓		✓		✓	
0533 PHYS 4203	✓	✓			✓						✓	✓
0533 PHYS 4204			✓	✓	✓		✓		✓		✓	
0533 PHYS 4205	✓	✓			✓					✓	✓	
0533 PHYS 4207	✓	✓			✓			✓		✓	✓	

Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
0533 PHYS 4209	✓	✓	✓		✓						✓	✓
0533 PHYS 4206	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
0533 PHYS 4208						✓	✓	✓	✓	✓	✓	✓





OUTCOME BASED EDUCATION (OBE) CURRICULUM

PART-B

Structure of the Curriculum

Bachelor of Science (Honours) in Physics

Department of Physics, Noakhali Science and Technology University

2 PART-B (Structure of the Curriculum)

2.1 Structure of the Curriculum

Item	Details
a) Duration of the Program	Years: 04 / Terms: 08
b) Admission Requirements	Applicants having HSC or equivalent degree
c) Total Minimum Credit Requirement	150
d) Total Class Weeks in a Term	14
e) Minimum CGPA Requirements for Graduation	2.20
f) Maximum Academic Years of Completion	6 years (12 terms)

Area-wise Credit Distribution

Area	Course Type	No. of Courses	Credits	Total
General Education (GED)	Theory	9	25	30
General Education (GED)	Sessional	4	5	
Core/Compulsory	Theory	29	83	116
Core/Compulsory	Sessional	17	25	
Core/Compulsory	Viva-Voce	8	8	
Capstone Courses	Honours Project I & II	2	4	4
Total		69 Courses		150

2.2 Year/Term-wise Distribution of Courses

Year I Term I

Course Code	Course Title	Credit
0533 PHYS 1101	Mechanics	3.0
0533 PHYS 1102	Physics Lab-1A	1.5
0533 PHYS 1103	Waves and Oscillations	2.0
0533 PHYS 1104	Physics Lab-1B	1.5
0541 MATH 1101	Differential and Integral Calculus	3.0
0531 CHEM 1101	Fundamentals of Chemistry	3.0
0531 CHEM 1102	Chemistry Lab	1.0
0611 CSE 1101	Computer Fundamentals	3.0
0611 CSE 1102	Computer Fundamentals Lab	1.0
0533 PHYS 1106	Viva-voce	1.0
Total		20.0

Year I Term II

Course Code	Course Title	Credit
0533 PHYS 1201	Electricity and Magnetism	3.0
0533 PHYS 1202	Physics Lab-1C	1.5
0533 PHYS 1203	Properties of Matters	2.0
0533 PHYS 1204	Physics Lab-1D	1.5
0613 CSE 1201	Computer Programming	3.0
0613 CSE 1202	Computer Programming Lab	2.0
0541 MATH 1201	Differential Equations and Matrices	3.0
0533 PHYS 1206	Viva-voce	1.0
Total		17.0

Year II Term I

Course Code	Course Title	Credit
0533 PHYS 2101	Optics	3.0
0533 PHYS 2102	Physics Lab-2A	1.5
0533 PHYS 2103	Basic Electronics	3.0
0533 PHYS 2104	Physics Lab-2B	1.5
0533 PHYS 2105	Mathematical Physics	3.0
0542 STAT 2101	Principles of Statistics-I	2.0
0231 ENG 2101	Functional English	3.0
0533 PHYS 2106	Viva-voce	1.0
Total		18.0

Year II Term II

Course Code	Course Title	Credit
0533 PHYS 2201	Thermal Physics	3.0
0533 PHYS 2202	Physics Lab-2C	1.5
0533 PHYS 2203	Atomic and Molecular Physics	3.0
0533 PHYS 2204	Physics Lab-2D	1.5
0533 PHYS 2205	Classical Mechanics and Relativity	3.0
0541 MATH 2201	Numerical Analysis and Applications	3.0
0542 STAT 2201	Principles of Statistics-II	2.0
0542 STAT 2202	Principles of Statistics Lab	1.0
0533 PHYS 2206	Viva-voce	1.0
Total		19.0

Year III Term I

Course Code	Course Title	Credit
0533 PHYS 3101	Laser Physics	3.0
0533 PHYS 3102	Physics Lab-3A	1.5
0533 PHYS 3103	Electrodynamics	3.0
0533 PHYS 3104	Physics Lab-3B	1.5
0533 PHYS 3105	Solid State Physics-I	3.0
0533 PHYS 3107	Quantum Mechanics-I	3.0

Course Code	Course Title	Credit
0533 PHYS 3109	Statistical Mechanics	3.0
0533 PHYS 3106	Viva-voce	1.0
Total		19.0

Year III Term II

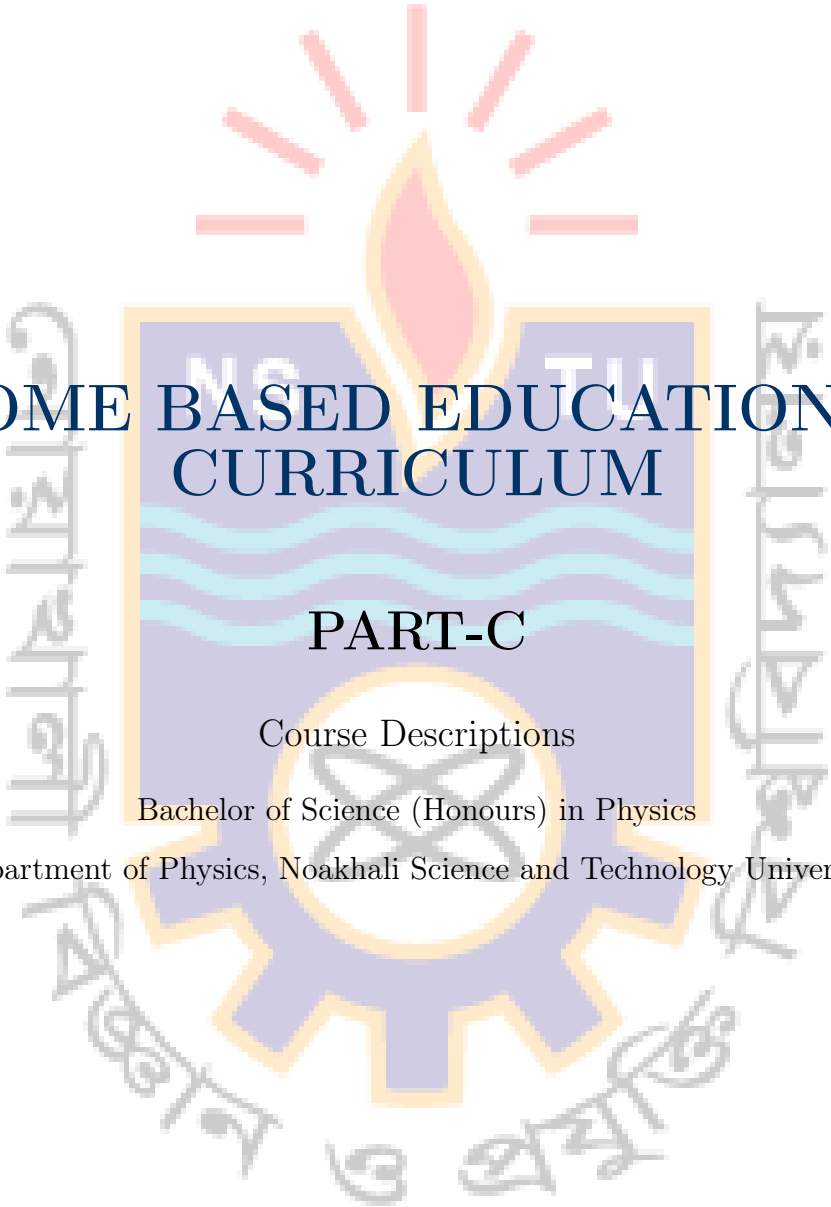
Course Code	Course Title	Credit
0533 PHYS 3201	Nuclear Physics-I	3.0
0533 PHYS 3202	Physics Lab-3C	1.5
0533 PHYS 3203	Electronic Devices and Circuits	3.0
0533 PHYS 3204	Physics Lab-3D	1.5
0533 PHYS 3205	Computational Physics	2.0
0533 PHYS 3206	Computational Physics Lab	1.0
0533 PHYS 3207	Introduction to Astrophysics	3.0
0533 PHYS 3209	Geophysics	3.0
0533 PHYS 3208	Viva-voce	1.0
Total		19.0

Year IV Term I

Course Code	Course Title	Credit
0533 PHYS 4101	Nuclear Physics-II	3.0
0533 PHYS 4102	Physics Lab-4A	1.5
0533 PHYS 4103	Solid State Physics-II	3.0
0533 PHYS 4104	Physics Lab-4B	1.5
0533 PHYS 4105	Digital Electronics and Pulse Techniques	3.0
0533 PHYS 4107	Experimental and Computational Methods in Physics	3.0
0533 PHYS 4106	Honors Project-I	2.0
0533 PHYS 4108	Viva-voce	1.0
Total		18.0

Year IV Term II

Course Code	Course Title	Credit
0533 PHYS 4201	Introduction to Material Science and Nanotechnology	3.0
0533 PHYS 4202	Physics Lab-4C	1.5
0533 PHYS 4203	Medical and Radiation Physics	3.0
0533 PHYS 4204	Physics Lab-4D	1.5
0533 PHYS 4205	Quantum Mechanics-II	3.0
0533 PHYS 4207	Reactor Physics	3.0
0533 PHYS 4209	Plasma Physics	2.0
0533 PHYS 4206	Honors Project-II	2.0
0533 PHYS 4208	Viva-voce	1.0
Total		20.0



OUTCOME BASED EDUCATION (OBE) CURRICULUM

PART-C

Course Descriptions

Bachelor of Science (Honours) in Physics

Department of Physics, Noakhali Science and Technology University

3 PART-C (Course Descriptions)

3.1 First Year – Course Descriptions

Year I – Term I

0533 PHYS 1101: Mechanics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course introduces the fundamental principles of classical mechanics that form the foundation of physics and engineering sciences. It covers particle kinematics and dynamics, Newton's laws of motion, work and energy, momentum conservation, rotational motion, gravitation, vector analysis, and the mechanical properties of matter. The course develops students' analytical and problem-solving skills through the application of physical laws to real-world systems and provides the necessary theoretical background for advanced courses in classical mechanics, electromagnetism, quantum mechanics, and engineering physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental concepts of kinematics, dynamics, rotational motion, gravitation, and fluid dynamics.	Understand
CLO 2	Describe conservation laws of energy, momentum, and angular momentum and their physical significance.	Understand
CLO 3	Apply mathematical formulations to solve classical mechanics problems including vector calculus and differential equations.	Apply
CLO 4	Analyze rotational systems, moment of inertia, central force orbits, and fluid flow phenomena.	Analyze
CLO 5	Evaluate mechanical systems using energy conservation and Lagrangian methods.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	✓
CLO 2	✓	✓									✓	✓
CLO 3	✓	✓									✓	✓
CLO 4	✓	✓									✓	✓
CLO 5	✓	✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Particle Kinematics and Dynamics: Newton's Law of Motion; Motion in One, Two and Three Dimensions, and Their Properties; Projectile Motion; Uniform Circular Motion; Concept of Mass and Forces; Frictional Forces; Conservative and Non-conservative Forces.	7	CLO 1, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
2	Momentum Conservation and System of Particles: Centre of Mass and Center of Gravity; Motion of a System of Particles and its Linear Momentum; Conservation of Linear Momentum; Collision Phenomena; Elastic and Inelastic Collisions; Impulse; Rocket Motion.	7	CLO 2, CLO 3
3	Rotational Motion: Rotational Kinematics; Rotation with Constant Angular Acceleration; Relation between Linear and Circular Motion; Torque and angular Momentum; Kinetic Energy of Rotation; Radius of Gyration; Rotational Inertia and its Calculation for Solids; Parallel & Perpendicular Axes Theorem, Conservation of Angular Momentum, Rotational Dynamics of Rigid Bodies.	7	CLO 1, CLO 3, CLO 4
4	Work, Energy, and Power: Work Done by Constant and Variable Forces; Conservative and Non-conservative forces; Power; Kinetic Energy; Work-Energy Theorem; Kinetic Energy in Collisions; Work and Kinetic Energy in Rotational Motion; Potential Energy; Conservation of Energy.	7	CLO 2, CLO 3, CLO 4
5	Gravitation: Law of Universal Gravitation; Calculation of the Gravitational Constant; Gravitational Mass; Accelerations Due to Gravity and its Variation; Escape Velocity; Motion of Planets and Satellites; Kepler's Laws.	7	CLO 1, CLO 4, CLO 5
6	Vector Analysis: Scalars and Vectors, Vector addition and subtraction, Scalar and vector multiplication, Dot product (scalar product), Cross product (vector product), Triple product, Gradient of a scalar field, Divergence and Curl of a vector field, Vector differentiation and integration.	7	CLO 2, CLO 3, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Halliday, D., Resnick, R. & Walker, J.	<i>Fundamentals of Physics</i>	Wiley
Young, H. D. & Freedman, R. A.	<i>University Physics with Modern Physics</i>	Pearson
Symon, K. R.	<i>Mechanics</i>	Addison-Wesley
Kittel, C.	<i>Mechanics (Berkeley Vol.1)</i>	McGraw-Hill

0533 PHYS 1102: Physics Lab-1A**Credits: 1.5 | Practical****a. Rationale:**

This laboratory course introduces students to experimental physics with emphasis on measurement techniques, data acquisition, graphical analysis, and uncertainty evaluation. It provides practical training in the fundamental principles of mechanics, rotational dynamics, oscillatory systems, and elasticity through experiments involving springs, pendulums, flywheels, torsional oscillations, sonometers, and flexural bending of beams.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the spring constant and effective mass of a spiral spring.	5	CLO 1, CLO 2
2	To determine the acceleration due to gravity using a simple pendulum.	5	CLO 1, CLO 2, CLO 3
3	To determine the moment of inertia of a flywheel.	5	CLO 1, CLO 2, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
4	To determine the modulus of rigidity of a wire by the method of torsional oscillation.	5	CLO 2, CLO 3, CLO 4
5	To determine the frequency of a tuning fork using a sonometer.	5	CLO 3, CLO 4, CLO 5
6	To determine Young's modulus of the material of a beam by the method of flexure.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold
Nelkon, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann

0533 PHYS 1103: Waves and Oscillations

Credits: 2.0 | Theory (Core)

a. Rationale:

This course provides the fundamental principles of oscillations and wave phenomena, including simple harmonic motion, resonance, and wave propagation. It develops analytical skills for understanding physical systems and prepares students for advanced courses in optics, electromagnetism, and modern physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the physics of simple harmonic motion, damped oscillations, resonance, and wave propagation.	Understand
CLO 2	Describe group and phase velocity, acoustic wave propagation, and ultrasonic applications.	Understand
CLO 3	Apply differential equations of harmonic motion to evaluate resonance amplitude and wave speed.	Apply
CLO 4	Analyze standing wave modes, Fourier synthesis of periodic waves, and coupled oscillator normal modes.	Analyze

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 5	Evaluate oscillatory systems and acoustic applications in architectural design.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	
CLO 2	✓	✓									✓	
CLO 3	✓	✓									✓	
CLO 4	✓	✓									✓	
CLO 5	✓	✓									✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Simple Harmonic Motion (SHM): Periodic motion; Simple harmonic motion; Differential equation of SHM and its solution; Velocity and acceleration; Time period and angular frequency; Energy of SHM; Combination of SHMs; Spring-mass system; Two-body oscillation; Reduced mass; Torsional pendulum; Lissajous figures.	6	CLO 1, CLO 3
2	Damped and Forced Oscillations: Free vibration; Damped oscillation; Logarithmic decrement; Relaxation time; Quality factor; Forced oscillation; Differential equation and solution; Resonance; Sharpness of resonance; Applications of resonance; Mechanical and electrical oscillators.	6	CLO 1, CLO 3, CLO 4
3	Wave Motion: Transverse and longitudinal waves; Wave equation; Progressive waves; Principle of superposition; Reflection and transmission of waves; Standing waves; Phase velocity and group velocity; Energy, power, and intensity of waves.	6	CLO 2, CLO 4
4	Sound and Acoustics: Characteristics of sound; Doppler effect; Beats; Reverberation; Sabine's formula; Architectural acoustics; Ultrasonic waves; Applications of acoustics in science and engineering.	5	CLO 2, CLO 3
5	Applications of Oscillations and Waves: Oscillations in electrical circuits; Damping in galvanometers; Vibrations in mechanical systems; Wave phenomena in optics and modern physics; Practical applications of oscillatory and wave systems.	5	CLO 1, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
French, A. P.	<i>Vibrations and Waves</i>	MIT Press
Crawford, F. S.	<i>Waves (Berkeley Physics Course, Vol. 3)</i>	McGraw-Hill
Georgi, H.	<i>The Physics of Waves</i>	Prentice Hall
King, G.	<i>Vibrations and Waves</i>	Wiley
Ingard, K. U.	<i>Fundamentals of Waves and Oscillations</i>	Cambridge UP
Fitzpatrick, R.	<i>Oscillations and Waves: An Introduction</i>	CRC Press
Lal, B. & Subrahmanyam, N.	<i>Waves and Oscillations</i>	S. Chand
Halliday, D., Resnick, R. & Walker, J.	<i>Fundamentals of Physics</i>	Wiley
Young, H. D. & Freedman, R. A.	<i>University Physics with Modern Physics</i>	Pearson
Pain, H. J.	<i>The Physics of Vibrations and Waves</i>	Wiley

0533 PHYS 1104: Physics Lab-1B

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides hands-on training in direct current (DC) circuits and precision electrical measurements. Students investigate fundamental network laws (Kirchhoff's current and voltage laws), resistance determination using meter bridge and Post Office Box techniques, end-correction analysis, and galvanometer characteristics including internal resistance and figure of merit.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the resistance of a galvanometer by the half-deflection method.	5	CLO 1, CLO 2
2	To determine the end correction of a meter bridge.	5	CLO 1, CLO 2, CLO 3
3	To determine the specific resistance (resistivity) of a wire using a meter bridge.	5	CLO 1, CLO 2, CLO 3
4	To determine an unknown resistance using a Post Office Box.	5	CLO 2, CLO 3, CLO 4
5	To verify Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL).	5	CLO 3, CLO 4, CLO 5
6	To determine the figure of merit of a galvanometer.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Nelson, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold

0541 MATH 1101: Differential and Integral Calculus**Credits: 3.0 | Theory (GED)****a. Rationale:**

This course provides the mathematical foundation required for physics and engineering by introducing differential and integral calculus. It develops analytical and problem-solving skills necessary for modeling physical phenomena and supports advanced studies in mechanics, electromagnetism, quantum mechanics, and computational physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental concepts, theorems, and techniques of differential and integral calculus including limits, continuity, differentiation, and integration.	Understand
CLO 2	Analyze mathematical functions and apply differential calculus to solve problems involving derivatives, extrema, curve tracing, and multivariable functions.	Analyze
CLO 3	Apply integral calculus, vector calculus, and tensor concepts to evaluate areas, volumes, line and surface integrals, and solve scientific and engineering problems.	Apply
CLO 4	Evaluate mathematical models arising in physics and engineering using calculus-based analytical techniques.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1		✓									✓	✓
CLO 2		✓									✓	✓
CLO 3		✓									✓	✓
CLO 4		✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Differential Calculus: Functions and their graphs; Limits and continuity; Differentiability; Successive differentiation; Rolle's theorem; Mean Value Theorem; Taylor's and Maclaurin's theorems; Indeterminate forms; L'Hospital's rule; Curve tracing; Tangents and normals; Curvature; Maxima and minima; Partial differentiation; Total derivative; Euler's theorem; Jacobian and Hessian.	17	CLO 1, CLO 2
2	Integral Calculus: Indefinite and definite integrals; Techniques of integration; Reduction formulae; Fundamental theorem of calculus; Improper integrals; Beta and Gamma functions; Applications to area, arc length, surface area, and volume; Multiple integrals; Line, surface, and volume integrals; Green's theorem; Gauss' divergence theorem; Stokes' theorem.	17	CLO 1, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
3	Tensor Analysis: Scalars, vectors, and tensors; Tensor notation; Einstein summation convention; Covariant, contravariant, and mixed tensors; Tensor algebra; Symmetric and antisymmetric tensors; Kronecker delta and Levi-Civita symbol; Tensor transformation laws; Applications in physics.	8	CLO 2, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, tutorial sessions	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, mathematical derivations, problem-solving sessions	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, tutorial classes, mathematical exercises	Homework, assignments, quizzes, midterm examination, final examination
CLO 4	Case studies, mathematical modeling, collaborative problem-solving	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ayres, F. & Mendelson, E.	<i>Calculus (Schaum's Outlines)</i>	McGraw-Hill
Das, B. C. & Mukherjee, B. N.	<i>Differential Calculus</i>	U. N. Dhur & Sons
Das, B. C. & Mukherjee, B. N.	<i>Integral Calculus</i>	U. N. Dhur & Sons
Anton, H., Bivens, I. & Davis, S.	<i>Calculus: Early Transcendentals</i>	Wiley

0531 CHEM 1101: Fundamentals of Chemistry

Credits: 3.0 | Theory (GED)

a. Rationale:

This course provides fundamental knowledge of inorganic, physical, and organic chemistry essential for understanding chemical processes and material behavior in physics and engineering. It covers chemical bonding, acid-base theories, chemical kinetics, electrochemistry, and basic organic and macromolecular chemistry.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental principles of atomic structure, chemical bonding, molecular geometry, and periodic properties of elements.	Understand
CLO 2	Apply principles of chemical thermodynamics, equilibrium, and electrochemistry to quantify chemical and physical reactions.	Apply
CLO 3	Analyze chemical reaction kinetics, mechanisms, and rate laws for homogeneous and heterogeneous systems.	Analyze

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 4	Evaluate structures, properties, and applications of organic compounds, polymers, and modern functional materials.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓										✓
CLO 2	✓	✓										✓
CLO 3	✓	✓										✓
CLO 4	✓	✓										✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Chemical Bonding: Electronic theory of valency; Ionic, covalent, coordinate, metallic, hydrogen bonding and van der Waals forces; Hybridization (sp, sp ² , sp ³ , d-orbitals); VSEPR theory; Molecular orbital theory for homonuclear and heteronuclear diatomic molecules.	6	CLO 1
2	Acids and Bases: Classical and modern acid–base theories (Arrhenius, Bronsted–Lowry, Lewis); Acid and base strength; Dissociation constants; pH scale; Buffer solutions and buffer capacity; Indicators and titration curves.	6	CLO 1, CLO 2
3	Chemical Equilibrium: Reversible and irreversible reactions; Dynamic equilibrium; Law of mass action; Equilibrium constants (K _c , K _p , K _x); Le Chatelier's principle and applications; Thermodynamics of equilibrium.	5	CLO 2
4	Chemical Kinetics: Rate laws; Order and molecularity of reactions; Integrated rate equations (zero, first, and second order); Half-life; Determination of reaction order; Temperature dependence: Arrhenius equation and activation energy; Catalysis.	5	CLO 2, CLO 3
5	Ionic Equilibrium and Electrochemistry: Ostwald's dilution law; Common ion effect; Solubility product; Conductance of electrolytes; Kohlrausch's law; Electrochemical cells; Nernst equation; Standard electrode potentials; Fuel cells and batteries.	7	CLO 2, CLO 3
6	Organic Chemistry: Nomenclature of organic compounds; Aliphatic hydrocarbons (alkanes, alkenes, alkynes); Aromatic compounds and resonance; Alcohols, phenols, and ethers; Carbonyl compounds; Carboxylic acids and derivatives; Basic reaction mechanisms.	7	CLO 1, CLO 4
7	Macromolecules and Polymers: Classification of polymers; Addition and condensation polymerization; Molecular weight of polymers; Thermoplastics and thermosets; Conducting polymers and biopolymers; Nanomaterials in chemistry.	6	CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, molecular model demonstrations, multimedia slides	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, numerical problem-solving sessions, group exercises	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, reaction kinetics tutorials, discussions	Homework, assignments, quizzes, final examination
CLO 4	Application-oriented lectures, case studies on polymers and materials	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Haider, S. Z.	<i>Introduction to Modern Inorganic Chemistry</i>	Friends International
Ebbing, D. D. & Gammon, S. D.	<i>General Chemistry</i>	Cengage Learning
Chang, R. & Goldsby, K. A.	<i>Chemistry</i>	McGraw-Hill
Bahl, A., Bahl, B. S. & Tuli, G. D.	<i>Essentials of Physical Chemistry</i>	S. Chand

0531 CHEM 1102: Chemistry Lab

Credits: 1.0 | Practical (GED)

a. Rationale:

This laboratory course provides hands-on experience in fundamental chemical experiments that reinforce the theoretical concepts covered in CHEM 1101. Students acquire practical skills in laboratory safety, chemical synthesis, volumetric analysis, pH measurement, reaction kinetics, and qualitative organic analysis.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate standard chemical laboratory equipment and glassware following chemical safety protocols and waste disposal guidelines.	Precision
CLO 2	Perform volumetric titrations and quantitative chemical preparations with appropriate precision and accuracy.	Articulation
CLO 3	Analyze experimental data involving reaction rates, equilibrium constants, and electrochemical measurements.	Analyze
CLO 4	Prepare structured laboratory reports detailing experimental methodology, observations, calculations, and error analysis.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Laboratory Experiment	Hrs.	CLO(s)
1	Laboratory orientation; Chemical safety regulations; Proper handling and disposal of hazardous chemicals and glassware; Analytical balance calibration.	2	CLO 1
2	Preparation of primary standard solutions (oxalic acid, sodium carbonate) and standardization of secondary standard solutions (NaOH, HCl).	3	CLO 1, CLO 2
3	Standardization of acids and bases by volumetric titration using acid–base indicators and determination of concentration.	3	CLO 2
4	Determination of the acid dissociation constant (K_a) of a weak acid by pH-metric titration with a strong base.	3	CLO 2, CLO 3
5	Kinetic study: Determination of the rate constant and reaction order for the reaction between sodium thiosulfate and hydrochloric acid.	3	CLO 2, CLO 3
6	Determination of the EMF of electrochemical cells and verification of the Nernst equation using zinc–copper voltaic cell.	3	CLO 3
7	Determination of melting point, mixed melting point, and boiling point of common organic compounds.	3	CLO 2, CLO 4
8	Qualitative organic analysis: Detection of elemental nitrogen, sulfur, and halogens (Lassaigne's test) and identification of functional groups.	4	CLO 3, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Laboratory demonstrations, safety briefing, guided equipment handling	Observation of laboratory technique, safety compliance, viva voce
CLO 2	Hands-on experimental work, guided volumetric titration, calculations	Experimental accuracy, lab performance, lab workbook evaluation
CLO 3	Data analysis, graphical representation, rate constant computations	Laboratory reports, data interpretation evaluation, quizzes
CLO 4	Report writing instruction, feedback on scientific documentation	Lab report assessment, practical examination, viva voce

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Mendham, J. et al.	<i>Vogel's Textbook of Quantitative Chemical Analysis</i>	Prentice Hall
Findlay, A. & Kitchener, J. A.	<i>Practical Physical Chemistry</i>	Longman
Furniss, B. S. et al.	<i>Vogel's Textbook of Practical Organic Chemistry</i>	Pearson

0611 CSE 1101: Computer Fundamentals**Credits: 3.0 | Theory (GED)****a. Rationale:**

This course provides fundamental knowledge of computer systems, digital technologies, and computing architectures essential for science and engineering students. It covers computer hardware organization, number systems, digital logic, operating systems, networking, multimedia, and emerging computing trends.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the architecture, organization, and functional units of modern digital computer systems.	Understand
CLO 2	Apply number systems, digital logic, and Boolean algebra to solve computational and data representation problems.	Apply
CLO 3	Analyze computer memory hierarchies, system and application software, networking topologies, and cybersecurity principles.	Analyze
CLO 4	Evaluate hardware specifications and emerging technologies (cloud computing, IoT, AI) for scientific computing needs.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1				✓					✓	✓		✓
CLO 2				✓					✓	✓		✓
CLO 3				✓					✓	✓		✓
CLO 4				✓					✓	✓		✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Computer Systems: History and generations of computers; Classification of computers; Functional components of a digital computer: Input/Output units, Central Processing Unit (ALU, CU, Registers); Bus architecture; System clock and instruction cycle.	7	CLO 1
2	Number Systems and Digital Logic: Binary, octal, decimal, and hexadecimal number systems; Base conversions; Binary arithmetic (addition, subtraction, 1's and 2's complement); Boolean algebra; Logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR); Combinational logic circuits.	7	CLO 1, CLO 2
3	Computer Memory and Hardware Organization: Memory hierarchy; Primary memory: RAM (SRAM, DRAM), ROM (PROM, EPROM, EEPROM); Cache memory and virtual memory; Secondary storage: Magnetic disks (HDD), Solid State Drives (SSD), Optical storage; I/O interfaces.	7	CLO 1, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
4	Computer Networks and Multimedia: Data communication fundamentals; Network transmission media; Network types (LAN, MAN, WAN); Network topologies; OSI and TCP/IP reference models; Internet protocols; Basics of multimedia and compression.	7	CLO 3
5	System and Application Software: Types of software; Operating systems: Functions, architecture, process management, memory management, file systems; Popular OS (Windows, Linux, macOS); Utility programs; Application software and productivity tools.	7	CLO 1, CLO 3
6	Computer Maintenance and Emerging Technologies: Preventative maintenance and troubleshooting; Computer viruses, malware, and cybersecurity basics; Cloud computing; Internet of Things (IoT); Artificial Intelligence and quantum computing fundamentals.	7	CLO 3, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, binary math and digital logic exercises, problem sets	Class test, assignments, midterm examination, final examination
CLO 3	Case studies, comparative analysis of software and network architectures	Homework, assignments, quizzes, final examination
CLO 4	Seminars, group presentations on emerging computing technologies	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Norton, Peter	<i>Introduction to Computers</i>	McGraw-Hill
Rahman, M. Lutfar & Hossain, M. Alamgir	<i>Computer Fundamentals</i>	Systech Publications
Balagurusamy, E.	<i>Fundamentals of Computers</i>	McGraw-Hill
Tanenbaum, A. S. & Austin, T.	<i>Structured Computer Organization</i>	Pearson

0611 CSE 1102: Computer Fundamentals Lab

Credits: 1.0 | Practical (GED)

a. Rationale:

This laboratory course provides practical experience in computer hardware assembly, operating system configuration, scientific word processing, spreadsheet data modeling, scientific presentations, and technical plotting software essential for experimental data analysis in physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Assemble, configure, and troubleshoot basic computer hardware, peripherals, and operating system environments.	Apply
CLO 2	Use office productivity software (Word, Excel, PowerPoint) to prepare scientific documents, data models, and technical presentations.	Apply
CLO 3	Analyze experimental scientific data using spreadsheet software and professional plotting tools (OriginLab/Excel).	Analyze
CLO 4	Produce formatted scientific reports and graphical analyses compliant with academic publication standards.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓					✓	✓		✓
CLO 2			✓	✓					✓	✓		✓
CLO 3			✓	✓					✓	✓		✓
CLO 4			✓	✓					✓	✓		✓

d. Summary of Course Contents:

Sl.	Laboratory Experiment	Hrs.	CLO(s)
1	Identification of motherboard components, processor, RAM, power supply; PC assembly, component configuration, and hardware troubleshooting.	4	CLO 1
2	Operating systems: Installation and administration of Windows and Linux environments; Command prompt and terminal commands; File management.	4	CLO 1
3	Microsoft Word: Preparation of technical reports; Equation editor for scientific formulas; Tables, figures, cross-referencing, and bibliographic management.	6	CLO 2, CLO 4
4	Microsoft Excel: Advanced data entry; Mathematical and statistical functions; Data sorting, filtering, and pivot tables; Charting and trendline fitting.	6	CLO 2, CLO 3
5	Microsoft PowerPoint: Designing scientific and academic presentations; Slide master; Audio, video, and animation embedding; Delivery techniques.	4	CLO 2, CLO 4
6	OriginLab / Technical Graphing: Importing experimental data; 2D and 3D plotting; Non-linear curve fitting; Error bars; Publication-quality graph export.	6	CLO 3, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hardware demonstration, hands-on PC disassembly/assembly, guided OS setup	Lab performance evaluation, practical hardware identification test
CLO 2	Hands-on software tutorials, step-by-step document and spreadsheet tasks	Lab assignments, continuous in-class evaluation, quizzes
CLO 3	Data analysis tasks on real physics experiment datasets in Excel and Origin	Laboratory assignment submissions, data analysis reports

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 4	Project report preparation, presentation rehearsal and delivery	Final project submission, practical examination, viva voce

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Norton, Peter	<i>Introduction to Computers</i>	McGraw-Hill
Rahman, M. Lutfar & Hossain, M. Alamgir	<i>Computer Fundamentals</i>	Systech Publications
Walkenbach, John	<i>Microsoft Excel Bible</i>	Wiley

0533 PHYS 1106: Viva-voce

Credits: 1.0 | Oral Examination

a. Rationale:

This course evaluates students' conceptual understanding, critical thinking, communication, and problem-solving abilities acquired from the courses completed during the semester. It encourages students to integrate knowledge from different subjects and develop confidence in scientific reasoning and oral presentation.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Recall and explain fundamental concepts across all courses offered in Year I – Term I.	Remember
CLO 2	Apply critical reasoning to answer spontaneous scientific and analytical questions.	Apply
CLO 3	Communicate physics concepts clearly and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		
CLO 3						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theory and practical courses of Year I – Term I.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion	Viva-voce oral examination
CLO 2	Q&A practice, tutorial discussion	Viva-voce oral examination
CLO 3	Presentation and oral response practice	Viva-voce oral examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Standard textbooks of the term courses	—	—

Year I – Term II

0533 PHYS 1201: Electricity and Magnetism

Credits: 3.0 | Theory (Core)

a. Rationale:

The course intends to provide students a solid base about electricity and magnetism, that will be efficient for them for future higher courses in the sciences and engineering. The fundamental laws of electricity and magnetism, and the correlation between current and magnet are the contents of this course. The behavior of AC and DC currents and their responses on the circuits with L, C and R combinations are discussed in this course. The constructions and working mechanisms of various devices such as galvanometer, motor, generator, transformer and thermocouple are explained.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental principles of electrostatics, magnetostatics, electromagnetic induction, and Maxwell's equations.	Understand
CLO 2	Describe electric and magnetic field behavior in matter, polarization, magnetization, and electromagnetic wave propagation.	Understand
CLO 3	Apply Coulomb's law, Gauss's law, Ampere's law, and Faraday's law to solve electromagnetic boundary problems.	Apply
CLO 4	Analyze transient circuits, Poynting vector, magnetic induction, and electromagnetic boundary conditions.	Analyze
CLO 5	Evaluate electromagnetic system performance for energy transmission and wave propagation.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	✓
CLO 2	✓	✓									✓	✓
CLO 3	✓	✓									✓	✓
CLO 4	✓	✓									✓	✓
CLO 5	✓	✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Electrostatics: Electric Charge; Coulomb's Law; Electric Field; Field Strength; Electric Potential; Relation between Electric Potential and Electric-field; Potential Due to a Point Charge; Electric Dipole and Quadrupole; Electric Flux; Gauss' Law and Its Applications; Permittivity.	8	CLO 1, CLO 3
2	Capacitors and Dielectrics: Capacitors and Capacitance; Parallel Plate Capacitors and Spherical Capacitors; Energy Stored in a Capacitor; Capacitors in Parallel and in Series; Capacitors Used as Charge Accelerators; Polarization; Dielectric Media; Gauss' Law with Dielectrics.	7	CLO 1, CLO 2, CLO 3
3	Current and Resistance: Current; Current Density; Drift Speed of Charge Carrier; Resistance, Resistivity and Conductivity; Ohm's law; Energy Transfer in an Electric Circuit, Electromotive Force; Potential Difference; Kirchhoff's Laws: Single loop and Multi Loop Circuits; RC Circuits; Time constant;	8	CLO 1, CLO 3, CLO 4
4	Thermoelectricity: Thermoelectric Phenomenon and Relation (Seebeck effect, Peltier effect, and Thomson effect); Thermoelectric Power; Thermoelectric Diagrams and its uses; Thermocouples.	4	CLO 2, CLO 4
5	Magnetic Field and its Interactions: Magnetic Induction; Magnetizing Force; Magnetic force on Charge and Current; Torque on a Current Loop; The Hall Effect; Ampere's Law and its Applications: Magnetic field of a solenoid and toroid; Biot-Savart Law and its Applications, Classification of Magnetic Materials, and Hysteresis Loop.	7	CLO 1, CLO 4, CLO 5
6	Electromagnetic Induction: Lorentz Force; Faraday's Law; Lenz's Laws of Electromagnetic Induction; Inductance and Inductors; Self- and Mutual Inductions; Solenoids; LR circuit; Growth and Decay of Current in Circuits Consisting of LR circuit; Time constant; Electromagnetic Oscillation by LC circuit; Damped Oscillation (LRC circuit); Forced damped Oscillation and three simple circuits (resistive load, capacitive load and inductive load); Relation between current and voltage with phasor diagram in LRC circuit; Power in Alternating Current circuit; Concept of Transformers; Resonant and Anti-resonant Circuits.	8	CLO 1, CLO 2

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Halliday, D., Resnick, R. & Walker, J.	<i>Fundamentals of Physics</i>	Wiley
Young, H. D. & Freedman, R. A.	<i>University Physics with Modern Physics</i>	Pearson
Griffiths, D. J.	<i>Introduction to Electrodynamics</i>	Pearson
Purcell, E. M.	<i>Electricity and Magnetism (Berkeley Vol.2)</i>	Cambridge

0533 PHYS 1202: Physics Lab-1C

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides practical training in precision electrical measurements, verification of fundamental electrical laws, and temperature-dependent transport properties. Students gain experimental experience in comparing cell electromotive forces and determining internal resistance using potentiometers, verifying Ohm's law, determining galvanometer resistance by the half-deflection method, and investigating the temperature coefficients of resistance for metallic conductors and semiconductors.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To compare the electromotive forces (emfs) of two cells using a potentiometer.	5	CLO 1, CLO 2
2	To determine the internal resistance of a cell using a potentiometer.	5	CLO 1, CLO 2, CLO 3
3	To verify Ohm's law and determine the resistance of a given conductor.	5	CLO 1, CLO 2, CLO 3
4	To determine the temperature coefficient of resistance of a metallic conductor.	5	CLO 2, CLO 3, CLO 4
5	To determine the resistance of a galvanometer by the half-deflection method.	5	CLO 3, CLO 4, CLO 5
6	To study the variation of resistance with temperature for a semiconductor.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold
Nelkon, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann

0533 PHYS 1203: Properties of Matters**Credits: 2.0 | Theory (Core)****a. Rationale:**

This course introduces the fundamental mechanical and fluid properties of matter, including elasticity, surface tension, viscosity, and fluid dynamics. It provides the theoretical basis for understanding the behavior of solids and fluids, which is essential for advanced studies in mechanics, materials science, engineering, and condensed matter physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental elasticity, surface tension, viscosity, and acoustic physics principles.	Understand
CLO 2	Describe stress-strain relations, elastic moduli, Poiseuille's law, and ultrasonic generation.	Understand
CLO 3	Apply elasticity equations and Sabine's formula to solve material properties problems.	Apply
CLO 4	Analyze experimental elasticity data, viscous damping, and sound absorption coefficients.	Analyze
CLO 5	Evaluate acoustic designs and industrial applications of ultrasonics.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	
CLO 2	✓	✓									✓	
CLO 3	✓	✓									✓	
CLO 4	✓	✓									✓	
CLO 5	✓	✓									✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Elasticity: Elastic and plastic deformation; Stress and strain; Hooke's law; Elastic constants; Young's modulus, Bulk modulus, Shear modulus; Poisson's ratio; Relation among elastic constants; Bending of beams; Bending moment; Cantilever; Torsion of cylindrical rods.	7	CLO 1, CLO 3
2	Surface Tension: Surface tension and surface energy; Molecular theory of surface tension; Cohesive and adhesive forces; Angle of contact; Capillary action; Excess pressure inside liquid drops and soap bubbles; Determination of surface tension; Applications of surface tension.	7	CLO 1, CLO 3, CLO 4
3	Fluid Dynamics: Properties of fluids; Hydrostatic pressure; Streamline and turbulent flow; Equation of continuity; Bernoulli's equation and applications; Euler's equation; Viscosity and coefficient of viscosity; Poiseuille's equation; Stokes' law; Reynolds number; Critical velocity; Measurement of viscosity; Variation of viscosity with temperature and pressure.	14	CLO 2, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Halliday, D., Resnick, R. & Walker, J.	<i>Fundamentals of Physics</i>	Wiley
Young, H. D. & Freedman, R. A.	<i>University Physics with Modern Physics</i>	Pearson
Mathur, D. S.	<i>Elements of Properties of Matter</i>	S. Chand
Bhattacharya, A. B.	<i>Acoustics</i>	Oxford & IBH

0533 PHYS 1204: Physics Lab-1D

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides practical training across acoustics, thermal properties of matter, fluid mechanics, thermoelectric phenomena, and electromagnetism. Students experimentally determine the speed of sound using Kundt's tube, the cubical expansion of liquids, the specific heat capacity via Newton's cooling law, the Seebeck coefficient of thermocouples, liquid viscosity by capillary flow, and the spatial distribution of magnetic fields along circular current loops.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the velocity of sound in air using Kundt's tube.	5	CLO 1, CLO 2
2	To determine the coefficient of cubical expansion of water by the method of heating.	5	CLO 1, CLO 2, CLO 3
3	To determine the specific heat capacity of a liquid by Newton's law of cooling.	5	CLO 1, CLO 2, CLO 3
4	To study the Seebeck effect and determine the Seebeck coefficient of a thermocouple.	5	CLO 2, CLO 3, CLO 4
5	To determine the coefficient of viscosity of a liquid by the capillary-tube method.	5	CLO 3, CLO 4, CLO 5
6	To study the magnetic field along the axis of a circular coil and determine its radius.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Nelson, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold

0613 CSE 1201: Computer Programming**Credits: 3.0 | Theory (GED)****a. Rationale:**

This course develops programming skills for solving scientific and physics-related computational problems using C++ and Python. It covers procedural programming, control structures, functions, arrays, file operations, Python data structures, NumPy, and scientific data visualization.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain programming fundamentals, algorithm design, syntax, and computational principles of C++ and Python.	Understand
CLO 2	Apply control structures (conditionals and loops), functions, and modular programming to solve scientific calculation problems.	Apply
CLO 3	Analyze and implement array operations, data structures, and file I/O for scientific data processing in C++ and Python.	Analyze
CLO 4	Evaluate computational algorithms and implement numerical algorithms and data visualization for physics models.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1		✓			✓				✓	✓		✓
CLO 2		✓			✓				✓	✓		✓
CLO 3		✓			✓				✓	✓		✓
CLO 4		✓			✓				✓	✓		✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Programming: Algorithms, flowcharts, pseudocode; Machine language vs. high-level language; Compilers and interpreters; Basic structure of C++ and Python programs.	2	CLO 1
2	Fundamentals of C++: Variables, data types, constants; Arithmetic, relational, and logical operators; Type casting; Standard input/output streams (cin, cout); Formatting output.	5	CLO 1, CLO 2
3	C++ Control Structures: Conditional statements (if, if-else, nested if, switch-case); Loop statements (for, while, do-while); Loop nesting; break and continue statements.	4	CLO 2
4	Arrays in C++: One-dimensional arrays; Multi-dimensional arrays; Array initialization and manipulation; Matrix addition and multiplication algorithms; Character arrays and strings.	4	CLO 2, CLO 3
5	Functions in C++: Function declaration, definition, and invocation; Pass by value vs. pass by reference; Default arguments; Return statements; Recursion; Scope and lifetime of variables.	3	CLO 2, CLO 3
6	File Handling in C++: File stream classes (ifstream, ofstream, fstream); Opening, closing, reading, and writing text and binary files; Formatting file output for scientific datasets.	3	CLO 3
7	Introduction to Python: Python in scientific computing; Interactive shell vs. script execution; Python variables, data types, indentation rules; Arithmetic and string operations.	3	CLO 1, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
8	Python Control Flow: Conditional statements (if, elif, else); For loops with range(); While loops; List comprehensions and iterative algorithms.	4	CLO 2, CLO 4
9	Python Data Structures and NumPy: Lists, tuples, sets, and dictionaries; NumPy library: ndarray creation, slicing, vectorization, universal functions, linear algebra operations.	5	CLO 3, CLO 4
10	Python Functions and Modules: Defining functions with def; Positional and keyword arguments; Variable-length arguments; Lambda functions; Importing modules and math/scipy packages.	3	CLO 3, CLO 4
11	Scientific Data Visualization: Matplotlib library: 2D line plots, scatter plots, error bars, histograms, subplots, titles, labels, legends; Introduction to 3D surface plotting.	6	CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual algorithm walkthroughs, code tracing	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, live coding demonstrations, programming problem-solving	Class test, programming assignments, midterm, final examination
CLO 3	Hands-on algorithm design, modular code architecture, debugging exercises	Programming assignments, quizzes, final examination
CLO 4	Project-based learning, scientific modeling case studies in Python	Term project, code review, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Malik, D. S.	<i>C++ Programming: From Problem Analysis to Program Design</i>	Cengage Learning
Stroustrup, Bjarne	<i>Programming: Principles and Practice Using C++</i>	Addison-Wesley
Downey, Allen B.	<i>Think Python: How to Think Like a Computer Scientist</i>	O'Reilly Media
VanderPlas, Jake	<i>Python Data Science Handbook</i>	O'Reilly Media

0613 CSE 1202: Computer Programming Lab

Credits: 2.0 | Practical (GED)

a. Rationale:

This laboratory course provides hands-on experience in computer programming with C++ and Python, focusing on scientific calculations, numerical algorithm implementation, simulation of physical processes, data analysis, and technical visualization.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Write, compile, debug, and execute structured C++ and Python programs using modern integrated development environments (IDEs).	Apply
CLO 2	Implement conditional structures, loops, arrays, and modular functions to solve computational physics problems.	Apply
CLO 3	Perform scientific data processing, file reading/writing, and numerical operations using NumPy in Python.	Analyze
CLO 4	Construct publication-quality 2D and 3D scientific plots and visualizations for experimental and simulated data.	Create

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓				✓	✓		✓
CLO 2			✓	✓	✓				✓	✓		✓
CLO 3			✓	✓	✓				✓	✓		✓
CLO 4			✓	✓	✓				✓	✓		✓

d. Summary of Course Contents:

Sl.	Laboratory Experiment	Hrs.	CLO(s)
1	Writing, compiling, and debugging basic C++ programs in IDEs (Code::Blocks/VS Code); I/O formatting, operator precedence, and syntax practice.	3	CLO 1
2	C++ conditional statements: Quadratic equation solver, leap year, piecewise physical functions with nested if-else and switch-case.	3	CLO 1, CLO 2
3	C++ loops: Factorial calculation, Fibonacci sequence, Taylor series approximation of trigonometric functions using for and while loops.	3	CLO 2
4	Arrays in C++: Array sorting, vector dot and cross product, matrix addition and multiplication for physical coordinate transformations.	3	CLO 2
5	Functions in C++: Modular program design with user-defined functions, recursive algorithms, pass-by-reference parameter passing.	3	CLO 2, CLO 3
6	File handling in C++: Reading experimental data from text files, calculating statistics, and writing output datasets.	3	CLO 2, CLO 3
7	Python basics: Interactive scripting in Jupyter Notebook / VS Code, data types, arithmetic operations, and string formatting.	3	CLO 1
8	Python control flow: Implementation of numerical summation, roots of equations, and trajectory calculations using loops and conditionals.	3	CLO 2, CLO 3
9	Python lists and NumPy arrays: Vector and matrix operations, matrix inversion, eigenvalues, and fast array computations.	3	CLO 2, CLO 3

Sl.	Laboratory Experiment	Hrs.	CLO(s)
10	Python functions and modules: Writing scientific functions, lambda expressions, and integrating math and SciPy routines.	3	CLO 3
11	Scientific data visualization in Python: Plotting projectile trajectories, harmonic oscillations, and damped wave patterns with Matplotlib.	3	CLO 4
12	Advanced visualization and mini-project: 3D surface plots of potential fields, animated physical simulations, and comprehensive lab exam.	3	CLO 3, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Live programming demonstration, guided IDE configuration, debugging assistance	In-lab coding evaluation, syntax quizzes, workbook check
CLO 2	Problem-based lab tasks, algorithm implementation on physical models	Continuous lab performance, weekly code submissions
CLO 3	Data processing exercises using real laboratory datasets, file I/O drills	Lab assignments, code quality assessment, mid-term practical test
CLO 4	Project-based learning: simulation and plotting of physics problems	Final programming project, practical examination, viva voce

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Malik, D. S.	<i>C++ Programming: From Problem Analysis to Program Design</i>	Cengage Learning
Downey, Allen B.	<i>Think Python</i>	O'Reilly Media
VanderPlas, Jake	<i>Python Data Science Handbook</i>	O'Reilly Media

0541 MATH 1201: Differential Equations and Matrices

Credits: 3.0 | Theory (GED)

a. Rationale:

This course provides the mathematical foundation for solving ordinary and partial differential equations and applies matrix algebra to physical systems. It covers first-order ODEs, higher-order linear ODEs with constant coefficients, series solutions, PDEs, matrices, linear transformations, and eigenvalue problems essential for advanced physics courses.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain classifications, solution methods, and physical significance of ordinary and partial differential equations and matrices.	Understand
CLO 2	Solve first-order and higher-order ordinary differential equations with applications to mechanical and electrical oscillatory systems.	Apply
CLO 3	Analyze partial differential equations representing wave, heat, and potential fields using separation of variables.	Analyze

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 4	Apply matrix operations, Gaussian elimination, eigenvalues, and diagonalization to solve systems of linear equations and physical transformations.	Apply

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1		✓									✓	✓
CLO 2		✓									✓	✓
CLO 3		✓									✓	✓
CLO 4		✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Differential Equations: Classification, origin, order and degree of differential equations; Formation of differential equations; General and particular solutions.	5	CLO 1
2	First-Order Differential Equations: Separable equations; Homogeneous equations; Exact differential equations and integrating factors; Linear first-order equations; Bernoulli equations; Orthogonal trajectories; Applications to decay, cooling, and RL circuits.	7	CLO 1, CLO 2
3	Higher-Order Ordinary Differential Equations: Homogeneous linear equations with constant coefficients; Non-homogeneous equations; Method of undetermined coefficients; Variation of parameters; Cauchy–Euler equations; Applications to damped and forced harmonic oscillations.	8	CLO 2
4	Series Solutions and Special Functions: Power series solutions about ordinary and regular singular points; Frobenius method; Legendre's differential equation and Legendre polynomials; Bessel's differential equation and Bessel functions.	7	CLO 2, CLO 3
5	Partial Differential Equations: Formation of PDEs; First-order linear and quasi-linear PDEs (Lagrange's method); Second-order PDEs: Classification (elliptic, parabolic, hyperbolic); Separation of variables method: One-dimensional wave equation, heat conduction equation, and two-dimensional Laplace equation.	8	CLO 3
6	Matrices and Linear Algebra: Types of matrices; Matrix operations; Elementary row and column operations; Rank and nullity; System of linear equations and Gaussian elimination; Determinants; Eigenvalues and eigenvectors; Cayley–Hamilton theorem; Matrix diagonalization and quadratic forms.	7	CLO 1, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual explanations of ODEs/PDEs, worked examples	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, mathematical derivations, problem-solving tutorials on physical oscillations	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, boundary-value problem analysis, derivations	Homework, assignments, quizzes, final examination
CLO 4	Lectures, matrix computation exercises, eigenvalue problem sets	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ross, S. L.	<i>Differential Equations</i>	John Wiley & Sons
Ayres, Frank	<i>Theory and Problems of Differential Equations</i>	McGraw-Hill
Anton, H. & Rorres, C.	<i>Elementary Linear Algebra</i>	Wiley
Zill, D. G.	<i>A First Course in Differential Equations with Modeling Applications</i>	Cengage Learning

0533 PHYS 1206: Viva-voce

Credits: 1.0 | Oral Examination

a. Rationale:

This course assesses students' conceptual understanding, analytical thinking, communication skills, and overall academic progress through oral examination based on all courses offered in the First Year Second Term. It also helps students develop confidence, logical reasoning, and the ability to articulate scientific concepts effectively.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Recall and explain fundamental concepts across all courses offered in Year I – Term II.	Remember
CLO 2	Apply critical reasoning to answer spontaneous scientific and analytical questions.	Apply
CLO 3	Communicate physics concepts clearly and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		
CLO 3						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theory and practical courses of Year I – Term II.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion	Viva-voce oral examination
CLO 2	Q&A practice, tutorial discussion	Viva-voce oral examination
CLO 3	Presentation and oral response practice	Viva-voce oral examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Standard textbooks of the term courses	—	—

3.2 Second Year – Course Descriptions

Year II – Term I

0533 PHYS 2101: Optics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers geometrical and physical optics including Fermat's principle, wave interference, Fresnel/Fraunhofer diffraction, polarization, and optical instruments.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental principles of wave optics, interference, diffraction, polarization, and optical dispersion.	Understand
CLO 2	Describe wavefront division, amplitude division, grating resolution, double refraction, and optical activity.	Understand
CLO 3	Apply mathematical wave formulations to calculate fringe spacing, grating resolution, and polarization angles.	Apply
CLO 4	Analyze optical spectra, interferometer outputs, diffraction patterns, and polarimetric data.	Analyze
CLO 5	Evaluate optical instrument designs and laser beam characteristics in modern optical systems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	
CLO 2	✓	✓									✓	
CLO 3	✓	✓									✓	
CLO 4	✓	✓									✓	

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 5	✓	✓									✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Nature of Light (What is Light?): Theories of light; Nature and propagation of light; Speed of light; Electromagnetic theory of light.	4	CLO 1
2	Interference: Huygens' Principle; Superposition of Waves; Conditions for Interference; Young's Double Slit Experiment; Lloyd's Mirror; Fresnel Double Mirror; Fresnel Biprism; Amplitude Splitting Interference; Haidinger Fringes; Fizeau Fringes; Thin Film Interference; Newton's Rings; Michelson Interferometer; Mach-Zehnder Interferometer.	8	CLO 1, CLO 3
3	Multiple-Beam Interference: Multiple reflections from plane parallel plates; Fabry-Perot Interferometer; Free Spectral Range; Chromatic Resolving Power; Anti-reflection Coatings; Interference Filters and Applications.	4	CLO 1, CLO 3, CLO 4
4	Fraunhofer Diffraction: Huygens-Fresnel Principle; Fresnel and Fraunhofer Diffraction; Single, Double and Multiple Slits; Circular Aperture; Diffraction Grating; Transmission and Reflection Gratings; Spectrometer; Resolving Power.	7	CLO 1, CLO 3, CLO 4
5	Fresnel Diffraction: Kirchhoff Integral Theorem; Fresnel Zone Plate; Fresnel Lens; Rectangular Aperture; Fresnel Integrals; Cornu Spiral; Fresnel Diffraction by a Slit.	5	CLO 2, CLO 4, CLO 5
6	Polarization: Plane, Circular and Elliptical Polarization; Malus' Law; Polarization by Reflection; Brewster's Law; Double Refraction; Optical Axis; Nicol and Wollaston Prisms; Wave Plates; Optical Activity; Polarimeter.	6	CLO 1, CLO 4, CLO 5
7	Dispersion and Scattering: Normal and Anomalous Dispersion; Cauchy's and Sellmeier's Equations; Rayleigh and Mie Scattering; Atmospheric Optical Phenomena including Blue Sky and Red Sunset.	3	CLO 2, CLO 4
8	Geometrical Optics and Aberrations: Ray tracing through optical systems; Matrix formulation of geometric optics; Transfer matrices of lenses and mirrors and for free propagation; Examples; Seidel aberrations; Spherical aberration; Coma; Astigmatism; Curvature of field; Distortion; Aspherical surfaces; Chromatic aberration; Achromatic doublets; Example.	5	CLO 1, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Hecht, E.	<i>Optics</i>	Pearson / Addison-Wesley
Ghatak, A.	<i>Optics</i>	McGraw-Hill
Jenkins, F. A. & White, H. E.	<i>Fundamentals of Optics</i>	McGraw-Hill
Subrahmanyam, N., Brijlal & Avadhanulu, M. N.	<i>A Textbook of Optics</i>	S. Chand

0533 PHYS 2102: Physics Lab-2A

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides hands-on training in fundamental optical experiments and measurement techniques. It enables students to develop practical skills in using optical instruments, analyzing experimental data, estimating uncertainties, and interpreting results based on the principles of geometrical and wave optics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the angle of a prism using a spectrometer.	5	CLO 1, CLO 2
2	To determine the refractive index of the material of a prism using a spectrometer.	5	CLO 1, CLO 2, CLO 3
3	To determine the wavelengths of spectral lines using a plane diffraction grating.	5	CLO 1, CLO 2, CLO 3
4	To calibrate a polarimeter and determine the specific rotation of a sugar solution.	5	CLO 2, CLO 3, CLO 4
5	To verify Malus' law using a polarizer and analyzer.	5	CLO 3, CLO 4, CLO 5
6	To determine the radius of curvature of a plano-convex lens using Newton's rings.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Nelkon, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold

0533 PHYS 2103: Basic Electronics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers semiconductor physics, PN junction devices, bipolar and field-effect transistors, operational amplifiers, and digital logic fundamentals.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain semiconductor physics, PN junction operation, transistor biasing, Op-Amp feedback, and logic gate functions.	Understand
CLO 2	Describe small-signal AC models, amplifier frequency response, voltage regulators, and binary arithmetic.	Understand
CLO 3	Apply circuit laws, load-line analysis, and Boolean algebra to design analog and digital circuits.	Apply
CLO 4	Analyze transistor amplifier configurations, Op-Amp mathematical operators, and digital logic networks.	Analyze
CLO 5	Evaluate electronic circuit performance for signal amplification, filtering, and digital data processing.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓		✓							✓	
CLO 2	✓	✓		✓							✓	
CLO 3	✓	✓		✓							✓	
CLO 4	✓	✓		✓							✓	
CLO 5	✓	✓		✓							✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Electricity and Electronics: Atomic Structure; Energy Levels; Energy Bands; Classification of Solids; Band Gap; Valence and Free Electrons; Voltage and Current Sources; Source Conversion Techniques.	8	CLO 1, CLO 3
2	Semiconductor Physics: Intrinsic and Extrinsic Semiconductors; n-type and p-type Semiconductors; PN Junction; Forward and Reverse Bias; Current-Voltage Characteristics of PN Junction Diodes.	8	CLO 1, CLO 3, CLO 4
3	Semiconductor Diodes and Rectifiers: Half-wave and Full-wave Rectifiers; Zener, Tunnel, Varactor, Photodiodes and LEDs; Filter Circuits (Capacitor Filter, Choke Input Filter, Capacitor Input Filter); Rectifier Performance.	10	CLO 2, CLO 4
4	Transistors and Amplifiers: Construction and Operation of BJTs; NPN and PNP Transistors; Common Base (CB), Common Emitter (CE), and Common Collector (CC) Configurations; Input and Output Characteristics; Load Line Analysis; Operating Point; Cutoff and Saturation.	8	CLO 1, CLO 4, CLO 5
5	Transistor Biasing and Stability: Thermal Stability; Stability Factor; Temperature Effects; Faithful Amplification; Fixed Bias; Emitter Bias; Collector-to-Base Feedback Bias; Voltage Divider Bias; Comparison of Biasing Methods.	8	CLO 1, CLO 3, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Boylestad, R. L. & Nashelsky, L.	<i>Electronic Devices and Circuit Theory</i>	Pearson
Malvino, A. P.	<i>Electronic Principles</i>	McGraw-Hill

0533 PHYS 2104: Physics Lab-2B

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides hands-on experimental training in geometrical and wave optics, string acoustics, and magnetometry. Students investigate the refractive index of liquids by lens-mirror combinations, transverse standing waves via Melde's experiment, focal length determination on an optical bench, Earth's horizontal magnetic field using a tangent galvanometer, magnetic moments of bar magnets, and the dispersive power of prisms using spectrometers.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the refractive index of a liquid by the plane-mirror and convex-lens method.	5	CLO 1, CLO 2
2	To verify the laws of transverse vibrations of a stretched string using Melde's experiment.	5	CLO 1, CLO 2, CLO 3
3	To determine the focal length and power of a convex lens by the displacement method using an optical bench.	5	CLO 1, CLO 2, CLO 3
4	To determine the horizontal component of the Earth's magnetic field using a tangent galvanometer.	5	CLO 2, CLO 3, CLO 4
5	To determine the magnetic moment of a bar magnet using a magnetometer.	5	CLO 3, CLO 4, CLO 5
6	To determine the dispersive power of the material of a prism using a spectrometer.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Nelkon, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold

0533 PHYS 2105: Mathematical Physics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course provides the mathematical methods essential for solving physical problems. It covers complex variable theory, contour integration, special functions of mathematical physics, partial differential equations, Fourier analysis, and integral transforms necessary for quantum mechanics, electrodynamics, and advanced theoretical physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain concepts of complex analytic functions, conformal mapping, residue calculus, and integral transforms.	Understand
CLO 2	Apply special functions (Legendre, Bessel, Hermite, Laguerre) to formulate solutions for physical boundary-value problems.	Apply
CLO 3	Analyze partial differential equations (wave, heat, Laplace) in diverse coordinate geometries using orthogonal function expansions.	Analyze
CLO 4	Evaluate complex contour integrals, Fourier series, and Fourier/Laplace transforms to solve advanced problems in physics.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	✓
CLO 2	✓	✓									✓	✓
CLO 3	✓	✓									✓	✓
CLO 4	✓	✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Complex Variables: Functions of a complex variable; Analytic functions; Cauchy–Riemann equations; Harmonic functions; Conformal mapping; Complex line integrals; Cauchy's integral theorem and Cauchy's integral formula; Derivatives of analytic functions; Taylor's and Laurent's series; Singularities, poles, and branch cuts; Cauchy's residue theorem and evaluation of definite real integrals.	10	CLO 1, CLO 4
2	Special Functions of Physics: Gamma and Beta functions and their properties; Legendre's differential equation and Legendre polynomials; Generating functions, Rodrigue's formula, and orthogonality; Associated Legendre polynomials; Bessel's differential equation, Bessel functions of the first and second kinds; Generating function and recurrence relations; Hermite and Laguerre polynomials and their applications in quantum mechanics.	12	CLO 2
3	Partial Differential Equations: Classification of second-order PDEs; Laplace, wave, and diffusion equations in Cartesian, cylindrical, and spherical coordinate systems; Boundary-value and initial-value problems; Method of separation of variables; Green's function method introduction.	6	CLO 2, CLO 3
4	Fourier Series: Periodic functions; Fourier series expansions; Dirichlet conditions; Determination of Fourier coefficients; Even and odd functions; Half-range expansions; Complex exponential form of Fourier series; Parseval's identity and power spectrum.	6	CLO 1, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
5	Integral Transforms: Fourier integral and Fourier transforms; Fourier sine and cosine transforms; Properties of Fourier transforms and convolution theorem; Laplace transforms and inverse Laplace transforms; Properties and convolution theorem; Application of Laplace and Fourier transforms to ordinary and partial differential equations in physics.	8	CLO 1, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, mathematical derivations, worked examples of contour integrals	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, problem-solving tutorials on special functions and differential equations	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, boundary-value modeling in physical coordinates	Homework, assignments, quizzes, final examination
CLO 4	Analytical case studies, transform technique applications to physical systems	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Arfken, G. B., Weber, H. J. & Harris, F. E.	<i>Mathematical Methods for Physicists</i>	Academic Press / Elsevier
Boas, M. L.	<i>Mathematical Methods in the Physical Sciences</i>	Wiley
Churchill, R. V. & Brown, J. W.	<i>Complex Variables and Applications</i>	McGraw-Hill
Wong, C. W.	<i>Introduction to Mathematical Physics</i>	Oxford University Press

0542 STAT 2101: Principles of Statistics-I

Credits: 2.0 | Theory (GED)

a. Rationale:

This course introduces the fundamental principles and methods of statistics required for scientific data analysis in physics. It covers data collection and presentation, measures of central tendency, measures of dispersion, correlation, regression, and basic hypothesis testing essential for interpreting experimental data.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental statistical concepts, methods of data collection, classification, tabulation, and graphical representation.	Understand
CLO 2	Calculate and interpret appropriate measures of central tendency and dispersion for experimental physical data.	Apply

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 3	Analyze bivariate datasets using linear correlation and simple regression models.	Analyze
CLO 4	Apply basic statistical hypothesis testing techniques to evaluate experimental and observational results.	Apply

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1		✓	✓						✓	✓		
CLO 2		✓	✓						✓	✓		
CLO 3		✓	✓						✓	✓		
CLO 4		✓	✓						✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Statistics: Nature, scope, and importance of statistics in physical sciences; Population and sample; Statistical data types: Qualitative and quantitative, discrete and continuous variables; Data collection and tabulation; Frequency distributions; Graphical representations (histograms, frequency polygons, ogives, stem-and-leaf plots).	6	CLO 1
2	Measures of Central Tendency: Arithmetic mean, geometric mean, harmonic mean, median, and mode; Partition values (quartiles, deciles, percentiles); Mathematical properties of means; Selection criteria for appropriate measures of central location.	6	CLO 1, CLO 2
3	Measures of Dispersion and Shape: Range, quartile deviation, mean deviation, standard deviation, and variance; Relative measures of dispersion; Coefficient of variation; Moments about origin and mean; Skewness and kurtosis; Shape analysis of experimental frequency curves.	6	CLO 2
4	Correlation and Simple Linear Regression: Bivariate distributions; Scatter diagram; Pearson's product-moment correlation coefficient; Spearman's rank correlation; Principle of least squares; Simple linear regression lines; Properties of regression coefficients; Standard error of estimate.	5	CLO 3
5	Introduction to Statistical Hypothesis Testing: Formulation of null and alternative hypotheses; Type I and Type II errors; Level of significance; Test statistic; Critical regions and p-values; One-sample and two-sample tests for means (Z-test, Student's t-test).	5	CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, multimedia presentations, data tabulation exercises	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, mathematical calculations, problem-solving tutorials on statistical dispersion	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, bivariate data modeling, regression fitting exercises	Homework, assignments, quizzes, final examination
CLO 4	Application-oriented discussions on significance testing for experimental data	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Bluman, A. G.	<i>Elementary Statistics: A Step-by-Step Approach</i>	McGraw-Hill
Mostafa, M. G.	<i>Basic Statistics</i>	Brothers Publications
Bhuyan, K. C.	<i>Methods of Statistics</i>	Sahitya Prokashani
Islam, M. N.	<i>An Introduction to Statistics and Probability</i>	Mullick & Brothers

0231 ENG 2101: Functional English

Credits: 3.0 | Theory (GED)

a. Rationale:

This course intends to equip students with essential English language skills necessary for effective communication in academic and professional settings. It enables students to use grammatical and communicative competence to articulate scientific concepts, write technical reports and research papers coherently, and communicate verbally with clarity and confidence.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Apply standard English grammatical structures, vocabulary, and syntactic rules accurately in written and oral communication.	Apply
CLO 2	Demonstrate listening comprehension and critical reading strategies for academic and scientific texts.	Understand
CLO 3	Compose structured technical documents, laboratory reports, abstracts, and formal correspondence adhering to academic conventions.	Apply
CLO 4	Analyze and edit academic texts for coherence, cohesion, conciseness, and stylistic appropriateness.	Analyze
CLO 5	Deliver effective oral presentations and participate constructively in scientific discussions and professional interviews.	Create

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 3						✓	✓	✓	✓	✓		
CLO 4						✓	✓	✓	✓	✓		
CLO 5						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Functional English: Course objectives, communicative competence framework, role of English in global scientific discourse.	2	CLO 1
2	Grammar in Context: Parts of speech; Subject-verb agreement; Tenses and aspect; Active and passive voice in scientific descriptions; Determiners and prepositions; Vocabulary expansion strategies.	6	CLO 1
3	Sentence Structure and Mechanics: Clause analysis; Simple, compound, and complex sentences; Synthesis, transformation, and reduction of clauses; Avoiding sentence fragments, run-ons, and comma splices; Punctuation rules.	6	CLO 1, CLO 4
4	Communicative Spoken English: Conversational strategies; Self-introduction; Asking and answering questions in scientific context; Small group discussions; Pronunciation and phonetics fundamentals.	6	CLO 1, CLO 5
5	Listening Comprehension and Note-Taking: Pre-listening, while-listening, and post-listening strategies; Identifying main ideas and supporting details; Note-taking techniques from recorded scientific lectures.	4	CLO 2
6	Academic Reading Skills: Skimming and scanning; Contextual vocabulary inference; Critical reading of scientific papers, abstracts, and textbook chapters; Summarizing and paraphrasing.	4	CLO 2, CLO 4
7	Technical and Scientific Writing: Paragraph architecture (topic sentence, development, concluding sentence); Structuring laboratory reports, technical essays, abstracts, and research papers (IMRAD format); Avoiding plagiarism and citation principles.	8	CLO 3, CLO 4
8	Formal Correspondence: Writing professional emails, cover letters, Curriculum Vitae (CV), statements of purpose, and formal academic inquiries.	4	CLO 3
9	Oral Presentation and Interview Skills: Designing visual presentation slides; Non-verbal communication and body language; Delivery techniques; Academic presentation rehearsal; Job interview strategies and mock sessions.	2	CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive grammar workshops, contextual writing drills, diagnostic exercises	Class test, grammar quizzes, in-class writing exercises

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 2	Audio lecture listening sessions, academic text reading and comprehension tasks	Comprehension tests, reading quizzes, note-taking evaluation
CLO 3	Guided report drafting, peer-review sessions, technical writing workshops	Lab report assessments, formal essays, CV/cover letter assignment
CLO 4	Textual analysis, error-correction drills, paraphrasing and summary workshops	Editing assignments, written examination, final examination
CLO 5	Oral presentation sessions, group discussions, mock interview simulations	Individual oral presentation, viva voce, group discussion performance

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Azar, B. S. & Hagen, S. A.	<i>Understanding and Using English Grammar</i>	Pearson Education
Swan, Michael	<i>Practical English Usage</i>	Oxford University Press
Eastwood, John	<i>Oxford Guide to English Grammar</i>	Oxford University Press
Pickett, N. A., Laster, A. A. & Staples, K. E.	<i>Technical English: Writing, Reading and Speaking</i>	Pearson

0533 PHYS 2106: Viva-voce

Credits: 1.0 | Oral Examination

a. Rationale:

The comprehensive viva-voce examination evaluates students' conceptual understanding, critical thinking, communication skills, and problem-solving ability across all courses offered in Year II – Term I.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Recall and explain fundamental concepts across all courses offered in Year II – Term I.	Remember
CLO 2	Apply critical reasoning to answer spontaneous scientific and analytical questions.	Apply
CLO 3	Communicate physics concepts clearly and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		
CLO 3						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theory and practical courses of Year II – Term I.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion	Viva-voce oral examination
CLO 2	Q&A practice, tutorial discussion	Viva-voce oral examination
CLO 3	Presentation and oral response practice	Viva-voce oral examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Standard textbooks of the term courses	—	—

Year II – Term II

0533 PHYS 2201: Thermal Physics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers the laws of thermodynamics, kinetic theory of gases, entropy, thermodynamic potentials, phase transitions, and blackbody radiation laws.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the zeroth, first, second, and third laws of thermodynamics, entropy, and kinetic theory principles.	Understand
CLO 2	Describe thermodynamic cycles, Maxwell relations, phase transitions, and Planck's radiation law.	Understand
CLO 3	Apply thermodynamic potentials (Helmholtz, Gibbs) to evaluate system equilibrium and natural processes.	Apply
CLO 4	Analyze heat engine efficiencies, Joule-Thomson coefficients, and entropy production.	Analyze
CLO 5	Evaluate thermal systems, refrigeration efficiency, and energy conversion in physical systems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	
CLO 2	✓	✓									✓	
CLO 3	✓	✓									✓	
CLO 4	✓	✓									✓	
CLO 5	✓	✓									✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	The Kinetic Theory of Gases and Transport Phenomenon: Assumptions of Kinetic Theory of Gases; Equation of State of an Ideal Gas; Concept of Pressure and Temperature; Brownian Motion; Einstein's Theory of Brownian motion and its Significance; Equipartition of Energy; Real Gases and Intermolecular Forces; Vander Waal's Equation of State; Mean Free Path; Joule-Thomson Effect for Real and Van der Waal Gases; Diffusion; Temperature of Inversion. Joule-Thomson Cooling.	8	CLO 1, CLO 3
2	Heat Transfer Process: Newton's law of cooling; Conduction; Thermal conductivity and thermal diffusivity; Fourier's equation for heat conduction – its solution for rectilinear and radial (spherical and cylindrical) flow of heat. Heat flow through a compound wall; Convection; Wiedemann-Franz law.	7	CLO 1, CLO 3, CLO 4
3	Concepts of Thermodynamics and First Law: Thermodynamic Systems; Thermodynamic Equilibrium and State of a System; Zeroth Law of Thermodynamics and Concept of Temperature. Work and Heat Energy; Statement of First Law of Thermodynamics; Internal Energy; Isothermal; Adiabatic; Quasi-static; Work Done during Isothermal and Adiabatic Processes; Reversible and Irreversible Processes.	8	CLO 2, CLO 3
4	Second Law of Thermodynamics and Entropy: Conversion of Work into Heat and Heat into Work; Statement of Second Law; Heat Engines. Carnot's Cycle and Carnot's Theorem; Carnot Engine and its Efficiency. Refrigerator and its Efficiency; Concept of Entropy; Entropy and Disorder; Principle of Increase of Entropy; Change of Entropy in Reversible and Irreversible Processes; Entropy of the Universe; Entropy Temperature Diagram; Theorem of Clausius.	10	CLO 2, CLO 4, CLO 5
5	Thermodynamic Potentials and Maxwell's Relations: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potential Functions; Their Definitions, Properties and Applications; Magnetic Work. Cooling due to Adiabatic Demagnetization. Approach to Absolute Zero; Phase Transitions; Values of $C_p - C_v$; Clausius-Clapeyron Equation; Tds Equations; Joule-Kelvin Coefficient for Ideal and Van der Waal Gases; Change of Temperature during an Adiabatic Process; Third Law of Thermodynamics.	9	CLO 1, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Halliday, D., Resnick, R. & Walker, J.	<i>Fundamentals of Physics</i>	Wiley
Young, H. D. & Freedman, R. A.	<i>University Physics with Modern Physics</i>	Pearson
Blundell, S. J. & Blundell, K. M.	<i>Concepts in Thermal Physics</i>	Oxford University Press
Zemansky, M. W. & Dittman, R. H.	<i>Heat and Thermodynamics</i>	McGraw-Hill
Landau, L. D. & Lifshitz, E. M.	<i>Statistical Physics (Course of Theoretical Physics Vol. 5)</i>	Butterworth-Heinemann

0533 PHYS 2202: Physics Lab-2C

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides practical training in thermal physics, calorimetry, and heat transfer phenomena. Students experimentally determine the mechanical equivalent of heat (J) by electrical methods, specific heat capacities of solids and liquids using method of mixtures, thermal conductivities of good and poor conductors using Searle's and Lee's apparatuses, and linear thermal expansion coefficients of metals.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the mechanical equivalent of heat, J, by the electrical method.	5	CLO 1, CLO 2
2	To determine the specific heat capacity of a solid by the method of mixtures.	5	CLO 1, CLO 2, CLO 3
3	To determine the thermal conductivity of a good conductor (metal) by Searle's method.	5	CLO 1, CLO 2, CLO 3
4	To determine the thermal conductivity of a bad conductor using Lee's apparatus.	5	CLO 2, CLO 3, CLO 4
5	To determine the specific heat capacity of a liquid by the method of mixtures.	5	CLO 3, CLO 4, CLO 5
6	To determine the coefficient of linear expansion of a metal using Searle's apparatus.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Nelkon, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold

0533 PHYS 2203: Atomic and Molecular Physics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers atomic structure, Bohr atom, Sommerfeld quantization, vector atom model, fine structure, Zeeman effect, Stark effect, and molecular spectroscopy.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain atomic models, vector atom model, quantum numbers, L-S/J-J coupling, and molecular energy levels.	Understand
CLO 2	Describe Zeeman effect, Paschen-Back effect, Stark effect, X-ray emission spectra, and molecular spectra.	Understand
CLO 3	Apply quantum mechanics principles to calculate atomic energy levels, spectral wavelengths, and magnetic moments.	Apply
CLO 4	Analyze atomic fine structure, spin-orbit interaction, selection rules, and IR/Raman spectroscopic data.	Analyze
CLO 5	Evaluate spectroscopic experimental data to deduce atomic and molecular constants.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	
CLO 2	✓	✓									✓	
CLO 3	✓	✓									✓	
CLO 4	✓	✓									✓	
CLO 5	✓	✓									✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Atomic Structure: Thomson model of atom; Rutherford's Model of Atom; Atomic Spectra; The Bohr Model and the Structure of Atoms; Energy levels and spectra; Atomic Excitation; Vector atom model l-s and j-j coupling; Many-electron atoms and atomic spectra; The Franck-Hertz Experiment; Nuclear motion and reduced mass.	9	CLO 1, CLO 3
2	Particle Properties of Wave: Electromagnetic radiation; Particles and waves in nature; Photoelectric Effect; Einstein's Photoelectric Equation and its Experimental Verification; Compton Effect; Pair Production and pair annihilation; Production and Origin of X-ray; X-ray spectrum and its properties; X-ray Absorption; X-ray diffraction; Photoelectric Cells and Their Application.	8	CLO 1, CLO 3, CLO 4
3	Wave Properties of Particles: Wave Particle Duality; de Broglie's hypothesis; Particle diffraction; Experimental Verification of Particle Waves; Phase and Group Velocities..	6	CLO 2, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
4	Quantum Concepts and Complex Atoms: Schrodinger equation; Four quantum numbers; Spin Angular Momentum; Exclusion Principle; Periodic Table; Stern-Gerlach Experiment; Spin-orbit Interaction– Fine Structure; Total Angular Momentum of Atoms; Atomic Spectra (Helium, Sodium and Mercury); Zeeman Effect: Normal and Anomalous; Stark Effect; Paschen-Back Effect.	10	CLO 2, CLO 3
5	Molecular Spectra: Molecular bonds; Electron sharing; The H ₂ molecular ion; the hydrogen molecule; Complex molecules; Rotational Spectra; Vibrational Spectra; Molecular Quantum States; Dissociation of Molecules; Heat of Dissociation; UV-spectra; Raman Spectra; Application of Raman Effect.	9	CLO 1, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Beiser, A.	<i>Concepts of Modern Physics</i>	McGraw-Hill International
Eisberg, R. M. & Resnick, R.	<i>Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles</i>	Wiley
Semat, H.	<i>Introduction to Atomic and Nuclear Physics</i>	Chapman & Hall / Rinehart
Weidner, R. T. & Sells, R. L.	<i>Elementary Modern Physics</i>	Allyn and Bacon Inc.
White, H. E.	<i>Introduction to Atomic Spectra</i>	McGraw-Hill
Beiser, A.	<i>Perspective of Modern Physics</i>	McGraw-Hill International
Banwell, C. N. & McCash, E. M.	<i>Fundamentals of Molecular Spectroscopy</i>	McGraw-Hill

a. Rationale:

This laboratory course provides practical training in advanced galvanometer dynamics, thermal physics,

refrigeration systems, and precision optical measurements. Students experimentally study ballistic galvanometer transients (logarithmic decrement, damping constants, critical damping resistance), thermal conductivity of liquids using the hot-wire method, cooling curves, coefficient of performance of refrigeration units, and thermal expansion of solids using optical levers.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To study the decay of deflection with time in a ballistic galvanometer and determine the undamped ballistic deflection, logarithmic decrement, and damping time constant.	5	CLO 1, CLO 2
2	To study the variation of logarithmic decrement with ballistic galvanometer loop resistance and determine the critical damping resistance.	5	CLO 1, CLO 2, CLO 3
3	To determine the coefficient of performance of a refrigeration system.	5	CLO 1, CLO 2, CLO 3
4	To determine the thermal conductivity of a liquid using the hot-wire method.	5	CLO 2, CLO 3, CLO 4
5	To study the cooling curve of a heated body and determine its rate of cooling.	5	CLO 3, CLO 4, CLO 5
6	To determine the thermal expansion coefficient of a solid using an optical lever.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Boylestad, R. L. & Nashelsky, L.	<i>Electronic Devices and Circuit Theory</i>	Pearson
Malvino, A. P.	<i>Electronic Principles</i>	McGraw-Hill

0533 PHYS 2205: Classical Mechanics and Relativity

Credits: 3.0 | Theory (Core)

a. Rationale:

The course intends to provide students with a comprehensive understanding of advanced classical mechanics and the foundations of relativity. The course develops analytical and problem-solving skills through the study of Lagrangian and Hamiltonian formulations, central force motion, rigid body dynamics, and relativistic mechanics, which form the basis for advanced theoretical physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental principles of analytical mechanics, generalized coordinates, constrained systems, and relativistic spacetime.	Understand
CLO 2	Apply Lagrangian and Hamiltonian formulations to model dynamical systems and derive equations of motion.	Apply
CLO 3	Analyze central force orbits, rigid body rotations, canonical transformations, and relativistic kinematic transformations.	Analyze
CLO 4	Evaluate complex mechanical systems using variational principles, Poisson brackets, and conservation laws in 4-vector spacetime.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	✓
CLO 2	✓	✓									✓	✓
CLO 3	✓	✓									✓	✓
CLO 4	✓	✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Review of Newtonian Mechanics: Mechanics of a system of particles; Generalized coordinates; Holonomic and non-holonomic constraints; Degrees of freedom; Principle of virtual work; D'Alembert's principle.	4	CLO 1
2	Lagrangian Formulation: Lagrange's equations from D'Alembert's principle; Calculus of variations and Euler-Lagrange equation; Hamilton's variational principle; Generalized momentum and cyclic coordinates; Conservation theorems and symmetry principles; Velocity-dependent potentials and Rayleigh dissipation function.	7	CLO 1, CLO 2
3	Central Force Motion: Two-body central force problem and reduction to equivalent one-body problem; Integrals of motion; Effective potential; Classification of orbits; Kepler's laws of planetary motion; Virial theorem; Rutherford scattering cross-section and laboratory coordinates.	10	CLO 2, CLO 3
4	Rigid Body Dynamics: Angular momentum and kinetic energy of rotation; Moment of inertia tensor and principal axes; Matrix representation of rotations; Euler's angles; Euler's equations of motion for a rigid body; Torque-free motion of symmetric top; Precession and nutation.	4	CLO 2, CLO 3
5	Hamiltonian Mechanics and Canonical Transformations: Legendre transformation and Hamiltonian function; Hamilton's canonical equations of motion; Principle of least action; Canonical transformations and generating functions; Poisson brackets, algebraic properties, and canonical invariants; Hamilton-Jacobi equation.	7	CLO 2, CLO 4
6	Relativistic Mechanics: Postulates of special relativity; Minkowski four-dimensional spacetime; Four-vectors (position, velocity, momentum); Relativistic mass, momentum, and energy equivalence ($E = mc^2$); Relativistic force and equations of motion; Conservation of four-momentum in particle collisions.	5	CLO 3, CLO 4
7	Special Theory of Relativity: Michelson-Morley experiment; Galilean transformations and failure of ether hypothesis; Lorentz transformations and spacetime intervals (timelike, spacelike, lightlike); Length contraction, time dilation, and relativity of simultaneity; Relativistic Doppler effect and twin paradox.	5	CLO 1, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, historical foundations of mechanics and relativity	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, mathematical derivations of Euler-Lagrange and Hamilton equations, tutorial problem sets	Class test, assignments, midterm examination, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 3	Problem-based learning, orbital mechanics and rigid body rotation exercises	Homework, assignments, quizzes, final examination
CLO 4	Application-oriented discussions on canonical transformations, relativistic collisions, and symmetries	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Hamill, P.	<i>A Student's Guide to Lagrangians and Hamiltonians</i>	Cambridge University Press
Taylor, J. R.	<i>Classical Mechanics</i>	University Science Books
Goldstein, H., Poole, C. & Safko, J.	<i>Classical Mechanics</i>	Pearson
Marion, J. B. & Thornton, S. T.	<i>Classical Dynamics of Particles and Systems</i>	Cengage Learning

0541 MATH 2201: Numerical Analysis and Applications Credits: 3.0 | Theory (GED)

a. Rationale:

The course intends to provide students with numerical techniques for solving mathematical problems that cannot be solved analytically. It develops computational and problem-solving skills through the study of numerical methods for non-linear equations, linear systems, interpolation, numerical differentiation and integration, and ordinary differential equations with applications in physical sciences and engineering.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain theoretical principles, convergence properties, and error sources of standard numerical algorithms.	Understand
CLO 2	Apply root-finding and linear system solution algorithms to solve non-linear and multidimensional algebraic problems.	Apply
CLO 3	Implement interpolation and polynomial approximation techniques for discrete physical datasets.	Apply
CLO 4	Analyze numerical differentiation and integration algorithms to evaluate mathematical models and physical integrals.	Analyze
CLO 5	Solve ordinary differential equations using single-step and multi-step numerical methods for physical dynamics.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓				✓		✓	
CLO 2	✓	✓			✓				✓		✓	
CLO 3	✓	✓			✓				✓		✓	
CLO 4	✓	✓			✓				✓		✓	
CLO 5	✓	✓			✓				✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Transcendental Equations and Solution of equation in one variable: Bisection method; Method of False position; Fixed point Iteration; Newton–Raphson Method; Error Analysis; First and Second Order Iteration Methods; Rate of Convergence; Acceleration of the Convergence; Efficiency of a Method.	8	CLO 1, CLO 4
2	Solution of System of Linear Equations: Basic Matrix Operations; Direct Methods – Matrix Inversion; Gauss Elimination Methods and Backward substitution; Gauss–Jordan Method; Gauss–Seidel Method; Triangularization Method; Iterative Methods – Jacobi Method; LU decomposition method.	9	CLO 2, CLO 4
3	Interpolation and Curve Fitting: Newton’s Forward and Backward Difference Interpolation Formula; Taylor polynomials; Hermite and Lagrange’s Interpolation Formula; Spline Interpolation; Linear and Polynomial Least Squares Curve Fitting; Extrapolation.	8	CLO 3, CLO 4
4	Numerical Differentiation and Integration: Numerical Differentiation using Interpolation; Finite Difference Method, Two-point formula, three-point formula and five-point formula; Cubic Spline Method; Numerical Integration: Newton–Cotes Method (Using Discrete Planes to approximate an integral), Trapezoidal Method; Simpson’s 1/3 and 3/8 rule for integration; Errors in these Methods; Romberg Method; Monte Carlo Integration.	8	CLO 3, CLO 4, CLO 5
5	Ordinary Differential Equations (ODE) solving with initial value: Solution by Taylor Series; Euler’s Method for 1st and 2nd Order ODE; Runge–Kutta Methods; Predictor–Corrector Methods: Adams–Moulton; Milne–Simpson; Verlet Method.	9	CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual algorithm demonstrations, error derivation walkthroughs	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, worked examples of root finding and matrix elimination, tutorial exercises	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, interpolation and curve fitting derivations, data exercises	Homework, assignments, quizzes, final examination
CLO 4	Lectures, numerical quadrature calculations, comparison of numerical accuracy	Assignments, midterm, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 5	Application-oriented case studies on physical ODE models (oscillators, orbital mechanics)	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Scheid, Francis	<i>Introduction to Numerical Analysis</i>	McGraw-Hill
Scarborough, J. B.	<i>Numerical Mathematical Analysis</i>	Oxford & IBH
Bau III, David & Trefethen, Lloyd N.	<i>Numerical Linear Algebra</i>	SIAM
Garcia, A. L.	<i>Numerical Methods for Physics</i>	Prentice Hall
Hamming, R. W.	<i>Numerical Methods for Scientists and Engineers</i>	McGraw-Hill / Dover
Jain, M. K., Iyengar, S. R. K. & Jain, R. K.	<i>Numerical Methods for Scientific and Engineering Computation</i>	New Age International

0542 STAT 2201: Principles of Statistics-II

Credits: 2.0 | Theory (GED)

a. Rationale:

This course introduces the mathematical foundations of probability, random variables, probability distributions, sampling theory, statistical inference, and experimental error analysis essential for the study of physics. It enables students to analyze uncertainty, interpret experimental data, make evidence-based inferences, and evaluate physical measurements using statistical techniques.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain concepts of events, probability spaces, random variables, and probability distributions.	Understand
CLO 2	Apply probability models (Binomial, Poisson, Normal) and sampling distributions to physical phenomena.	Apply
CLO 3	Analyze experimental data using statistical hypothesis testing, confidence intervals, and significance tests.	Analyze
CLO 4	Evaluate experimental measurements and quantify uncertainty using the theory of error propagation.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1		✓	✓						✓	✓		
CLO 2		✓	✓						✓	✓		
CLO 3		✓	✓						✓	✓		
CLO 4		✓	✓						✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Events and Probability Theory: Elements of set theory; Random experiments and sample space; Events and event algebra; Venn diagrams; Definitions of probability (classical, empirical, axiomatic); Addition and multiplication theorems; Conditional probability; Independent events; Total probability theorem and Bayes' theorem.	4	CLO 1
2	Random Variables and Probability Distributions: Discrete and continuous random variables; Probability mass function (PMF) and probability density function (PDF); Cumulative distribution function (CDF); Mathematical expectation, variance, and moments; Moment generating functions; Joint and marginal distributions.	6	CLO 1, CLO 2
3	Theoretical Probability Distributions: Binomial distribution and Poisson distribution: Derivations, properties, and applications to radioactive decay and counting statistics; Normal distribution: Standard normal distribution, properties, and area under the normal curve; Central Limit Theorem.	7	CLO 2
4	Sampling Theory and Sampling Distributions: Population and sample; Simple random sampling; Sampling distribution of sample mean and proportion; Standard error; Chi-square, Student's t, and Snedecor's F distributions.	4	CLO 2, CLO 3
5	Statistical Inference and Tests of Significance: Point estimation and interval estimation; Confidence intervals for population mean and proportion; Hypothesis testing: Null and alternative hypotheses, Type I and Type II errors, significance level; Large-sample tests (Z-test); Small-sample tests (t-test); Chi-square test of goodness of fit and independence of attributes.	4	CLO 3
6	Theory of Errors: Sources and classifications of measurement errors (systematic and random); Precision vs. accuracy; Propagation of uncertainties for single and multivariable functions; Weighted mean; Rejection of anomalous data (Chauvenet's criterion); Applications to physics laboratory experiments.	3	CLO 3, CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual probability puzzles, Venn diagram demonstrations	Quiz, class test, midterm examination, final examination
CLO 2	Lectures, mathematical derivations, problem-solving tutorials on probability distributions	Class test, assignments, midterm examination, final examination
CLO 3	Problem-based learning, statistical inference and hypothesis testing exercises	Homework, assignments, quizzes, final examination
CLO 4	Application-oriented case studies on experimental error analysis in physical measurements	Assignment, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Blitzstein, J. K. & Hwang, J.	<i>Introduction to Probability</i>	CRC Press
Walpole, R. E., Myers, R. H., Myers, S. L. & Ye, K.	<i>Probability and Statistics for Engineers and Scientists</i>	Pearson
Taylor, J. R.	<i>An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements</i>	University Science Books
Bevington, P. R. & Robinson, D. K.	<i>Data Reduction and Error Analysis for the Physical Sciences</i>	McGraw-Hill

0542 STAT 2202: Principles of Statistics Lab**Credits: 1.0 | Practical (GED)****a. Rationale:**

This laboratory course complements STAT 2201: Principles of Statistics-II by providing practical experience in probability simulation, descriptive and inferential statistics, sampling, hypothesis testing, and experimental error analysis using statistical software (MS Excel, SPSS, R, Python) applied to real physics datasets.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Use statistical software packages (MS Excel, SPSS, R, Python) to enter, clean, organize, and visualize experimental data.	Apply
CLO 2	Fit theoretical probability distributions (Binomial, Poisson, Normal) to experimental physics datasets using software.	Apply
CLO 3	Perform statistical hypothesis testing (t-tests, Z-tests, Chi-square tests) and regression analysis on empirical data.	Analyze
CLO 4	Evaluate measurement uncertainties, propagate experimental errors, and prepare formal scientific data analysis reports.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓				✓	✓		
CLO 2			✓	✓	✓				✓	✓		
CLO 3			✓	✓	✓				✓	✓		
CLO 4			✓	✓	✓				✓	✓		

d. Summary of Course Contents:

Sl.	Laboratory Experiment	Hrs.	CLO(s)
1	Introduction to statistical software (MS Excel, SPSS, R, Python): Interface overview, data input, data importing from instruments, data transformation.	2	CLO 1
2	Computation of descriptive statistics: Calculating mean, median, standard deviation, skewness, and kurtosis for laboratory datasets.	2	CLO 1
3	Graphical representation of statistical data: Constructing histograms, density plots, box plots, and scatter diagrams.	2	CLO 1
4	Probability simulations and distribution fitting: Simulating random variables; Fitting Binomial and Poisson distributions to radioactive counting data.	2	CLO 2
5	Fitting the Normal distribution: Evaluating experimental measurement distributions; Assessing normality using Q-Q plots and Shapiro-Wilk test.	2	CLO 2
6	Hypothesis testing for means: One-sample and two-sample t-tests to evaluate precision and compare experimental methods.	2	CLO 3
7	Paired t-test: Before-and-after experimental comparisons and calibration verification.	2	CLO 3
8	Chi-square test of goodness of fit: Testing experimental frequency distributions against theoretical physics models.	2	CLO 3
9	Simple linear regression and correlation analysis: Fitting calibration curves, estimating coefficients, evaluating R-squared and residual plots.	2	CLO 3, CLO 4
10	Uncertainty propagation and comprehensive case study: Processing a complete physics experimental dataset, computing error propagation, and generating a scientific laboratory report.	2	CLO 4

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Software demonstration, guided hands-on data manipulation tutorials	In-class lab tasks, software execution checks, workbook evaluation
CLO 2	Hands-on data modeling tasks on real laboratory physics data	Lab assignments, continuous evaluation, quizzes
CLO 3	Problem-based laboratory exercises in hypothesis testing and regression modeling	Weekly lab reports, data analysis assessments
CLO 4	End-of-term comprehensive data analysis project and formal documentation	Final project report, practical examination, viva voce

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Walpole, R. E., Myers, R. H., Myers, S. L. & Ye, K.	<i>Probability and Statistics for Engineers and Scientists</i>	Pearson
Bevington, P. R. & Robinson, D. K.	<i>Data Reduction and Error Analysis for the Physical Sciences</i>	McGraw-Hill

Author(s)	Book Title	Publisher / Ed.
Taylor, J. R.	<i>An Introduction to Error Analysis</i>	University Science Books

0533 PHYS 2206: Viva-voce**Credits: 1.0 | Oral Examination****a. Rationale:**

The comprehensive viva-voce examination evaluates students' conceptual understanding, critical thinking, communication skills, and problem-solving ability across all courses offered in Year II – Term II.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Recall and explain fundamental concepts across all courses offered in Year II – Term II.	Remember
CLO 2	Apply critical reasoning to answer spontaneous scientific and analytical questions.	Apply
CLO 3	Communicate physics concepts clearly and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		
CLO 3						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theory and practical courses of Year II – Term II.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion	Viva-voce oral examination
CLO 2	Q&A practice, tutorial discussion	Viva-voce oral examination
CLO 3	Presentation and oral response practice	Viva-voce oral examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Standard textbooks of the term courses	—	—

3.3 Third Year – Course Descriptions

Year III – Term I

0533 PHYS 3101: Laser Physics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers the fundamental principles of laser operation, stimulated emission, optical resonators, laser types, and their applications in science and technology.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the principles of stimulated emission, population inversion, optical resonators, and laser operation.	Understand
CLO 2	Describe various laser types (solid-state, gas, semiconductor, dye) and their characteristics.	Understand
CLO 3	Apply laser physics principles to calculate threshold conditions, gain, and coherence parameters.	Apply
CLO 4	Analyze laser beam propagation, Gaussian optics, laser-matter interaction, and nonlinear optical effects.	Analyze
CLO 5	Evaluate laser applications in holography, spectroscopy, communications, and medicine.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓				✓					✓	
CLO 2	✓	✓				✓					✓	
CLO 3	✓	✓				✓					✓	
CLO 4	✓	✓				✓					✓	
CLO 5	✓	✓				✓					✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Basics of Laser: Absorption, Spontaneous Emission and Stimulated Emission; Einstein A and B Coefficients; Population inversion and active medium; Pumping Schemes; Basic Laser Idea; Critical population inversion; Different types of lasers: i) Solid state lasers: Ruby and Nd:YAG, ii) Gas lasers: He-Ne and Ar ⁺ lasers.	7	CLO 1, CLO 3
2	Properties of Laser Beams and Coherence: Properties of laser beams, including monochromaticity, coherence, directionality, beam divergence, and brightness; comparison of laser and thermal light sources; fundamentals of spatial and temporal coherence, coherence length and coherence time, mutual coherence function, coherence measurement, and the relationship between coherence and monochromaticity.	7	CLO 1, CLO 3, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
3	Nonlinear Optics: Introduction to nonlinear optics; nonlinear optical response of materials; nonlinear polarization and optical susceptibility; second- and third-order nonlinear effects; second harmonic generation, sum- and difference-frequency generation, optical rectification, electro-optic and Kerr effects; self-focusing, self-phase modulation, four-wave mixing, optical solitons; nonlinear optical materials; and applications of nonlinear optics in lasers.	7	CLO 2, CLO 3
4	Continuous Wave Laser Behavior: Rate Equations of Four-Level Laser and Quasi-Three-Level Laser, Expression for B and γ , Limitation of Rate equation, Threshold Conditions and Output Power: Four-Level Laser, Threshold Condition and Output Power: Quasi-Three-Level Laser, slope efficiency, Optimum Output Coupling.	7	CLO 2, CLO 4
5	Transient Laser Behavior: Dynamical Instabilities and Pulsations in Lasers, Q-Switching: Dynamics of the Q-Switching Process, Methods of Q-Switching, Electro-Optical Q-Switching, Rotating Prisms, Acousto-Optic Q-Switches, Saturable-Absorber Q-Switch, Operating Regimes, Theory of Active Q-Switching, Gain Switching, Mode-Locking: Frequency-Domain Description, Time-Domain Picture, Methods of Mode-Locking: Active Mode-Locking, Passive Mode Locking, The Role of Cavity Dispersion in Femtosecond Mode-Locked Lasers: Phase-Velocity, Group-Velocity and Group-Delay-Dispersion, Limitation on Pulse Duration due to Group-Delay Dispersion	7	CLO 1, CLO 4, CLO 5
6	Fibre Optics: Basic Concept; principle of light propagation in Optical Fibers; Acceptance Angle; Core and cladding; Numerical Aperture; Fibre Bundles; Coherent and Incoherent bundles; Types of Fibre: Step Index Fibre; Graded Index Fibre; Multimode and Single Mode Fibre; Fibre Loss: dB/km; Communication Windows; Dispersion in Fibre; Modal Dispersion; Modal delay calculation; Material Dispersion; Waveguide Dispersion; Optical Fibre Communications; EDFA; WDM; DWDM.	7	CLO 2, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Svelto, O.	<i>Principles of Lasers</i>	Springer
Saleh, B. E. A. & Teich, M. C.	<i>Fundamentals of Photonics</i>	Wiley
Yariv, A.	<i>Optical Electronics</i>	Oxford University Press
Silfvast, W. T.	<i>Laser Fundamentals</i>	Cambridge University Press

0533 PHYS 3102: Physics Lab-3A

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides practical training in RC filter circuits, solid-state physics, and modern physics measurements. Students experimentally analyze the frequency response, cut-off frequency, and attenuation characteristics of low-pass, high-pass, band-pass, and twin-T notch filters, alongside determining the energy band gap of semiconductors and measuring the Planck constant using optoelectronic and photoelectric techniques.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To study the frequency response characteristics of an RC low-pass filter.	5	CLO 1, CLO 2
2	To study the frequency response characteristics of an RC high-pass filter.	5	CLO 1, CLO 2, CLO 3
3	To study the frequency response characteristics of an RC band-pass filter.	5	CLO 1, CLO 2, CLO 3
4	To study the frequency response characteristics of an RC twin-T filter.	5	CLO 2, CLO 3, CLO 4
5	To determine the energy band gap of a semiconductor.	5	CLO 3, CLO 4, CLO 5
6	To determine the Planck constant using an LED or photoelectric-effect setup.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Boylestad, R. L. & Nashelsky, L.	<i>Electronic Devices and Circuit Theory</i>	Pearson
Malvino, A. P.	<i>Electronic Principles</i>	McGraw-Hill

0533 PHYS 3103: Electrodynamics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers Maxwell's equations, gauge transformations, electromagnetic waves in media, waveguides, radiation from accelerated charges, and relativistic electrodynamics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain Maxwell's equations, gauge invariance, Poynting's theorem, wave propagation, and retarded potentials.	Understand

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 2	Describe EM wave propagation in conductors and dielectrics, waveguides, and Lienard-Wiechert potentials.	Understand
CLO 3	Apply vector field calculus and tensor formulations to solve electromagnetic boundary value problems.	Apply
CLO 4	Analyze radiation fields from electric and magnetic dipoles, accelerated charges, and relativistic transformations.	Analyze
CLO 5	Evaluate electromagnetic wave propagation and radiation patterns in guided and free-space systems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	✓
CLO 2	✓	✓									✓	✓
CLO 3	✓	✓									✓	✓
CLO 4	✓	✓									✓	✓
CLO 5	✓	✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Maxwell's field equation: Maxwell's Modification of Ampere's Law; Equation of Continuity; Maxwell's Equations in Vacuum and matter-integral and differential formulation; Scalar and Vector Potentials; Energy in electromagnetic fields; Poynting vector; Poynting's theorem and Wave Equations, Continuity equation, Poynting's Theorem, Newton's Third Law in Electrodynamics, Conservation of Momentum.	7	CLO 1, CLO 3
2	Propagation of Electromagnetic Waves: Propagation of EM Waves in free space, Propagation of EM wave in non-conducting isotopic Media: Conditions of Normal and Oblique Incidence for Reflection and Refraction of electromagnetic waves at a plane interface between dielectrics, Fresnel equations, Total Internal Reflection; Snell's Law and Brewster's Law. Waves in Conducting Media: Metallic Reflection; attenuation phenomena and skin depth.	10	CLO 1, CLO 3, CLO 4
3	Boundary Value Problems in Electrostatics: Poisson equations and Laplace equations. Uniqueness of the solution. Method of Image Charges. Solution of Laplace's equations in two and three dimensions in Cartesian, Cylindrical and Spherical coordinates with azimuthal symmetry. Multipole expansion of the potential due to a localized charge distribution: dipole and quadrupole moments. Field inside dielectrics, Boundary value problems involving dielectrics.	4	CLO 2, CLO 4, CLO 5

Sl.	Course Content / Module	Hrs.	CLO(s)
4	Radiation from an Accelerated Charge: Scalar and Vector Potentials, Fields in terms of potentials, Maxwell's equation in terms of potentials, Gauge transformation, Coulomb Gauge and Lorenz Gauge transformation, inhomogeneous wave equation for all transformation, Lorentz Force Law in Potential Form, Retarded time and Retarded Potentials, advanced time, and advanced potential, Jefimenko's Equations, Liénard-Wiechert Potentials for point source, the potentials of a point charge moving with constant velocity, Fields on moving point charge, Fields on a moving point charge, the electric and magnetic fields of a point charge moving with constant velocity, power radiated by the point source, Larmor formula, generalized Larmor formula, classical bremsstrahlung, Radiation, Electric dipole radiation: Poynting vector and radiated power for electric dipole radiation, Magnetic dipole radiation: Poynting vector and radiated power for magnetic dipole radiation, Radiation reaction and Abraham-Lorentz formula. Radiation damping.	12	CLO 2, CLO 4
5	Waveguide: Solution of the wave equation in a cylindrical and rectangular waveguide. TE, TM, and TEM modes and their differences. Cutoff frequencies, phase and group velocities in a waveguide.	9	CLO 1, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Griffiths, D. J.	<i>Introduction to Electrodynamics</i>	Pearson
Zangwill, A.	<i>Modern Electrodynamics</i>	Cambridge University Press
Purcell, E. M. & Morin, D. J.	<i>Electricity and Magnetism (Berkeley Vol. 2)</i>	Cambridge University Press
Jackson, J. D.	<i>Classical Electrodynamics</i>	Wiley

Author(s)	Book Title	Publisher / Ed.
Landau, L. D. & Lifshitz, E. M.	<i>The Classical Theory of Fields (Vol. 2) & Electrodynamics of Continuous Media (Vol. 8)</i>	Butterworth-Heinemann

0533 PHYS 3104: Physics Lab-3B**Credits: 1.5 | Practical****a. Rationale:**

This laboratory course provides practical training in analog electronics and linear integrated circuits. Students gain experimental experience in designing, assembling, and testing diode and transistor switching networks, basic operational amplifier configurations (inverting, non-inverting, and summing amplifiers using IC 741), astable pulse generation with IC 555 timers, and sinusoidal signal generation using Wien-bridge oscillators.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To design, construct, and test a diode and NPN transistor switching circuit.	5	CLO 1, CLO 2
2	To design, construct, and test an inverting amplifier using a 741 operational amplifier.	5	CLO 1, CLO 2, CLO 3
3	To design, construct, and test a non-inverting amplifier using a 741 operational amplifier.	5	CLO 1, CLO 2, CLO 3
4	To design, construct, and test a summing amplifier using a 741 operational amplifier.	5	CLO 2, CLO 3, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
5	To design, construct, and test an astable multivibrator using a 555 timer IC.	5	CLO 3, CLO 4, CLO 5
6	To design and study a Wien-bridge oscillator using an operational amplifier.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Melissinos, A. C.	<i>Experiments in Modern Physics</i>	Academic Press
Nelkon, M. & Ogborn, J. M.	<i>Advanced Level Practical Physics</i>	Heinemann

0533 PHYS 3105: Solid State Physics-I

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers crystal structures, X-ray diffraction, lattice vibrations, phonon dynamics, free electron Fermi gas, and band theory of solids.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain crystal lattices, Miller indices, reciprocal lattice, Bragg diffraction, phonons, and band structures.	Understand
CLO 2	Describe phonon heat capacity models (Einstein, Debye), Fermi-Dirac statistics, and electronic transport.	Understand
CLO 3	Apply solid state physics concepts to compute lattice parameter, Brillouin zones, density of states, and Fermi energy.	Apply
CLO 4	Analyze XRD patterns, electronic band gaps, effective mass, and transport properties of solids.	Analyze
CLO 5	Evaluate solid-state properties to classify materials as metals, semiconductors, and insulators.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓									✓	✓
CLO 2	✓	✓									✓	✓
CLO 3	✓	✓									✓	✓
CLO 4	✓	✓									✓	✓
CLO 5	✓	✓									✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Crystal Systems: Crystalline and Non-crystalline States; Unit Cell; Bravais Lattice; Miller Indices; Simple Crystal Structures; Packing Fraction; Inter-planar Spacing; Concept of Reciprocal Lattice; Bragg Diffraction in Reciprocal Lattice; Brillouin Zones.	9	CLO 1, CLO 3
2	Crystal Bindings: Crystals of Inert Gas; Ionic Crystals; Binding Energy; Covalent, Metal and Hydrogen Bonded Crystals.	8	CLO 1, CLO 3, CLO 4
3	Dynamics of Crystal Lattice: Concept of Phonon; Elastic Vibration of a Continuous Medium; Classical Dulong-Petit Law; One-dimensional Monatomic and Diatomic Lattices; Theories of Lattice Specific Heat–Einstein Model and Debye Model.	9	CLO 2, CLO 3, CLO 4
4	Free Electron Theory of Metals: Energy Levels and Density of States in One-dimension and Threedimensions; Electrical Conductivity and Ohm's Law; Thermal Conductivity of Metals; Wiedemann-Franz Law.	8	CLO 1, CLO 4, CLO 5
5	Imperfections in Crystals: Classification of Defects; Point Defects; Dislocations; Screw and Edge Dislocations; Plane Defects; Crystal Grains and Grain Boundaries; Colour of Crystals; Excitons; Photoconductivity.	8	CLO 2, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Kittel, C.	<i>Introduction to Solid State Physics</i>	Wiley
Ashcroft, N. W. & Mermin, N. D.	<i>Solid State Physics</i>	Harcourt
Omar, M. A.	<i>Elementary Solid State Physics: Principles and Applications</i>	Addison-Wesley
Dekker, A. J.	<i>Solid State Physics</i>	Prentice-Hall
Kantorovich, L.	<i>Quantum Theory of the Solid State: An Introduction</i>	Springer

0533 PHYS 3107: Quantum Mechanics-I**Credits: 3.0 | Theory (Core)****a. Rationale:**

This course introduces wave-particle duality, Schrödinger equation, 1D potential problems, the quantum harmonic oscillator, angular momentum, and the hydrogen atom.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain wave function, probability density, Hermitian operators, commutation relations, and uncertainty principle.	Understand
CLO 2	Describe time-independent Schrödinger equation, potential steps, barriers, wells, and harmonic oscillator.	Understand
CLO 3	Apply operator algebra and differential equations to calculate eigenvalues and eigenfunctions.	Apply
CLO 4	Analyze quantum tunneling, bound state energies, and hydrogen atom radial probability distributions.	Analyze
CLO 5	Evaluate quantum physical systems and compare quantum predictions with classical mechanics.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓					✓	✓	
CLO 2	✓	✓			✓					✓	✓	
CLO 3	✓	✓			✓					✓	✓	
CLO 4	✓	✓			✓					✓	✓	
CLO 5	✓	✓			✓					✓	✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Physical Foundations of Quantum Mechanics: Failures of classical physics; Bohr atom and old quantum theory; Domain of quantum mechanics; Blackbody radiation; Photoelectric effect; Compton effect; Atomic spectra; Wave-particle duality; de Broglie hypothesis; Wave packets; Complementarity; Heisenberg uncertainty principle.	6	CLO 1, CLO 3
2	Schrödinger Equation and Wave Function: Wave equation; Development of Schrödinger equation; Wave function and probability interpretation; Normalization; Probability density; Linearity and superposition principle; Time-dependent Schrödinger equation; Conservation of probability; Probability current density; Time-independent Schrödinger equation; Stationary states; Energy quantization; Time evolution of expectation values; Ehrenfest theorem.	8	CLO 1, CLO 3, CLO 4
3	Postulates of Quantum Mechanics and Operators: Postulates of quantum mechanics; Observables; Operators; Construction of position, momentum, kinetic energy, and Hamiltonian operators; Eigenvalue equation; Eigenfunctions and eigenvalues; Orthogonality and completeness; Expectation values; Hermitian operators; Parity operator; Commutation relations; Compatible observables; General uncertainty relation; Hilbert space.	10	CLO 2, CLO 3, CLO 4
4	One-Dimensional Quantum Systems and Harmonic Oscillator: Free particle; Particle in one-dimensional box; Particle in three-dimensional box; Potential step; Potential barrier; Reflection and transmission coefficients; Quantum tunneling; Infinite potential well; Finite square well; Classical harmonic oscillator; Schrödinger equation for one-dimensional harmonic oscillator; Zero-point energy.	9	CLO 2, CLO 4
5	Central Potentials and Hydrogen Atom: Central potential; Schrödinger equation in spherical polar coordinates; Separation of variables; Orbital angular momentum operators; Quantum numbers (n, l, m); Radial wave functions; Ladder operators; Spherical harmonics; Radial equation; Hydrogen atom energy levels; Schrodinger's equation for the Hydrogen atom in spherical coordinates and its solution.	9	CLO 1, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Griffiths, D. J.	<i>Introduction to Quantum Mechanics</i>	Pearson
Zettili, N.	<i>Quantum Mechanics: Concepts and Applications</i>	Wiley
Shankar, R.	<i>Principles of Quantum Mechanics</i>	Springer
Cohen-Tannoudji, C., Diu, B. & Laloë, F.	<i>Quantum Mechanics (Vol. 1 & 2)</i>	Wiley-VCH
Sakurai, J. J. & Napolitano, J.	<i>Modern Quantum Mechanics</i>	Cambridge University Press

0533 PHYS 3109: Statistical Mechanics

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers the statistical basis of thermodynamics, microcanonical, canonical, and grand canonical ensembles, Bose-Einstein and Fermi-Dirac statistics, and phase transitions.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the statistical basis of thermodynamics, ensembles, partition functions, and entropy.	Understand
CLO 2	Describe Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distribution functions and their applications.	Understand
CLO 3	Apply partition function formalism to calculate thermodynamic properties of ideal gases and quantum systems.	Apply
CLO 4	Analyze Bose-Einstein condensation, photon gas, free electron gas, and phase transitions.	Analyze
CLO 5	Evaluate statistical mechanical models for predicting macroscopic properties of physical systems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓					✓	✓	
CLO 2	✓	✓			✓					✓	✓	
CLO 3	✓	✓			✓					✓	✓	
CLO 4	✓	✓			✓					✓	✓	
CLO 5	✓	✓			✓					✓	✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Classical Statistical Mechanics: The scope of statistical physics; Assemblies; Phase Space and Phase Trajectory; Volume in Phase Space; Specification of States of a System; Density of States and its General Behavior; Liouville's theorem and its Consequences; The Postulates of Classical Statistical Mechanics; Stirling Approximation; Thermodynamic Probability; Statistical Equilibrium; Macrostates and Microstates.	08	CLO 1, CLO 3
2	Statistics and Thermodynamics: Probability and thermal probability, Statistical concept of Temperature; Ensembles: Microcanonical Ensemble, Canonical Ensemble-its Connection with thermodynamic parameters and grandcanonical ensemble; Entropy, Free energy and other thermodynamic functions and their equilibrium conditions; Statistical Distribution Function; The Boltzmann partition function; The evaluation of the classical partition function; The semi-classical perfect gas components of the partition function; Maxwell velocity distribution and mean values; Maxwell-Boltzmann Statistics and its Applications; Ideal monatomic gas; Harmonic oscillator; Specific heat of solids.	12	CLO 1, CLO 3, CLO 4
3	Quantum Statistical Mechanics: Postulates of Quantum Statistical Mechanics; Transition from Classical to Quantum Statistical Mechanics; Particle Statistics: Principle of indistinguishability for quantum particles, Spin-statistics connection, Exchange degeneracy; Average value and Quantum Statistics; The Density Matrix; Statistics of various Ensembles.	6	CLO 2, CLO 3
4	Fermi Systems: Fermi-Dirac distribution function; Fermi-Dirac gas; Fermi Energy; Fermi Temperature; Fermi Velocity and Mean Velocity of a free electron in a Metal; Degenerate Fermi systems; Landau Diamagnetism; Pauli Paramagnetism; Thermionic Emission; Statistical equilibrium.	4	CLO 2, CLO 4, CLO 5
5	Bose Systems: Bose-Einstein distribution function and its application; Planck's radiation law; The Photon Gas; The Specific heat of Solids; The Phonon gas; Bose-Einstein Condensation; Superfluidity in Liquid He; Thermodynamics of Bose systems; Thermodynamic Properties of Diatomic Molecules; Nuclear Spin Effects in Diatomic Molecules.	4	CLO 1, CLO 4, CLO 5
6	Radiation: Thermal radiation and its properties, emissive power, absorptive power, energy density, black body (Ferry and Wien's), black body radiation, Kirchhoff's law, Diffuse radiation and radiation pressure, Stefan-Boltzmann law, Wien's law, Rayleigh Jean's law and Planck's law.	8	CLO 1, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Reif, F.	<i>Fundamentals of Statistical and Thermal Physics</i>	McGraw-Hill
Landau, L. D. & Lifshitz, E. M.	<i>Statistical Physics (Part 1, Course of Theoretical Physics Vol. 5)</i>	Butterworth-Heinemann / Pergamon
Kittel, C. & Kroemer, H.	<i>Thermal Physics</i>	W. H. Freeman

0533 PHYS 3106: Viva-voce

Credits: 1.0 | Oral Examination

a. Rationale:

The comprehensive viva-voce examination evaluates students' conceptual understanding, critical thinking, communication skills, and problem-solving ability across all courses offered in Year III – Term I.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Recall and explain fundamental concepts across all courses offered in Year III – Term I.	Remember
CLO 2	Apply critical reasoning to answer spontaneous scientific and analytical questions.	Apply
CLO 3	Communicate physics concepts clearly and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		
CLO 3						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theory and practical courses of Year III – Term I.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion	Viva-voce oral examination
CLO 2	Q&A practice, tutorial discussion	Viva-voce oral examination
CLO 3	Presentation and oral response practice	Viva-voce oral examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Standard textbooks of the term courses	—	—

Year III – Term II

0533 PHYS 3201: Nuclear Physics-I

Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers nuclear properties, binding energy, radioactivity, alpha/beta/gamma decay, nuclear reactions, and radiation detection principles.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain static properties of the nucleus, liquid drop model, semi-empirical mass formula, and radioactive decay laws.	Understand
CLO 2	Describe alpha, beta, and gamma decay mechanisms, nuclear fission, fusion, and detector operating principles.	Understand
CLO 3	Apply Q-value equations and decay laws to evaluate nuclear stability and reaction energetics.	Apply
CLO 4	Analyze nuclear decay schemes, Kurie plots, gamma multipoles, and detector pulse signals.	Analyze
CLO 5	Evaluate nuclear radiation detection setups and radioisotope applications in industry and medicine.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓						✓	
CLO 2	✓	✓			✓						✓	
CLO 3	✓	✓			✓						✓	
CLO 4	✓	✓			✓						✓	
CLO 5	✓	✓			✓						✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Nuclear Properties: Measurements of Nuclear Mass; Radius and Density of Nucleus; Mirror Nuclei; Mass Defect; Binding Energy; Nucleon Separation Energy; Semi-empirical Mass Formula; Angular Momentum: Spin, Parity and Symmetry; Nuclear Forces; Liquid Drop Model and Shell Model.	9	CLO 1, CLO 3
2	Radioactivity: Radioactive Decay Laws, Half Life and Mean Life; Radioactive Equilibrium; Radioactive Series; Artificial Radioactivity; Uses of Radioisotopes.	8	CLO 1, CLO 2, CLO 3
3	Alpha, Beta and Gamma Emission: Theory of Alpha Decay; Beta Decay and Its Energy Measurement; Conservation of Energy and Momentum in Beta Decays; Neutrino Hypothesis; Orbital Electron Capture; Positron Emission; Gamma Decay; Mean Lives for Gamma Emission; Internal Conversion.	10	CLO 2, CLO 4
4	Nuclear Reaction: Different Types of Reactions; The Q-value of Nuclear Reactions; Crosssection; Compound Nucleus Hypothesis; Nuclear Fission and Fusion; Fission Process; Energy Release in Fission; Chain Reaction; Nuclear Fusion.	8	CLO 2, CLO 3, CLO 4
5	Nuclear Detectors and Particle Accelerators: Ionization Chambers; Proportional Counter; Geiger-Muller Counters; Linear Accelerator; Betatron; Cyclotron; Synchrotron; Large Hadron Collider (LHC).	7	CLO 1, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Krane, K. S.	<i>Introductory Nuclear Physics</i>	Wiley
Martin, B. R.	<i>Nuclear and Particle Physics</i>	Wiley

0533 PHYS 3202: Physics Lab-3C

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides hands-on training in advanced operational amplifier applications and non-linear signal processing. Students design, build, and evaluate differential amplifiers, active differentiators, integrators, relaxation waveform generators, Schmitt triggers, and zero-crossing detectors using operational amplifier integrated circuits.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To design, construct, and test a differential amplifier using a 741 operational amplifier.	5	CLO 1, CLO 2
2	To design, construct, and test a differentiator using a 741 operational amplifier.	5	CLO 1, CLO 2, CLO 3
3	To design, construct, and test an integrator using a 741 operational amplifier.	5	CLO 1, CLO 2, CLO 3
4	To design, construct, and test a relaxation oscillator using a 741 operational amplifier.	5	CLO 2, CLO 3, CLO 4
5	To design, construct, and test a Schmitt trigger using an operational amplifier.	5	CLO 3, CLO 4, CLO 5
6	To design, construct, and test a zero-crossing detector using an operational amplifier.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Boylestad, R. L.	<i>Electronic Devices and Circuit Theory</i>	Pearson
Gayakwad, R. A.	<i>Op-Amps and Linear Integrated Circuits</i>	Pearson

0533 PHYS 3203: Electronic Devices and Circuits

Credits: 3.0 | Theory (Core)

a. Rationale:

This course is designed to understand the construction, working and uses of unipolar and bipolar devices, Oscillator, Operational amplifier and pnpn devices. Introduce the behavior of insulators, semiconductors, and conductors based on band theory. Explain the working principle of different kinds of diodes and analyze their applications in rectifier, clipper, clamper, regulator, etc. Familiarize with the characteristics of BJT, JFET, NMOS, PMOS, and CMOS and perform their operation under different configurations. Give an idea how to analyze various amplifier circuits using different models and use them.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain multi-stage amplifiers, feedback principles, oscillator criteria, and Op-Amp linear/non-linear applications.	Understand
CLO 2	Describe frequency response curves, Barkhausen criterion, active filter designs, and power electronics devices.	Understand
CLO 3	Apply small-signal models, gain formulas, and feedback equations to design amplifier circuits.	Apply
CLO 4	Analyze amplifier bandwidth, distortion, phase margin, Op-Amp active filters, and converter circuits.	Analyze
CLO 5	Evaluate electronic system stability and design custom analog signal processing networks.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓		✓						✓	✓	
CLO 2	✓	✓		✓						✓	✓	

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 3	✓	✓		✓						✓	✓	
CLO 4	✓	✓		✓						✓	✓	
CLO 5	✓	✓		✓						✓	✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Semiconductor and PN junction: Classification of different materials with respect to their resistivity, conductivity and band structure properties. The intrinsic and extrinsic semiconductor with atomic structures. The comparison among different carrier actions of drift, diffusion, generation and recombination. The p-n junction, formation of depletion region. The biasing circuits of NPN and PNP transistors. The NPN transistor be worked as ON and OFF switches. Construction of the JFET, nMOS, pMOS and CMOS structures and various applications using CMOS gates. Design the clipping and clamping circuits using diodes.	4	CLO 1, CLO 3
2	Principle of bipolar transistor: Junction transistor, npn and pnp transistors, principle of transistor action, potential distribution through a transistor, transistor current components, emitter efficiency. Transistor as an amplifier, transistor I-V characteristics in CB, CE and CC configurations of NPN and PNP.	8	CLO 1, CLO 3, CLO 4
3	DC Biasing and Load line: The operating point, capacitive coupling, the static and dynamic load lines, bias stability, thermal stability. Analyzing of different types biasing circuit. Transistor as an amplifier: Classification of amplifier, BJT small signal amplifier circuit analysis in three configurations using different biasing circuit. Push-pull amplifier.	10	CLO 2, CLO 3, CLO 4
4	BJT AC analysis and Transistor model: BJT transistor modeling, the re transistor model, the hybrid equivalent model.	6	CLO 2, CLO 4
5	Operational amplifier: The characteristics of ideal Op-Amp, basics of operational amplifier, classification of Op-Amp, Basic differential amplifier, differential amplifier circuits, differential amplifier with current mirror and active load. Study of Op-Amp parameters, Analysis of Op-Amp circuits, active filters, voltage regulation.	8	CLO 1, CLO 4, CLO 5
6	Field effect transistor: JFET: construction, operation, static characteristics, small signal model and parameters. MOSFET: MOSFET: different types, operation, characteristics curves. DC biasing of depletion type and enhancement type MOSFET.	6	CLO 2, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Millman, J. & Halkias, C. C.	<i>Electronic Devices and Circuits</i>	McGraw-Hill
Boylestad, R. L.	<i>Electronic Devices and Circuit Theory</i>	Prentice Hall
Malvino, A. P.	<i>Electronic Principles</i>	Career Education / McGraw-Hill
Gayakwad, R. A.	<i>Op-Amps and Linear Integrated Circuits</i>	Pearson

0533 PHYS 3204: Physics Lab-3D

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides practical training in wave-shaping circuitry, clipping networks, and pulse-generation architectures. Students gain experimental proficiency in designing and testing op-amp sine-to-square converters, square-to-triangular converters, unbiased and biased diode clipping circuits, and timing multivibrators (monostable and bistable modes) utilizing IC 555 timers.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate laboratory apparatus and experimental setups safely and accurately.	Precision
CLO 2	Perform measurements, calibrations, and experimental data acquisition.	Articulation
CLO 3	Analyze experimental data using statistical methods and graphical techniques.	Analyze
CLO 4	Prepare scientific laboratory reports following standard technical writing guidelines.	Value
CLO 5	Demonstrate teamwork, collaborative problem-solving, and safety compliance in the laboratory.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To design, construct, and test a sine-wave to square-wave converter using an operational amplifier.	5	CLO 1, CLO 2
2	To design, construct, and test a square-wave to triangular-wave converter using an operational amplifier.	5	CLO 1, CLO 2, CLO 3
3	To design, construct, and test a diode clipper circuit.	5	CLO 1, CLO 2, CLO 3
4	To design, construct, and test a biased diode clipper circuit.	5	CLO 2, CLO 3, CLO 4
5	To design, construct, and test a monostable multivibrator using a 555 timer IC.	5	CLO 3, CLO 4, CLO 5
6	To design, construct, and test a bistable multivibrator using a 555 timer IC.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Hands-on experiments, instrument demonstration	Practical performance, lab observation
CLO 2	Guided measurement, laboratory supervision	Data sheets, practical examination
CLO 3	Data processing tutorials, graph analysis	Lab reports, assignment, quizzes
CLO 4	Scientific report drafting, oral examination	Lab reports, oral viva voce
CLO 5	Group laboratory sessions, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G. & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Malvino, A. P. & Leach, D. P.	<i>Digital Principles and Applications</i>	McGraw-Hill
Gayakwad, R. A.	<i>Op-Amps and Linear Integrated Circuits</i>	Pearson

0533 PHYS 3205: Computational Physics

Credits: 2.0 | Theory (Core)

a. Rationale:

This course introduces computational methods in physics: numerical algorithms, root-finding, ODE integration, Monte Carlo methods, and physics simulation programming.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain numerical methods for root-finding, integration, differentiation, and ODE solving used in physics.	Understand
CLO 2	Describe Monte Carlo methods, random number generation, and their physical applications.	Understand
CLO 3	Apply numerical algorithms to solve physics differential equations and compute physical observables.	Apply
CLO 4	Analyze numerical errors, stability, convergence, and accuracy of computational physics algorithms.	Analyze
CLO 5	Evaluate and implement physics simulations for classical mechanics, quantum, and statistical problems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1		✓		✓	✓				✓		✓	
CLO 2		✓		✓	✓				✓		✓	
CLO 3		✓		✓	✓				✓		✓	
CLO 4		✓		✓	✓				✓		✓	
CLO 5		✓		✓	✓				✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	C++ Programming Concepts: Role of programming in physics and scientific computing; Basic syntax: variables, data types, input/output; Conditional statements: if, if-else, switch; Operators; Looping constructs: for, while, do-while, Nested loops; Functions: Function declaration and definition, calling, arguments, return types, Recursive functions, and Applications: numerical formulas (e.g., projectile motion, factorial, power series); Scope of variables and basics of recursion; 1D and 2D arrays; Matrix representation and basic matrix operations; File input and output using fstream; Standard libraries: <cmath>, <cstdlib>, <iomanip>; Reading and writing numerical data; Handling large experimental datasets; Output formatting for data analysis and plotting; Interfacing C++ programs with plotting tools (e.g., GNUplot).	8	CLO 1, CLO 3
2	Root Finding: Bisection method; Newton-Raphson method; Secant method; Convergence criteria and error analysis.	4	CLO 1, CLO 3, CLO 4
3	Numerical Differentiation: Finite difference methods: Forward difference, Backward difference, Central difference method; First order and 2nd order differentiation; Two-point, three-point, and five-point formulas.	4	CLO 1, CLO 3, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
4	Numerical Integration: Newton-Cotes methods: Constant rule, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule; Romberg integration; Monte Carlo integration.	4	CLO 2, CLO 3, CLO 4
5	Solution of Ordinary Differential Equations (ODEs) with Initial Values: Euler method; Runge-Kutta method; Verlet method; Application to oscillatory systems and central force motion.	4	CLO 3, CLO 4, CLO 5
6	Generation of Random Numbers & Monte Carlo: Linear Congruential Generator (LCG); Generation of non-uniform random numbers; Monte Carlo methods and applications in physical simulations.	4	CLO 2, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Newman, M.	<i>Computational Physics</i>	CreateSpace
Thijssen, J. M.	<i>Computational Physics</i>	Cambridge University Press
Landau, R. H., Páez, M. J. & Bordeianu, C. C.	<i>Computational Physics: Problem Solving with Python</i>	Wiley-VCH
Press, W. H. et al.	<i>Numerical Recipes: The Art of Scientific Computing</i>	Cambridge University Press
Giordano, N. J. & Nakanishi, H.	<i>Computational Physics</i>	Pearson Prentice Hall
Pang, T.	<i>An Introduction to Computational Physics</i>	Cambridge University Press
Koonin, S. E. & Meredith, D. C.	<i>Computational Physics: Fortran Version</i>	CRC Press / Westview

0533 PHYS 3206: Computational Physics Lab

Credits: 1.0 | Practical

a. Rationale:

This laboratory course provides hands-on experience implementing numerical algorithms and simulating physical systems using Python/C++.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Implement root-finding and interpolation algorithms (Bisection, Newton-Raphson) using Python or C++.	Apply
CLO 2	Apply numerical integration rules (Trapezoidal, Simpson's) to compute physics integrals.	Apply
CLO 3	Solve ordinary differential equations (Euler, RK4) for harmonic oscillator and orbital mechanics.	Apply
CLO 4	Perform matrix operations, eigenvalue calculations, and solve linear systems for physics problems.	Apply
CLO 5	Run Monte Carlo simulation for random walk, pi estimation, and Ising model.	Apply

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓				✓		✓	
CLO 2			✓	✓	✓				✓		✓	
CLO 3			✓	✓	✓				✓		✓	
CLO 4			✓	✓	✓				✓		✓	
CLO 5			✓	✓	✓				✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Root-finding algorithms: Bisection, Newton-Raphson, secant methods – implementation and testing.	5	CLO 1
2	Numerical integration: Trapezoidal, Simpson's 1/3, 3/8 rules – comparison of accuracy.	5	CLO 2
3	ODE solvers: Euler and RK4 for SHM and projectile motion – step-size analysis.	5	CLO 3
4	Matrix operations: Gauss elimination, eigenvalue problems, solution of physics linear systems.	5	CLO 4
5	Monte Carlo simulation: Random walk, pi estimation by MC integration, Ising model basic simulation.	5	CLO 5
6	Project: Computational physics mini-project and report submission.	5	CLO 1, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Supervised programming lab, algorithm walkthroughs	Programming assignments, lab report
CLO 2	Supervised programming lab	Programming assignments, lab report
CLO 3	Supervised programming lab, simulation demos	Programming assignments, lab report
CLO 4	Supervised programming lab	Programming assignments, quiz
CLO 5	Project-based learning, simulation exercise	Mini-project report and presentation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Newman, M.	<i>Computational Physics</i>	CreateSpace
Landau, R. H., Páez, M. J. & Bordeianu, C. C.	<i>Computational Physics: Problem Solving with Python</i>	Wiley-VCH
Press, W. H. et al.	<i>Numerical Recipes: The Art of Scientific Computing</i>	Cambridge University Press
Kinder, J. M. & Nelson, P.	<i>A Student's Guide to Python for Physical Modeling</i>	Princeton University Press
Langtangen, H. P.	<i>A Primer on Scientific Programming with Python</i>	Springer

0533 PHYS 3207: Introduction to Astrophysics

Credits: 3.0 | Theory (Elective)

a. Rationale:

This course introduces stellar structure, stellar evolution, nucleosynthesis, galaxy formation, and cosmology including the Big Bang model.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain stellar structure, energy generation, stellar evolution, and end states (white dwarfs, neutron stars, black holes).	Understand
CLO 2	Describe galaxy types, formation, active galactic nuclei, and large-scale structure of the universe.	Understand
CLO 3	Apply physics principles to calculate stellar luminosity, temperature, mass-luminosity relations, and cosmological parameters.	Apply
CLO 4	Analyze HR diagrams, stellar spectra, nucleosynthesis pathways, and cosmic microwave background data.	Analyze
CLO 5	Evaluate observational evidence for dark matter, dark energy, and Big Bang cosmology.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓					✓	✓	
CLO 2	✓	✓			✓					✓	✓	
CLO 3	✓	✓			✓					✓	✓	
CLO 4	✓	✓			✓					✓	✓	
CLO 5	✓	✓			✓					✓	✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Fundamentals of Astronomy and Celestial Mechanics: Greek Tradition; Copernican Revolution; Modern Astronomy; Rough Scales of the Universe; Contents of the Universe; Celestial Sphere; Astronomical Coordinate Systems; Positions on the Celestial Sphere; Elliptical Orbits; Basic Laws of Celestial Mechanics.	7	CLO 1, CLO 3
2	The Solar System: Surveying the Solar System; Structure of the Solar System; Physical Processes in the Solar System; The Terrestrial Planets; The Giant Planets; Comets; Asteroids; Meteorites; Origin of the Solar System.	7	CLO 1, CLO 3, CLO 4
3	The Sun and Planetary Systems: The Sun as a Star; Interior Structure of the Sun; Source of Solar Energy; Solar Atmosphere; Solar Activity and Solar Cycle; Physics of Stellar Atmospheres; Extrasolar Planetary Systems; Methods of Exoplanet Detection; Formation and Evolution of Planetary Systems.	7	CLO 2, CLO 3
4	Stellar Structure and Evolution: Properties of Stars; Stellar Clusters; Interstellar Medium; Star Formation; Pre-Main-Sequence Evolution; Main Sequence Evolution; Post-Main-Sequence Evolution; White Dwarfs; Degenerate Matter; Chandrasekhar Limit; Massive Star Evolution; Supernovae; Neutron Stars; Pulsars; Gamma-Ray Bursts; Final End States of Stars.	7	CLO 1, CLO 4
5	The Milky Way and Galaxies: Structure of the Milky Way; Spiral Structure; Density Wave Theory; Cosmic Rays; Formation and Classification of Galaxies; Active Galaxies; Peculiar Galaxies; Quasars; Clusters of Galaxies; Large-Scale Structure of the Universe.	7	CLO 2, CLO 4
6	Cosmology: Red Shift; Hubble's Law; Expansion of the Universe; Age of the Universe; Static Cosmological Models; Expanding Models; Big Bang Theory; Early Universe; Cosmology and Particle Physics; Dark Matter and Dark Energy (introductory concepts); Life and Intelligence in the Universe.	7	CLO 1, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Carroll, B. W. & Ostlie, D. A.	<i>An Introduction to Modern Astrophysics</i>	Cambridge University Press / Pearson
Ryden, B.	<i>Introduction to Cosmology</i>	Cambridge University Press
Choudhuri, A. R.	<i>Astrophysics for Physicists</i>	Cambridge University Press
Karttunen, H. et al.	<i>Fundamental Astronomy</i>	Springer
Maoz, D.	<i>Astrophysics in a Nutshell</i>	Princeton University Press
Kippenhahn, R., Weigert, A. & Weiss, A.	<i>Stellar Structure and Evolution</i>	Springer
Padmanabhan, T.	<i>Theoretical Astrophysics (Vol. 1–3)</i>	Cambridge University Press

0533 PHYS 3209: Geophysics**Credits: 3.0 | Theory (Elective)****a. Rationale:**

This course introduces the physics of the Earth including seismology, geomagnetism, gravity, heat flow, plate tectonics, and remote sensing methods.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain Earth's internal structure, seismic wave propagation, geomagnetism, and gravitational field.	Understand
CLO 2	Describe plate tectonics, earthquake mechanics, geophysical exploration methods, and heat flow.	Understand
CLO 3	Apply seismic, magnetic, and gravitational data analysis to determine subsurface properties.	Apply
CLO 4	Analyze travel-time curves, magnetic anomalies, and gravity data to interpret geological structures.	Analyze
CLO 5	Evaluate geophysical exploration methods for hydrocarbon, mineral, and groundwater resource assessment.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓						✓	✓
CLO 2	✓	✓			✓						✓	✓
CLO 3	✓	✓			✓						✓	✓
CLO 4	✓	✓			✓						✓	✓
CLO 5	✓	✓			✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	The Solar System: Solar System Formation, Accretion, and the Early Thermal State of the Earth; The Sun; The planets; Meteorites and their composition; Cosmic ray exposures of meteorites; The pointing-Robertson effect; Compositions of terrestrial planets; One-dimensional Earth's Structure; Lateral Heterogeneity in the Mantle.	6	CLO 1, CLO 3
2	Rotation and Figure of the Earth: Figure of the earth; Precession of the equinoxes; The Chandler wobble; Tidal friction and the history of the earth-moon system; Fluctuation in rotation and the excitation of the wobble.	6	CLO 1, CLO 2
3	The Earth's Gravitational Field: Gravity as a Gradient of the geopotential; The satellite geoid; Crustal structure and the principle of isostasy; Earth tides; Cartesian and Spherical Coordinate Systems; Spherical Harmonics; Global Gravity Anomalies; Correlation between Gravity Anomalies and Topography.	6	CLO 3, CLO 4
4	Seismology and The Internal Structure of The Earth: Seismicity of the earth; Elastic waves and seismic rays; Wave Equation; P and S-waves; Surface Waves; Travel time and velocity depth curves for body waves; internal density and composition; free oscillation.	6	CLO 2, CLO 4
5	Geomagnetism: The magnetism of the earth; Fundamental equations; Magnetic Cleaning Procedures; Measurement of the magnetic field; Method of Gauss; Saturation induction magnetometer; Proton precession magnetometer; Alkali vapour magnetometer.	6	CLO 1, CLO 3
6	Geodynamics (The Earth's Internal Heat): Heat Flow, Geothermal Gradient, Diffusion, Thermal Structure of the Oceanic Lithosphere, Bending, or Flexure, of Thin Elastic Plate; The Upper Mantle Transition Zone; The geothermal flux; Thermal conduction in the mantle; Temperatures in the interior of the earth; Energy source for the geomagnetic dynamo.	7	CLO 2, CLO 4, CLO 5
7	Radioactivity and The Age of The Earth: The pre-radioactivity age problem; radioactive elements and the principle of radiometric dating; Age of the earth and meteorites; Dating the nuclear synthesis.	5	CLO 3, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual demonstrations, multimedia presentations	Quiz, class test, midterm, final examination
CLO 2	Lectures, tutorial sessions, problem-solving classes, group discussion	Class test, assignments, midterm, final examination
CLO 3	Problem-based learning, numerical exercises, tutorial sessions	Homework, assignments, quizzes, midterm, final examination
CLO 4	Case studies, application-oriented discussions, collaborative learning	Assignment, presentation, final examination
CLO 5	Seminars, research discussion, peer learning	Term paper, presentation, final examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Telford, W. M. et al.	<i>Applied Geophysics</i>	Cambridge
Lowrie, W.	<i>Fundamentals of Geophysics</i>	Cambridge

0533 PHYS 3208: Viva-voce

Credits: 1.0 | Oral Examination

a. Rationale:

The comprehensive viva-voce examination evaluates students' conceptual understanding, critical thinking, communication skills, and problem-solving ability across all courses offered in Year III – Term II.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Recall and explain fundamental concepts across all courses offered in Year III – Term II.	Remember
CLO 2	Apply critical reasoning to answer spontaneous scientific and analytical questions.	Apply
CLO 3	Communicate physics concepts clearly and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓		
CLO 2						✓	✓	✓	✓	✓		
CLO 3						✓	✓	✓	✓	✓		

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theory and practical courses of Year III – Term II.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion	Viva-voce oral examination
CLO 2	Q&A practice, tutorial discussion	Viva-voce oral examination
CLO 3	Presentation and oral response practice	Viva-voce oral examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Standard textbooks of the term courses	—	—

3.4 Fourth Year – Course Descriptions

Year IV – Term I

0533 PHYS 4101: Nuclear Physics-II

Credits: 3.0 | Theory (Core)

a. Rationale:

This course provides an in-depth understanding of advanced nuclear models, nuclear reactions, nuclear forces, fission and fusion processes, decay mechanisms, and elementary particle physics required for advanced nuclear research.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental concepts of nuclear forces, deuteron ground state, nuclear potentials, and elementary particle classifications.	Understand
CLO 2	Describe mechanisms of two-body scattering, electromagnetic transitions, reaction kinetics, and particle interactions.	Understand
CLO 3	Apply mathematical models (effective range theory, Breit-Wigner formula, deuteron wave functions) to evaluate nuclear properties.	Apply
CLO 4	Analyze cross-sections, phase shifts, selection rules in multipole radiative transitions, and optical models.	Analyze
CLO 5	Evaluate elementary particle symmetries, conservation laws, Gell-Mann-Nishijima formula, and quark models.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓						✓	✓
CLO 2	✓	✓			✓						✓	✓
CLO 3	✓	✓			✓						✓	✓
CLO 4	✓	✓			✓						✓	✓
CLO 5	✓	✓			✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	The Deuteron Problem: Ground state of the deuteron; Excited state of the deuteron; Electric quadrupole moment and deuteron wave function; Radius of deuteron. Photodisintegration.	6	CLO 1, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
2	Two Body Problems: Neutron-proton scattering at low energy; Spin dependence of neutron-proton scattering; Phase shift; Scattering lengths; Effective range theory in n-p scattering; Neutron-proton scattering at intermediate and high energies; Coherent and incoherent scattering at low energy neutrons; Ortho- and para-hydrogen.	7	CLO 2, CLO 3
3	Nuclear Force: General properties and characteristics; Symmetries in nuclear physics; From quarks to pions and nucleons; Exchange of virtual particles; Exchange forces; Yukawa potential; Meson theory of nuclear forces.	6	CLO 1, CLO 2
4	Interaction of Nuclei with Electromagnetic Radiation: Introduction; Multiple radiation and selection rules; Probability of multiple emission and absorption; Radiative transition in the two body problem; Internal conversion; Transition between two low-lying states of nuclei; Transition involving highly excited states.	6	CLO 2, CLO 4
5	Nuclear Structure Models: (a) Nuclear Shell Model: Independent particle shell model; Fermi gas model; Single particle potentials; Spin-orbit interaction & potential; Magic numbers; Shell model predictions; Ground state spins; Spin and magnetic moments of nuclei; Schmidt curves. (b) Collective Phenomena in nuclei: Fermi gas; Mean field; Deformation; Vibrational and rotational motion; Super and hyper deformation.	8	CLO 1, CLO 4
6	Nuclear Scattering and Reactions – Optical Model: Complex Potential; Nuclear reaction cross-section; Energy Averaged Cross-sections; Phenomenological Optical Model Cross-sections by the Method of Partial Waves; Elastic and inelastic processes; Direct and compound-nuclear mechanisms; Continuum Theory; Resonance; Breit-Wigner dispersion formula for an s-state.	6	CLO 3, CLO 4
7	Elementary Particles: Classification of elementary particles; Fundamental interactions and conservation laws; Isospin, strangeness, hypercharge, parity, Gell-Mann-Nishijima formula; Quark model.	3	CLO 1, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Lectures, multimedia presentations, conceptual Q&A	Class Tests, Quizzes, Final Examination
CLO 2	Interactive lectures, problem-solving tutorials	Class Tests, Assignment, Final Examination
CLO 3	Guided mathematical derivations, group discussions	Assignments, Mid-term / Class Tests, Final Examination
CLO 4	Case study discussions, numerical problem sessions	Assignments, Class Tests, Final Examination
CLO 5	Literature review seminars, problem-based learning	Presentation, Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Martin, B. R.	<i>Nuclear and Particle Physics: An Introduction</i>	Wiley (2nd Ed.)
Krane, K. S.	<i>Introductory Nuclear Physics</i>	Wiley
Wong, S. S. M.	<i>Introductory Nuclear Physics</i>	Wiley
Bertulani, C.	<i>Nuclear Physics in a Nutshell</i>	Princeton University Press
Williams, W. S. C.	<i>Nuclear and Particle Physics</i>	Clarendon Press / Oxford
Blatt, J. M. & Weisskopf, V. F.	<i>Theoretical Nuclear Physics</i>	Wiley / Springer
Martin, B. R. & Shaw, G.	<i>Particle Physics</i>	Wiley
Hodgson, P. E., Gadioli, E. & Gadioli Erba, E.	<i>Introductory Nuclear Physics</i>	Oxford University Press
Perkins, D. H.	<i>Introduction to High Energy Physics</i>	Cambridge University Press
Enge, H. A.	<i>Introduction to Nuclear Physics</i>	Addison-Wesley (4th Ed.)
Lilley, J.	<i>Nuclear Physics: Principles and Applications</i>	Wiley
Burcham, W. E.	<i>Elements of Nuclear Physics</i>	Longman
Halzen, F. & Martin, A. D.	<i>Quarks and Leptons: An Introductory Course in Modern Particle Physics</i>	Wiley

0533 PHYS 4102: Physics Lab-4A**Credits: 1.5 | Practical****a. Rationale:**

This laboratory course provides hands-on experimental training in advanced linear and non-linear operational amplifier circuits, active filter topologies, and signal generators. Students design, construct, and evaluate precision rectifiers, peak detectors, active low-pass and high-pass filters, voltage-controlled oscillators (VCO), and RC phase-shift oscillators.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate advanced optical and modern physics experimental apparatus safely and accurately.	Precision
CLO 2	Measure optical fiber attenuation, Stefan-Boltzmann radiation, electron specific charge, work function, and magnetic susceptibility.	Articulation
CLO 3	Analyze experimental modern physics data using statistical methods, error propagation, and scientific curve fitting.	Analyze
CLO 4	Demonstrate effective scientific reporting, lab documentation, data visualization, and oral defense of experimental methodologies.	Value
CLO 5	Formulate team-based solutions to practical experimental problems in precision physics measurement.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To design, construct, and test a precision rectifier using an operational amplifier.	5	CLO 1, CLO 2
2	To design, construct, and test a peak detector using an operational amplifier.	5	CLO 1, CLO 2, CLO 3
3	To design, construct, and test an active low-pass filter using an operational amplifier.	5	CLO 1, CLO 2, CLO 3
4	To design, construct, and test an active high-pass filter using an operational amplifier.	5	CLO 2, CLO 3, CLO 4
5	To design, construct, and test a voltage-controlled oscillator.	5	CLO 3, CLO 4, CLO 5
6	To design, construct, and test a phase-shift oscillator using an operational amplifier.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Demonstrations, safety briefing, hands-on instrumentation	Continuous observation, practical lab exam
CLO 2	Guided experimental setups, measurement supervision	Lab notebook, data collection evaluation
CLO 3	Data analysis tutorials, statistical curve fitting exercises	Lab reports, error analysis assessment
CLO 4	Report drafting feedback, individual viva-voce examination	Lab report grading, oral viva-voce
CLO 5	Collaborative experiment execution, lab team management	Peer assessment, team performance evaluation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G., & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications

Author(s)	Book Title	Publisher / Ed.
Melissinos, A. C.	<i>Experiments in Modern Physics</i>	Academic Press
Tyler, F.	<i>Laboratory Manual of Physics</i>	Edward Arnold

0533 PHYS 4103: Solid State Physics-II**Credits: 3.0 | Theory (Core)****a. Rationale:**

This course covers advanced solid-state physics including band theory of solids, dielectric, ferroelectric, and magnetic properties of materials, advanced superconductivity, and mechanical properties of crystalline solids.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the principles of band theory, dielectric response, ferroelectricity, magnetism, and superconductivity.	Understand
CLO 2	Describe energy band gaps, ferroelectric transitions, magnetic domains, and superconducting phase states.	Understand
CLO 3	Apply mathematical models (Kronig-Penney model, Clausius-Mossotti relation, Langevin theory, London equations) to solids.	Apply
CLO 4	Analyze relationships between crystalline defect structures, magnetic hysteresis, dielectric loss, and transport properties.	Analyze
CLO 5	Evaluate advanced solid-state materials for modern applications in electronics, spintronics, magnetic storage, and high-T _c devices.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓			✓						✓	✓
CLO 2	✓	✓			✓						✓	✓
CLO 3	✓	✓			✓						✓	✓
CLO 4	✓	✓			✓						✓	✓
CLO 5	✓	✓			✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Band Theory of Solids: Electrons in a Periodic Potential; E vs. k Dispersion; Crystal Momentum k, Conditions for Bragg Reflection of Electrons; Formation of Band Gap; Nearly Free Electron Model; Bloch Theorem; Kronig-Penney Model; Motion of Electrons in One and Three Dimensions in a Periodic Potential; Band Theory; Distinction among Metals, Insulators and Intrinsic Semiconductors; Direct and Indirect Band Gap Semiconductors; Extrinsic Semiconductor; and Concept of Holes and Effective Mass.	9	CLO 1, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
2	Dielectric Properties: Macroscopic Electric Field; Local Electric Field of Atom; Dielectric Constants and Polarizabilities; Clausius-Mossotti Relation; Dielectric Phenomena in an AC Field; Debye Equations for Dielectric Constant and Dielectric Loss; Dielectric Response of an Electron Gas- Concept of Plasmon and Calculation of Plasma Frequency; Screened and Unscrened Coulomb Potential; Motion in Magnetic Fields.	9	CLO 1, CLO 2, CLO 3
3	Ferroelectric Properties: Ferroelectricity; Characteristics of Ferroelectric Materials; Ferroelectric Domains and Domain Walls; P-E Hysteresis Loop, Curie Temperature and Ferroelectric Phase Transition; Piezoelectric Effect, Classification of Ferroelectrics; Theory of Structural Phase Transition; Landau-Ginzburg Free Energy Theory; Devonshire Theory; Structure of Ferroelectrics; Polar Nanoregions; Cluster-Glass State.	8	CLO 2, CLO 4
4	Magnetism: Types of Magnetism and Their Origins; Langevin Equation for Diamagnetism and Paramagnetism; Curie Law; Quantum Theory of Paramagnetism; Hund's Rules; Quenching of the Orbital Angular Momentum; Ferromagnetism; Weiss Molecular Field and Exchange Integral; Magnetic Domain and Bloch Wall; Anti-ferromagnetism; Neel's Theory; Two-sublattice Model; Ferri-magnetism and Structure of Ferrites and Garnets; Uses of Various Magnetic Materials; Magnetic Anisotropy; Magnetic Resonance.	9	CLO 1, CLO 3, CLO 5
5	Superconductivity and Mechanical Properties: Basic properties of superconductors; Meissner effect; Type-I and type-II superconductors; London equation; BCS theory; Coherence length, flux quantization, Vortex state; Tunneling and Josephson Effect; High-Tc superconductors; SQUID; Elastic Constants and Moduli of Elasticity; Elastic and Plastic Deformations; Creep; Fatigue; Hardness Testing; Hardness Scales, Machinability.	7	CLO 2, CLO 5, CLO 6

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Lectures, multimedia presentations, interactive derivations	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, tutorials, band diagram visualization	Class Tests, Assignments, Final Examination
CLO 3	Problem-solving sessions, mathematical modeling	Assignments, Mid-term / Class Tests, Final Examination
CLO 4	Case study discussions, property correlation tasks	Assignments, Class Tests, Final Examination
CLO 5	Literature seminars, advanced topic presentations	Presentation, Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Kittel, C.	<i>Introduction to Solid State Physics</i>	Wiley
Ashcroft, N. W., & Mermin, N. D.	<i>Solid State Physics</i>	Harcourt
Cullity, B. D., & Graham, C. D.	<i>Introduction to Magnetic Materials</i>	Wiley-IEEE Press
Tinkham, M.	<i>Introduction to Superconductivity</i>	McGraw-Hill / Dover
Marder, M. P.	<i>Condensed Matter Physics</i>	John Wiley & Sons

0533 PHYS 4104: Physics Lab-4B**Credits: 1.5 | Practical****a. Rationale:**

This laboratory course provides practical training in diode clipping circuits, biased AC wave-clippers, IC 555 and transistorized multivibrator pulse generators, atomic energy levels via the Franck-Hertz experiment, and Four-Probe semiconductor resistivity.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate physics experiments related to crystal diffraction, GM counters, Franck-Hertz setup, and Four-Probe apparatus safely and accurately.	Precision
CLO 2	Measure X-ray diffraction angles, gamma ray attenuation, GM plateau, Franck-Hertz excitation potentials, semiconductor resistivity, and solar cell parameters.	Articulation
CLO 3	Analyze experimental data, discrete atomic energy levels, I-V solar characteristics, and radiation attenuation curves.	Analyze
CLO 4	Compile structured laboratory reports with detailed uncertainty analysis and scientific discussion.	Value
CLO 5	Demonstrate collaborative skills, laboratory safety compliance, and research ethics.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Design, construction, and testing of two simple diode clipper circuits (positive and negative) when diode and resistor are interchanged.	5	CLO 1, CLO 2

Sl.	Course Content / Module	Hrs.	CLO(s)
2	Design, construction, and testing of a clipper circuit that clips both halves of an AC signal using two diodes, reference DC voltages, and a resistor.	5	CLO 1, CLO 2, CLO 3
3	Design, construction, and testing of an astable multivibrator using IC 555 timer trainer.	5	CLO 1, CLO 2, CLO 3
4	Design, construction, and testing of a multivibrator circuit using NPN transistors.	5	CLO 2, CLO 3, CLO 4
5	Study of the Franck-Hertz experiment to demonstrate discrete atomic energy levels.	5	CLO 3, CLO 4, CLO 5
6	Measurement of the resistivity and temperature coefficient of resistance of a semiconductor by Four-Probe method.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Experimental setup demonstration, safety briefing	Practical observation, lab performance assessment
CLO 2	Guided experimental execution, measurement supervision	Data sheet evaluation, continuous assessment
CLO 3	Data processing tutorials, graph plotting exercises	Lab reports, curve fitting evaluation
CLO 4	Scientific report review, viva-voce defense	Lab reports, oral viva-voce
CLO 5	Group laboratory assignments, safety compliance checks	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G., & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Melissinos, A. C.	<i>Experiments in Modern Physics</i>	Academic Press
Knoll, G. F.	<i>Radiation Detection and Measurement</i>	John Wiley & Sons

0533 PHYS 4105: Digital Electronics and Pulse Techniques Credits: 3.0 | Theory (Core)

a. Rationale:

This course covers digital logic gates, combinational and sequential circuit design, memory and programmable logic, pulse generation and wave shaping, and digital instrumentation applications in experimental physics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain principles of number systems, Boolean algebra, logic families (TTL, CMOS), and pulse fundamentals.	Understand
CLO 2	Describe operational principles of combinational circuits, flip-flops, counters, multivibrators, and PLDs.	Understand
CLO 3	Apply Boolean reduction, Karnaugh maps, and timing diagrams to design digital and pulse shaping circuits.	Apply
CLO 4	Analyze pulse propagation, waveform shaping networks, multivibrators, and digital instrumentation systems.	Analyze
CLO 5	Evaluate digital measurement architectures, data acquisition systems, and coincidence circuits for physics experiments.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓		✓						✓	
CLO 2	✓	✓	✓		✓						✓	
CLO 3	✓	✓	✓		✓						✓	
CLO 4	✓	✓	✓		✓						✓	
CLO 5	✓	✓	✓		✓						✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Digital Electronics: Analog and digital systems; Advantages of digital techniques; Number systems: Binary, Octal, Decimal, Hexadecimal; Number conversions; Binary arithmetic; Complements and signed numbers.	4	CLO 1
2	Boolean Algebra and Logic Gates: Basic postulates and theorems of Boolean algebra; De Morgan's theorems; Logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR; Universal gates; Logic families: TTL and CMOS; Truth tables and logic simplification.	6	CLO 1, CLO 2
3	Combinational Logic Circuits: Karnaugh maps; Logic minimization; Adders and subtractors; Multiplexers and demultiplexers; Encoders and decoders; Comparators; Applications in measurement systems.	7	CLO 2, CLO 3
4	Sequential Logic Circuits: Latches and flip-flops (SR, JK, D, T); Registers and shift registers; Counters (asynchronous and synchronous); Ring and Johnson counters; Timing diagrams; State diagrams.	7	CLO 2, CLO 3
5	Memory and Programmable Logic Devices: RAM, ROM, PROM, EPROM, EEPROM; Memory organization; Programmable logic devices (PLDs); Introduction to FPGA concepts; Applications in instrumentation.	3	CLO 2, CLO 3, CLO 5
6	Pulse Fundamentals: Pulse characteristics; Pulse parameters: amplitude, width, rise time, fall time; Pulse distortion; Pulse propagation and transmission.	3	CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
7	Pulse Generation and Shaping Circuits: RC and RL pulse circuits; Differentiator and integrator circuits; Clipping and clamping circuits; Schmitt trigger; Multivibrators: Astable, Monostable, Bistable; Pulse shaping techniques.	5	CLO 4, CLO 5
8	Timing and Pulse Processing Techniques: Time-delay circuits; Trigger circuits; Gate circuits; Coincidence and anti-coincidence circuits; Pulse counting techniques; Applications in nuclear and particle physics instrumentation.	4	CLO 3, CLO 4, CLO 5
9	Digital Electronics in Physics Instrumentation: Digital measurement systems; Data acquisition systems; Digital counters and timers; Scalers; Detector signal processing; Applications in modern experimental physics.	3	CLO 3, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, circuit simulation demos	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, waveform analysis sessions	Class Tests, Assignment, Final Examination
CLO 3	Problem-solving tutorials, logic minimization exercises	Class Tests, Assignments, Final Examination
CLO 4	Circuit design exercises, analysis case studies	Assignments, Class Tests, Final Examination
CLO 5	System design projects, conceptual hardware tasks	Presentation, Design Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Malvino, A. P., & Leach, D. P.	<i>Digital Principles and Applications</i>	McGraw-Hill
Taub, H., & Schilling, D.	<i>Digital Integrated Electronics</i>	McGraw-Hill
Millman, J., & Taub, H.	<i>Pulse, Digital, and Switching Waveforms</i>	McGraw-Hill
Floyd, T. L.	<i>Digital Fundamentals</i>	Pearson

0533 PHYS 4107: Experimental and Computational Methods in Physics Theory (Core)

Credits: 3.0 |

a. Rationale:

This course provides comprehensive knowledge of modern experimental, computational, and theoretical techniques used in contemporary physics and materials research. The course introduces advanced characterization methods, computational approaches, materials design strategies, machine learning applications, and scientific data analysis tools.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain operating principles of advanced characterization techniques (XRD, SEM, TEM, AFM, FTIR, UV-Vis, DSC/TGA) and synthesis methods.	Understand
CLO 2	Describe computational physics methods including density functional theory (DFT), Monte Carlo, molecular dynamics (MD), and machine learning in materials science.	Understand
CLO 3	Apply analytical equations, diffraction formulas (Scherrer, Bragg), and numerical algorithms to process physical data.	Apply
CLO 4	Analyze experimental diffraction patterns, spectroscopic data, microstructure micrographs, and computational simulation outputs.	Analyze
CLO 5	Formulate research hypotheses, experimental design workflows, computational models, and scientific data analysis protocols.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction to Modern Research Techniques & Materials Synthesis: Classification of research methods in physics; Experimental, computational, and theoretical approaches; Materials synthesis and characterization workflow; Selection of characterization techniques based on material properties; Solid-state synthesis; Sol-gel method; Hydrothermal and solvothermal synthesis; Chemical vapor deposition (CVD); Physical vapor deposition (PVD); Thin-film fabrication techniques; Nanomaterial synthesis approaches; Synthesis of ceramics, polymers, semiconductors, and functional materials; Process parameters and optimization.	6	CLO 1, CLO 2
2	Diffraction and Structural Characterization: X-ray Diffraction (XRD): Powder and single-crystal XRD, Phase identification, Lattice parameters, Crystallite size (Scherrer equation), Strain analysis, Rietveld refinement, Small-angle X-ray scattering (SAXS), X-ray reflectivity (XRR); Electron Diffraction; Neutron Diffraction.	5	CLO 1, CLO 3
3	Microscopy Techniques: Surface morphology; Scanning Electron Microscopy (SEM); Transmission Electron Microscopy (TEM): Imaging modes, High-resolution TEM, Selected Area Electron Diffraction (SAED); Atomic Force Microscopy (AFM): Contact mode, tapping mode, non-contact mode; Scanning Tunneling Microscopy (STM).	5	CLO 1, CLO 3

Sl.	Course Content / Module	Hrs.	CLO(s)
4	Spectroscopic Techniques: UV-Visible spectroscopy; Fourier Transform Infrared Spectroscopy (FTIR); Energy Dispersive X-ray Spectroscopy (EDS/EDX), X-ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES); Raman Spectroscopy; Photoluminescence (PL) spectroscopy; Fluorescence spectroscopy.	5	CLO 1, CLO 4
5	Thermal, Electrical and Magnetic Characterization: Differential Scanning Calorimetry (DSC); Thermogravimetric Analysis (TGA); Four-probe electrical conductivity measurement; Hall effect measurement; Dielectric characterization; Vibrating Sample Magnetometer (VSM); SQUID magnetometry.	5	CLO 1, CLO 4
6	Computational Methods & Electronic Structure: Mathematical modelling, numerical simulation, Monte Carlo methods, Molecular Dynamics (MD), Finite Element Method (FEM), and introduction to high-performance computing; Density Functional Theory (DFT): Basic concepts, exchange-correlation functionals, Kohn-Sham equations, crystal structure optimization, electronic band structure, Density of States (DOS), phonon calculations.	6	CLO 2, CLO 3, CLO 5
7	Materials Design, Machine Learning & Scientific Software: Computational materials design; High-throughput materials screening; Materials databases; Crystal structure prediction; Machine learning in materials science; AI-assisted materials discovery; Introduction to Materials Genome Initiative; Scientific tools: OriginPro, MATLAB/Python, VESTA, GSAS/FullProf, ImageJ; Statistical analysis and error estimation.	5	CLO 2, CLO 5
8	Research Workflow & Thesis Documentation: Formulation of research problem, literature review, experiment/simulation setup, data processing, scientific report preparation, thesis formatting, and oral defense.	5	CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, characterization instrument video demos	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, simulation software demonstrations	Class Tests, Assignments, Final Examination
CLO 3	Coding tutorials, numerical problem sessions	Assignments, Class Tests, Final Examination
CLO 4	Spectra analysis exercises, XRD peak indexing tasks	Assignments, Class Tests, Final Examination
CLO 5	Research proposal writing, mini-project presentations	Project Presentation, Proposal, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Martin, R. M.	<i>Electronic Structure: Basic Theory and Practical Methods</i>	Cambridge University Press
Sholl, D. S., & Steckel, J. A.	<i>Density Functional Theory: A Practical Introduction</i>	Wiley
Cullity, B. D., & Stock, S. R.	<i>Elements of X-Ray Diffraction</i>	Pearson
Williams, D. B., & Carter, C. B.	<i>Transmission Electron Microscopy</i>	Springer
Thijssen, J. M.	<i>Computational Physics</i>	Cambridge University Press

0533 PHYS 4106: Honors Project-I**Credits: 2.0 | Capstone Project****a. Rationale:**

This capstone course enables undergraduate students to conduct independent scientific research under faculty supervision, developing research planning, literature review, technical execution, scientific report writing, and oral defense capabilities.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Formulate a well-defined research problem, research objectives, and methodology through critical review of scientific literature.	Analyze
CLO 2	Execute experimental, theoretical, or computational research work safely and methodically under faculty guidance.	Articulation
CLO 3	Analyze and interpret research data using suitable scientific models, error analysis, computational tools, and literature comparison.	Evaluate
CLO 4	Prepare a comprehensive, formatted scientific research report/thesis following standard academic guidelines and ethical publishing standards.	Value
CLO 5	Deliver a professional oral presentation defending research methodology, results, conclusions, and future directions before an examination panel.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Research Planning and Topic Selection: Identification of research areas in Physics; Selection and formulation of research problem; Research objectives and hypotheses; Research proposal preparation; Research ethics and academic integrity.	6	CLO 1, CLO 4
2	Literature Review: Searching scientific literature; Use of scientific databases (Scopus, Web of Science, Google Scholar, arXiv); Critical evaluation of journal articles; Literature review writing; Reference management software (Mendeley, Zotero, EndNote).	8	CLO 1, CLO 4
3	Research Methodology: Experimental research methods; Theoretical and computational approaches; Numerical simulations and modeling; Instrumentation and measurement techniques; Data collection procedures; Safety considerations in laboratory research.	8	CLO 2, CLO 3
4	Data Analysis and Interpretation: Data organization and processing; Statistical analysis and uncertainty estimation; Graphical representation of data; Error analysis; Scientific computing tools (Python, MATLAB, Origin, Mathematica, etc.); Interpretation and validation of results.	8	CLO 2, CLO 3
5	Thesis Writing, Presentation and Defense: Structure of scientific thesis; Abstract, introduction, methodology; Results and discussion; Conclusion and recommendations; Citation and referencing styles; Preparation of oral presentations; Final thesis preparation and oral defense.	12	CLO 3, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Individual research supervision, literature guidance	Research proposal evaluation, supervisor feedback
CLO 2	Hands-on lab/coding guidance, regular consultation	Progress reports, supervisor continuous assessment
CLO 3	Data analysis consultation, result review meetings	Draft report evaluation, supervisor review
CLO 4	Thesis writing guidance, document formatting feedback	Part 1: Written Thesis / Project Report Evaluation
CLO 5	Presentation practice sessions, viva preparation	Part 2: Oral Presentation / Defense on Thesis

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Kothari, C. R.	<i>Research Methodology: Methods and Techniques</i>	New Age International
Day, R. A., & Gastel, B.	<i>How to Write and Publish a Scientific Paper</i>	Cambridge University Press

0533 PHYS 4108: Viva-voce

Credits: 1.0 | Oral Examination

a. Rationale:

The comprehensive viva-voce assesses the student's mastery, depth of understanding, critical thinking, problem-solving ability, and oral scientific communication across all theoretical and laboratory courses completed in Year IV Term I.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Demonstrate comprehensive knowledge of theoretical physics, solid-state physics, digital electronics, nuclear physics, and research methodologies.	Understand
CLO 2	Explain experimental techniques, error analysis, computational algorithms, and analytical physics derivations.	Apply
CLO 3	Communicate physics concepts clearly, concisely, and confidently in an oral examination setting.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓	✓	✓
CLO 2						✓	✓	✓	✓	✓	✓	✓
CLO 3						✓	✓	✓	✓	✓	✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive oral examination covering all theoretical, practical, and computational physics courses of Year IV Term I.	Full Term	CLO 1, CLO 2, CLO 3

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion, self-study guidance	Oral Examination / Viva-voce
CLO 2	Interactive question-answer practice, tutorial review	Oral Examination / Viva-voce
CLO 3	Mock oral presentations, academic communication practice	Oral Examination / Viva-voce

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Prescribed textbooks and reference materials of Year IV Term I courses	—	—

Year IV – Term II

0533 PHYS 4201: Introduction to Material Science and Nanotechnology Theory (Core)**Credits: 3.0 |****a. Rationale:**

The course aims to provide a comprehensive understanding of the physical and chemical principles governing the structure, properties, thermodynamics, and processing of materials and nanostructures. It covers the fundamentals of metals, ceramics, polymers, composites, soft matter, and biological materials, along with modern nanotechnology concepts including quantum confinement, scaling laws, and self-assembled systems. This knowledge is essential for understanding advanced material behavior, designing novel materials, and applying nanotechnology in modern scientific research and cutting-edge industrial applications.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Define the fundamental concepts of material structure, thermodynamics, kinetic processes, soft matter, colloidal systems, and nanoscale phenomena.	Understand
CLO 2	Describe the structure, classification, and properties of metals, ceramics, polymers, composites, biologics, and nanostructured materials.	Understand
CLO 3	Explain thermodynamic principles of phase equilibria, diffusion kinetics, self-assembly mechanisms, and quantum behavior of low-dimensional systems.	Understand
CLO 4	Apply theoretical models of thermodynamics, scaling relations, and quantum mechanics to analyze the behavior of materials and nanostructures.	Apply
CLO 5	Analyze the effects of size reduction, interparticle forces, and quantum confinement on the physical, chemical, and functional properties of materials.	Analyze
CLO 6	Evaluate the design, fabrication, and performance of advanced materials and nanostructures for applications in modern science and engineering.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓		✓						✓	✓
CLO 2	✓	✓	✓		✓						✓	✓
CLO 3	✓	✓	✓		✓						✓	✓
CLO 4	✓	✓	✓		✓						✓	✓
CLO 5	✓	✓	✓		✓						✓	✓
CLO 6	✓	✓	✓		✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	The Structure of Materials: Introduction and Objectives, Structure of Metals and Alloys, Structure of Ceramics and Glasses, Structure of Polymers, Structure of Composites, Structure of Biologics.	6	CLO 1, CLO 2
2	Thermodynamics of Condensed Phases: Thermodynamics of Metals and Alloys, Thermodynamics of Ceramics and Glasses, Thermodynamics of Polymers, Thermodynamics of Composites, Thermodynamics of Biologics.	5	CLO 1, CLO 3
3	Kinetic Processes in Materials: Kinetic Processes in Metals and Alloys, Kinetic Processes in Ceramics and Glasses, Kinetic Processes in Polymers, Kinetic Processes in Composites, Kinetic Processes in Biologics.	6	CLO 1, CLO 3, CLO 4
4	Soft Matter: The colloidal system, Forces acting in the colloidal system, The DLVO theory, Amphiphiles (surfactants) in solution, Interfacial films and spontaneous curvature, Micellar shapes and phase behavior, The structure of Microemulsions, Self-organization of Macromolecules.	5	CLO 1, CLO 3, CLO 5
5	Introduction to Nanotechnology & Systematics of Making Things Smaller: Nanometers, Micrometers, Millimeters, Moore's Law, Esaki's Quantum Tunneling Diode, Quantum Dots of Many Colors, GMR 100Gb Hard Drive Read Heads, Accelerometers in your Car, Nanopore Filters, Nanoscale Elements in Traditional Technologies; Pre-quantum systematics: Mechanical Frequencies Increase in Small Systems, Scaling Relations Illustrated by a Simple Harmonic Oscillator, Scaling Relations Illustrated by Simple Circuit Elements, Thermal Time Constants and Temperature Differences Decrease, Viscous Forces Become Dominant for Small Particles in Fluid Media, Frictional Forces can Disappear in Symmetric Molecular Scale Systems.	5	CLO 2, CLO 4, CLO 5
6	Limits to Smallness & Quantum Nature of the Nanoworld: Particle (Quantum) Nature of Matter: Photons, Electrons, Atoms, Molecules; Biological Examples of Nanomotors and Nanodevices, Linear Spring Motors, Linear Engines on Tracks, Rotary Motors, Ion Channels, the Nano transistors of Biology; Methods for Making Small Objects, Approaches to Assembly of Small Three-dimensional Objects, Use of DNA Strands in Guiding Self-assembly of Nanometer Size Structures; Review of Quantum mechanics, Maxwell's Equations; E and B as Wavefunctions for Photons, Optical Fiber Modes, Quantum States and Energies, Barrier Tunneling, The Trapped Particle in one Dimension, Penetration of a Barrier, Escape Time from a Well, Resonant Tunneling Diode, Trapped Particles in Two and Three Dimensions: Quantum Dot, 2D Bands and Quantum Wires, One-electron Atoms, Excitons, Magnetic Moments, Magnetization and Magnetic Susceptibility, Positronium and Excitons, Fermions, Bosons and Occupation Rules.	8	CLO 3, CLO 4, CLO 5

Sl.	Course Content / Module	Hrs.	CLO(s)
7	Self-assembled Nanostructures in Nature and Industry: Carbon Atom, Methane, Ethane and Octane, Ethylene, Benzene, and Acetylene, C60 Buckyball, C Nanotube (0.5 nm), Si Nanowire (5 nm), InAs Quantum Dot (5 nm), AgBr Nanocrystal (0.1–2 nm), Fe3O4 Magnetite and Fe3S4 Greigite Nanoparticles in Magnetotactic Bacteria, Self-assembled Monolayers on Au and Other Smooth Surfaces.	7	CLO 2, CLO 5, CLO 6

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, 3D lattice visual demos	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, nanostructure synthesis workflow presentations	Class Tests, Assignments, Final Examination
CLO 3	Problem-solving sessions, phase diagram and scaling exercises	Class Tests, Assignments, Final Examination
CLO 4	Property correlation exercises, case study discussions	Assignments, Class Tests, Final Examination
CLO 5	Nano-application seminars, student presentations	Presentation, Assignment, Final Examination
CLO 6	Advanced topic reviews, design problem evaluation	Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Wolf, E. L.	<i>Nanophysics and Nanotechnology</i>	Wiley-VCH
Dupas, C., Houdy, P., & Lahmani, M.	<i>Nanoscience: Nanotechnologies and Nanophysics</i>	Springer
Mitchell, B. S.	<i>An Introduction to Materials Engineering and Science</i>	Wiley-Interscience
Callister, W. D.	<i>Materials Science and Engineering: An Introduction</i>	John Wiley & Sons
Daoud, M., & Williams, C. E.	<i>Soft Matter Physics</i>	Springer

0533 PHYS 4202: Physics Lab-4C

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides hands-on experimental training in quantum phenomena, photoelectric effect, and nuclear radiation detection. Students experimentally determine the Planck constant and photocathode work function using photoelectric apparatus, and investigate the operating characteristics, dead time, half-life, and gamma radiation absorption coefficients using Geiger-Müller (GM) counting systems.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Operate advanced electronics breadboards, function generators, digital oscilloscopes, and microprocessor trainers safely and accurately.	Precision
CLO 2	Construct ADC/DAC converters, Butterworth filters, Schmitt triggers, PLL circuits, and AM modulation networks.	Articulation
CLO 3	Analyze frequency response curves, transient switching times, PLL capture range, and modulation indices.	Analyze
CLO 4	Compile structured laboratory reports with detailed uncertainty analysis, circuit diagrams, and waveform interpretations.	Value
CLO 5	Develop microprocessor assembly routines and collaborative troubleshooting skills in an electronics laboratory setting.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine Planck's constant using the photoelectric effect.	5	CLO 1, CLO 2
2	To determine the work function of a photocathode using the photoelectric effect.	5	CLO 1, CLO 2, CLO 3
3	To determine the dead time of a Geiger-Müller (GM) counter by the two-source method.	5	CLO 1, CLO 2, CLO 3
4	To determine the operating voltage and plateau characteristics of a Geiger-Müller counter.	5	CLO 2, CLO 3, CLO 4
5	To determine the half-life of a radioactive source using a Geiger-Müller counter.	5	CLO 3, CLO 4, CLO 5
6	To determine the absorption coefficient of gamma radiation in a material using a Geiger-Müller counter.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Experimental demonstration, circuit wiring supervision	Continuous observation, practical lab exam
CLO 2	Guided digital circuit assembly, IC testing supervision	Data sheet assessment, continuous assessment

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 3	Filter and Schmitt trigger design tutorials, waveform analysis	Lab reports, curve fitting evaluation
CLO 4	Scientific report review, viva-voce defense	Lab reports, oral viva-voce
CLO 5	Collaborative circuit troubleshooting, laboratory safety compliance	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G., & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications
Malvino, A. P.	<i>Electronic Principles</i>	McGraw-Hill
Gayakwad, R. A.	<i>Op-Amps and Linear Integrated Circuits</i>	Pearson
Ramesh, G.	<i>Microprocessor Architecture, Programming, and Applications with the 8085</i>	Penram International

0533 PHYS 4203: Medical and Radiation Physics

Credits: 3.0 | Theory (Core)

a. Rationale:

This undergraduate course provides a foundational understanding of the physical principles governing biological systems, medical imaging, radiation physics, and health safety. By consolidating key topics from biophysics, radiation and health physics, students will explore human physiological mechanics, radiation interactions, dosimetry, medical diagnostics, and radiation protection standards.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain fundamental principles of bioelectricity, cell membrane potentials, human physiological mechanics, radiation interactions, and dosimetry.	Understand
CLO 2	Describe working principles of medical diagnostics (Ultrasound, Gamma Camera, CT Scanner, PET) and biomedical instrumentation.	Understand
CLO 3	Apply mathematical formulations of radiation dosimetry (Exposure, Absorbed Dose, Dose Equivalent, Effective Dose, Bragg-Gray cavity principle, Kerma).	Apply
CLO 4	Analyze biological effects of ionizing radiation at the cellular and tissue levels, somatic vs hereditary risks, and acute vs delayed responses.	Analyze
CLO 5	Evaluate radiation protection protocols, external/internal control measures, ICRP/IAEA/NSRC regulatory safety standards, and radioactive waste management.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓		✓						✓	✓

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 2	✓	✓	✓		✓						✓	✓
CLO 3	✓	✓	✓		✓						✓	✓
CLO 4	✓	✓	✓		✓						✓	✓
CLO 5	✓	✓	✓		✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Cell Membrane & Bioelectricity: Membrane structure, transport mechanisms (diffusion, active transport, chemical pumps); Membrane potentials and electrical activity of the nervous system (Hodgkin-Huxley model); Action potentials in muscles (cardiac, smooth, striated) and ECG basics (Einthoven's triangle).	5	CLO 1, CLO 2
2	Cardiovascular & Respiratory Mechanics: Fluid mechanics applied to blood flow and blood velocity; Vascular pressure measurements and physiological monitoring.	4	CLO 1, CLO 2
3	Medical Diagnostics & Imaging Principles: Ultrasound: Production, detection, A-scan, B-scan, and clinical application; Nuclear & X-ray Imaging: Fundamentals of Gamma Camera, CT Scanner, and basic PET concepts.	7	CLO 2, CLO 4
4	Biomedical Instrumentation & Safety: Bio-electric amplifiers and signal acquisition; Principles of defibrillators and general patient safety in clinical environments.	5	CLO 2, CLO 5
5	Radiation & Matter Interaction: Alpha, beta, gamma, and neutron interactions with matter, penetrating power; Radioactive decay laws, half-life, and natural/artificial radionuclides.	5	CLO 1, CLO 3
6	Radiation Dosimetry & Biological Effects: Radiation units: Exposure, Absorbed Dose, Dose Equivalent, and Effective Dose; Bragg-Gray cavity principle and Kerma; Biological effects: Interaction at the cellular level, somatic vs. hereditary effects, acute vs. delayed responses.	6	CLO 1, CLO 3, CLO 4
7	Radiation Hazards, Control & Safety: External Control: Time, distance, shielding, and Inverse Square Law; Internal Control: Contamination routes, annual limits on intake (ALI), and facility classification; Personal monitoring devices (pocket dosimeters, survey meters, film badges).	5	CLO 3, CLO 5
8	Radiation Safety Standards & Regulations: Regulatory guidelines: ICRP, IAEA, and national safety frameworks (e.g., Bangladesh NSRC guidelines); System of dose limitation: Occupational, medical, and public exposure limits; Radioactive waste classification and basic management principles.	5	CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, physiological animations and bioelectricity demos	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, imaging equipment schematics, clinical diagnostics video sessions	Class Tests, Assignments, Final Examination
CLO 3	Dosimetry derivation tutorials, numerical problem-solving sessions	Class Tests, Assignments, Final Examination
CLO 4	Radiobiology case studies, cell irradiation data analysis tasks	Assignments, Class Tests, Final Examination
CLO 5	Radiation safety seminars, regulatory guidelines case discussions, group presentations	Presentation, Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Cameron, J. R., & Skofronick, J. G.	<i>Medical Physics</i>	John Wiley & Sons
Cember, H., & Johnson, T. E.	<i>Introduction to Health Physics</i>	McGraw-Hill / Pergamon
Davidovits, P.	<i>Physics in Biology and Medicine</i>	Academic Press
Brown, B. H., et al.	<i>Medical Physics and Physiological Measurements</i>	Blackwell Scientific Publications
Martin, A., & Harbison, S.	<i>An Introduction to Radiation Protection</i>	CRC Press

0533 PHYS 4204: Physics Lab-4D

Credits: 1.5 | Practical

a. Rationale:

This laboratory course provides advanced practical training in nuclear spectroscopy, atomic physics constants, and laser optics. Students perform gamma-ray spectrometry using scintillation detectors and multichannel analyzers for source calibration and identification, experimentally verify the Compton scattering relation, determine the electron charge-to-mass ratio (e/m) using magnetic deflection, and measure laser wavelengths using diffraction gratings.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Perform advanced experiments using GM counters, ferroelectric capacitance bridges, Langmuir probes, Hall/magnetoresistance setups, scintillation spectrometers, and ESR spectrometers safely and accurately.	Precision
CLO 2	Measure radiation activity, inverse square law compliance, Curie transition temperature, plasma electron temperature/density, magnetoresistance, and Landé g-factor.	Articulation
CLO 3	Apply theoretical concepts of solid-state, nuclear, and plasma physics to interpret experimental results.	Apply
CLO 4	Evaluate measurement uncertainties and demonstrate proper error analysis in advanced experimental findings.	Analyze

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 5	Develop scientific reporting and critical thinking skills through accurate documentation and interpretation of laboratory results.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1			✓	✓	✓		✓		✓		✓	
CLO 2			✓	✓	✓		✓		✓		✓	
CLO 3			✓	✓	✓		✓		✓		✓	
CLO 4			✓	✓	✓		✓		✓		✓	
CLO 5			✓	✓	✓		✓		✓		✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	To determine the energy of gamma rays using a scintillation detector and multichannel analyzer.	5	CLO 1, CLO 2
2	To calibrate a gamma-ray spectrometer using standard radioactive sources.	5	CLO 1, CLO 2, CLO 3
3	To identify an unknown radioactive source using gamma-ray spectroscopy.	5	CLO 1, CLO 2, CLO 3
4	To verify the Compton scattering relation and determine the Compton wavelength of the electron.	5	CLO 2, CLO 3, CLO 4
5	To determine the charge-to-mass ratio (e/m) of the electron by the magnetic field method.	5	CLO 3, CLO 4, CLO 5
6	To determine the wavelength of a laser using a diffraction grating.	5	CLO 2, CLO 4, CLO 5

NB: This list of laboratory experiments is subject to change at the discretion of the respective course instructor(s), depending on the available laboratory setup and equipment at the time of offering.

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Instrument demonstration, practical supervision	Practical performance, lab observation
CLO 2	Guided experimental execution, data collection supervision	Data sheets, practical examination
CLO 3	Data analysis tutorials, error fitting exercises	Lab reports, data sheets, quizzes
CLO 4	Lab report review, viva-voce defense	Lab reports, oral viva voce
CLO 5	Group lab assignments, safety training	Peer observation, lab participation

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Ahmed, G., & Uddin, M. S.	<i>Practical Physics</i>	Standard Publications

Author(s)	Book Title	Publisher / Ed.
Melissinos, A. C.	<i>Experiments in Modern Physics</i>	Academic Press
Knoll, G. F.	<i>Radiation Detection and Measurement</i>	John Wiley & Sons
Chen, F. F.	<i>Introduction to Plasma Physics and Controlled Fusion</i>	Springer

0533 PHYS 4205: Quantum Mechanics-II**Credits: 3.0 | Theory (Core)****a. Rationale:**

The course intends to equip the students with the tools of matrix formulation of quantum mechanics and a thorough understanding of the role of operators in the Hilbert space for problem solving. The importance of the transformation theory has been highlighted. It also contains an extended section on various approximation methods of solving quantum mechanical problems, another section on scattering theory. An introduction to relativistic quantum mechanics is also included.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Define the fundamental concepts of quantum mechanics including Hilbert space, operators, angular momentum, approximation methods, identical particles, scattering theory, and relativistic quantum equations.	Understand
CLO 2	Describe quantum representations, matrix formulation, angular momentum properties, symmetry of wave functions, scattering processes, and relativistic particle behavior.	Understand
CLO 3	Explain the principles of operator algebra, spin and rotation, perturbation techniques, quantum statistics, scattering mechanisms, and relativistic wave equations.	Understand
CLO 4	Apply quantum mechanical methods such as matrix mechanics, angular momentum addition, perturbation theory, and approximation techniques to solve physical problems.	Apply
CLO 5	Analyze quantum systems involving identical particles, scattering interactions, and relativistic effects using appropriate mathematical and conceptual tools.	Analyze
CLO 6	Evaluate the validity and limitations of approximation methods, scattering models, and relativistic formulations in describing real quantum systems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓		✓					✓	✓	
CLO 2	✓	✓	✓		✓					✓	✓	
CLO 3	✓	✓	✓		✓					✓	✓	
CLO 4	✓	✓	✓		✓					✓	✓	
CLO 5	✓	✓	✓		✓					✓	✓	
CLO 6	✓	✓	✓		✓					✓	✓	

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Matrix Formulation and Quantum Representations: State vectors in Hilbert space; Linear vector spaces; Basis and dimension; Dirac bra-ket notation; Completeness and orthogonality; Matrix representation of operators; Projection operator; Hermitian and unitary operators; Diagonalization of matrices; Density matrix; Schrödinger, Heisenberg and Dirac (interaction) pictures; Equations of motion.	8	CLO 1, CLO 2, CLO 3
2	Theory of Angular Momentum: Rotation operators; Angular momentum as generator of rotation; Orbital angular momentum operators; Commutation relations; Ladder operators; Eigenvalues and eigenfunctions of angular momentum; Angular momentum matrices; Spin angular momentum; Stern-Gerlach experiment; Pauli matrices; Addition of angular momenta; Total angular momentum; Clebsch-Gordon coefficients; Recursion relations; Wigner-Eckart theorem.	10	CLO 1, CLO 2, CLO 3
3	Approximation Methods: Time-independent perturbation theory; Non-degenerate case; First-order and second-order corrections; Degenerate perturbation theory; Stark effect; Zeeman effect; Time-dependent perturbation theory; Transition probability; Harmonic perturbation; Fermi's Golden Rule; Selection rules; Variational method; Upper bound theorem; Applications to helium atom and excited states; WKB approximation; Classical limit; Validity condition; Turning points; Connection formulae; Tunneling; Adiabatic approximation; Sudden approximation.	10	CLO 3, CLO 4, CLO 5
4	Identical Particles and Symmetry: Symmetric and antisymmetric wave functions; Permutation symmetry; Symmetrization postulate; Pauli exclusion principle; Fermions and bosons; Two-electron system; Exchange interaction; Slater determinant; Degenerate Fermi gas.	4	CLO 2, CLO 3, CLO 5
5	Scattering Theory: Scattering cross-section; Differential and total cross-section; Center of mass and laboratory coordinates; Partial wave analysis; Phase shifts; Hard sphere scattering; Square well scattering; Coulomb scattering; Resonance scattering; Optical theorem; Lippmann-Schwinger equation; Green's function method; Born approximation; Validity criterion.	6	CLO 1, CLO 5, CLO 6
6	Relativistic Quantum Mechanics: Need for relativistic quantum mechanics; Klein-Gordon equation; Dirac equation; Free particle solutions; Electron spin; Magnetic moment; Positive and negative energy states; Hole theory.	4	CLO 4, CLO 5, CLO 6

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual quantum physics discussions	Class Tests, Quizzes, Final Examination

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 2	Theoretical lectures, operator matrix derivations	Class Tests, Assignments, Final Examination
CLO 3	Mathematical derivation tutorials, perturbation problem sessions	Class Tests, Assignments, Final Examination
CLO 4	Scattering analysis exercises, partial wave calculations	Assignments, Class Tests, Final Examination
CLO 5	Advanced relativistic physics lectures, seminars	Presentation, Assignment, Final Examination
CLO 6	Approximation limits evaluation, term paper discussion	Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Griffiths, D. J.	<i>Introduction to Quantum Mechanics</i>	Pearson
Shankar, R.	<i>Principles of Quantum Mechanics</i>	Springer
Sakurai, J. J.	<i>Modern Quantum Mechanics / Advanced Quantum Mechanics</i>	Cambridge University Press / Addison-Wesley
Cohen-Tannoudji, C., Diu, B., & Laloë, F.	<i>Quantum Mechanics (Vol. 1 & 2)</i>	Wiley-VCH
Zettili, N.	<i>Quantum Mechanics: Concepts and Applications</i>	Wiley
Landau, L. D., & Lifshitz, E. M.	<i>Quantum Mechanics: Non-Relativistic Theory (Vol. 3)</i>	Butterworth-Heinemann
Dirac, P. A. M.	<i>The Principles of Quantum Mechanics</i>	Oxford University Press

0533 PHYS 4207: Reactor Physics

Credits: 3.0 | Theory (Core)

a. Rationale:

The course aims to provide a comprehensive understanding of the fundamental principles governing nuclear reactors, focusing on neutron interactions, diffusion, and reactor theory. It covers reactor control, heat removal, and fuel cycle management, emphasizing criticality, safety, and efficiency. This knowledge is essential for analyzing reactor behavior, designing control systems, and ensuring safe and sustainable nuclear energy production in both research and power reactor applications.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Define the fundamental concepts of neutron interactions, cross-sections, diffusion processes, reactor theory, control mechanisms, heat removal, and reactor fuel cycles.	Understand
CLO 2	Describe neutron behavior in matter, including slowing down and diffusion, reactor types and configurations, control systems, cooling methods, and fuel processing techniques.	Understand
CLO 3	Explain the principles of neutron reactions, multiplication factors, criticality conditions, reactor control, thermal energy removal, and fuel cycle management.	Understand

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 4	Apply theoretical models such as diffusion equations, four-factor formula, and reactivity concepts to analyze reactor performance and operation.	Apply
CLO 5	Analyze neutron transport, reactor stability, heat transfer, and fuel utilization to evaluate efficiency and safety of nuclear reactors.	Analyze
CLO 6	Evaluate reactor design, control strategies, cooling systems, and waste management practices for safe and sustainable nuclear energy production.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓		✓						✓	✓
CLO 2	✓	✓	✓		✓						✓	✓
CLO 3	✓	✓	✓		✓						✓	✓
CLO 4	✓	✓	✓		✓						✓	✓
CLO 5	✓	✓	✓		✓						✓	✓
CLO 6	✓	✓	✓		✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Neutron Reactions: Interaction of Neutrons with Matter; Neutron Cross-section and its Determination; Energy Dependence of Neutron Cross-section; Fission Cross-section.	6	CLO 1, CLO 2, CLO 3
2	Diffusion and Slowing Down of Neutrons: Thermal Neutron Diffusion; Diffusion Equations; Fast Neutron Diffusion and Fermi Age Equation; Energy Distribution and Cross-section of Thermal Neutrons.	6	CLO 2, CLO 3, CLO 4
3	Reactor Theory: Infinite and effective multiplication factors; Four-factor formula; Six-factor formula; Neutron cycle; Criticality condition; One-group reactor equation for bare homogeneous thermal reactor; Geometric and material buckling for standard core shapes (sphere, cylinder, parallelepiped).	6	CLO 2, CLO 3, CLO 4
4	Control of Nuclear Reactors: Reactor Kinematics; General Features of Reactor Control; Effect of Temperature on Reactivity; Design of the Control System and Reactor Operation; Fission Product Poisoning; Burnable Poisons.	6	CLO 1, CLO 3, CLO 4
5	Energy Removal: Thermal Problems in Reactor Design; Design of Cooling System; Heat Sources in Reactor Systems; Reactor Coolants.	6	CLO 3, CLO 5, CLO 6
6	Reactor Fuels: The Fuel Cycle; Production of Reactor Fuels; Sources of Uranium; Separation of Uranium Isotopes; Re-processing of Irradiated Fuel; Radioactive Waste Disposal.	6	CLO 1, CLO 3, CLO 5, CLO 6

Sl.	Course Content / Module	Hrs.	CLO(s)
7	Nuclear Engineering: Reactor Components and Core Design – Fuel, cladding, moderator, coolant, control rods, reflectors, and pressure vessel; Reactor Thermal-Hydraulics – Heat generation and transfer in fuel rods, coolant convection, and critical heat flux (CHF); Nuclear Power Plant Cycles – Rankine cycle, steam generation, turbines, and electricity production; Nuclear Safety and Waste Management – Defense-in-depth, active/passive safety systems, and management of radioactive waste.	6	CLO 4, CLO 5, CLO 6

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, nuclear reactor schematic demos	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, neutron diffusion tutorials	Class Tests, Assignments, Final Examination
CLO 3	Mathematical derivation sessions, criticality calculations	Class Tests, Assignments, Final Examination
CLO 4	Thermal hydraulics case studies, reactivity analysis	Assignments, Class Tests, Final Examination
CLO 5	Reactor safety seminars, waste management presentations	Presentation, Assignment, Final Examination
CLO 6	Reactor safety case evaluation, waste disposal review	Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Liverhant, S. E.	<i>Elementary Introduction to Nuclear Reactor Physics</i>	John Wiley & Sons
Glasstone, S., & Edlund, M. C.	<i>The Elements of Nuclear Reactor Theory</i>	CBS Publishers
Lamarsh, J. R.	<i>Introduction to Nuclear Reactor Theory</i>	Addison-Wesley
Glasstone, S., & Sesonske, A.	<i>Nuclear Reactor Engineering</i>	CBS Publishers
Bennet, D. J., & Thomson, J. R.	<i>The Elements of Nuclear Power</i>	Longman

0533 PHYS 4209: Plasma Physics

Credits: 2.0 | Theory (Core)

a. Rationale:

This course provides a comprehensive introduction to the fundamental concepts of plasma physics, single-particle motions in electromagnetic fields, fluid and kinetic descriptions of plasmas, wave phenomena in magnetized and unmagnetized plasmas, and applications in controlled thermonuclear fusion, space physics, and astrophysics.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Explain the fundamental concepts of plasma criteria, Debye shielding, plasma parameters, single-particle motions, and adiabatic invariants.	Understand
CLO 2	Describe the fluid and kinetic descriptions of plasmas, distribution functions, drift velocities, and plasma approximations.	Understand
CLO 3	Apply mathematical formulations of electromagnetic theory and fluid equations to analyze plasma equilibria and single-particle trajectories.	Apply
CLO 4	Analyze electrostatic and electromagnetic wave propagation, dispersion relations, plasma oscillations, and Landau damping.	Analyze
CLO 5	Evaluate plasma confinement mechanisms, wave-particle interactions, and plasma applications in laboratory fusion and astrophysical systems.	Evaluate

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓		✓						✓	✓
CLO 2	✓	✓	✓		✓						✓	✓
CLO 3	✓	✓	✓		✓						✓	✓
CLO 4	✓	✓	✓		✓						✓	✓
CLO 5	✓	✓	✓		✓						✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Introduction: Occurrence of plasma in nature; Definition of plasma; Basic concepts of temperature; Debye length; Plasma parameters; Distribution function; Plasma frequency; Criteria for plasmas; Plasma production; Application of plasma physics.	6	CLO 1, CLO 2
2	Single-particle Motions: The equations of motion; Motion of charged particles in static homogeneous electric and magnetic fields; Motion of charged particles in nonuniform E and B fields; Motion of charged particles in time-varying E and B fields; Adiabatic invariants.	6	CLO 1, CLO 3
3	Plasma as a Fluid: Relation of plasma physics to ordinary electromagnetics; The fluid equation of motion; The complete set of fluid equations; Fluid drifts; Plasma approximation.	5	CLO 2, CLO 3
4	Waves in Plasmas: Representation of waves; Group velocity and phase velocity; Plasma oscillations; Electron plasma waves; Sound waves; Ion waves; Comparison of ion and electron waves; Electrostatic electron and ion waves in magnetic fields; Electromagnetic waves in magnetic fields.	6	CLO 1, CLO 4

Sl.	Course Content / Module	Hrs.	CLO(s)
5	Kinetic Theory: The meaning of distribution function $f(v)$; Equations of kinetic theory; Derivations of the fluid equations; Plasma oscillations and Landau damping.	5	CLO 2, CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Interactive lectures, conceptual plasma physics demonstrations	Class Tests, Quizzes, Final Examination
CLO 2	Lectures, fluid and kinetic formulation tutorials	Class Tests, Assignments, Final Examination
CLO 3	Mathematical derivation sessions, particle drift calculations	Class Tests, Assignments, Final Examination
CLO 4	Wave dispersion analysis exercises, Landau damping problem sessions	Assignments, Class Tests, Final Examination
CLO 5	Seminars on fusion applications and astrophysical plasmas	Presentation, Assignment, Final Examination

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Krall, N. A., & Trivelpiece, A. W.	<i>Principles of Plasma Physics</i>	McGraw-Hill
Chen, F. F.	<i>Introduction to Plasma Physics and Controlled Fusion</i>	Plenum Press / Springer
Bittencourt, J. A.	<i>Fundamentals of Plasma Physics</i>	Springer
Ichimaru, S.	<i>Basic Principles of Plasma Physics: A Statistical Approach</i>	W. A. Benjamin
Artsimovich, L. A.	<i>Elementary Plasma Physics</i>	Blaisdell

0533 PHYS 4206: Honors Project-II

Credits: 2.0 | Capstone Project

a. Rationale:

This capstone course is the culmination of the undergraduate research experience. Students complete advanced experimental characterization, theoretical derivation, or numerical modeling, followed by thesis defense.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Execute advanced experimental measurements, numerical simulations, or theoretical physics derivations independently.	Articulation
CLO 2	Perform comprehensive data processing, error propagation, statistical fitting, and scientific literature comparison.	Evaluate
CLO 3	Synthesize original research findings into a publication-quality undergraduate research thesis.	Value
CLO 4	Defend scientific research findings, methodology, and future research directions before a board of examiners.	Organize

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 5	Demonstrate professional academic ethics, scientific rigor, and collaborative competencies.	Organize

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CLO 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

d. Summary of Course Contents:

Sl.	Course Content / Module	Hrs.	CLO(s)
1	Advanced Research Execution: Completing experimental characterization, refining numerical algorithms, or completing theoretical physics derivations under supervisor guidance.	10	CLO 1, CLO 2
2	Data Analysis, Validation and Error Analysis: Rigorous error propagation, statistical fitting, uncertainty quantification, literature comparison, and scientific interpretation.	10	CLO 2, CLO 3
3	Comprehensive Thesis Drafting and Revision: Compiling complete bachelor thesis according to university formatting guidelines, scientific ethics, and supervisor review.	12	CLO 3, CLO 5
4	Oral Presentation and Defense: Defending research methodology, analytical rigor, scientific findings, and future scopes before the examination board.	10	CLO 4, CLO 5

e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Direct research supervision, laboratory/coding mentoring	Continuous supervisor assessment
CLO 2	Data validation meetings, error analysis reviews	Research progress reports, supervisor review
CLO 3	Thesis drafting guidance, formatting feedback	Part 1: Written Thesis / Project Report Evaluation
CLO 4	Presentation coaching, mock defense sessions	Part 2: Oral Presentation / Defense on Thesis
CLO 5	Ethics and research integrity consultation	Supervisor assessment, academic integrity check

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Kothari, C. R.	<i>Research Methodology: Methods and Techniques</i>	New Age International
Day, R. A., & Gastel, B.	<i>How to Write and Publish a Scientific Paper</i>	Cambridge University Press

0533 PHYS 4208: Viva-voce**Credits: 1.0 | Oral Examination****a. Rationale:**

The grand viva-voce serves as the comprehensive final evaluation of graduating physics students across all theoretical, laboratory, and capstone research subjects of Year IV Term II.

b. Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

CLO	Course Learning Outcome Statement	Bloom's Level
CLO 1	Demonstrate comprehensive mastery of advanced materials science, medical physics, quantum mechanics-II, reactor physics, and research projects.	Understand
CLO 2	Articulate theoretical physics principles, analytical derivations, and experimental methodologies clearly.	Apply
CLO 3	Defend scientific knowledge and critical thinking effectively in an academic oral examination.	Value

c. Mapping CLOs with Program Learning Outcomes (PLOs):

CLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CLO 1						✓	✓	✓	✓	✓	✓	✓
CLO 2						✓	✓	✓	✓	✓	✓	✓
CLO 3						✓	✓	✓	✓	✓	✓	✓

d. Summary of Course Contents:

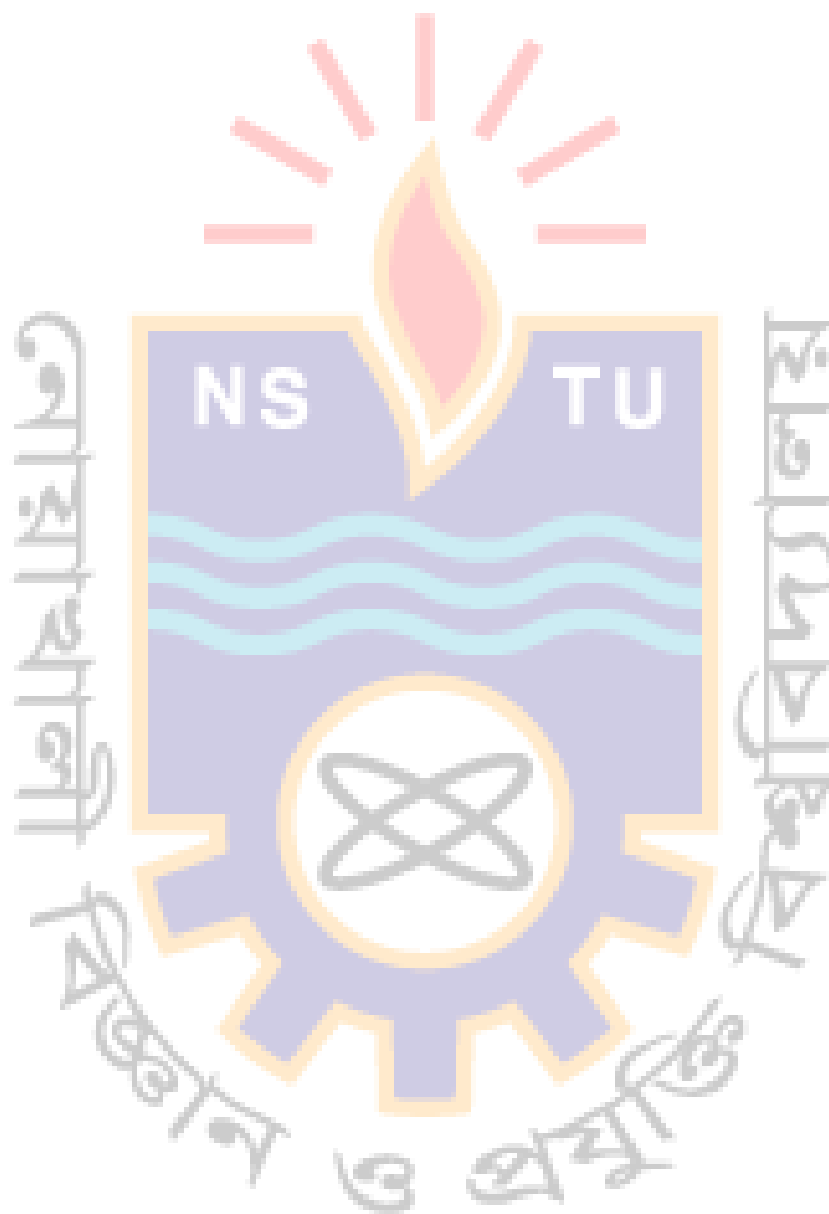
Sl.	Course Content / Module	Hrs.	CLO(s)
1	Comprehensive evaluation of core theoretical, practical, and computational physics subjects of Year IV Term II.	Full Term	CLO 1, CLO 2, CLO 3

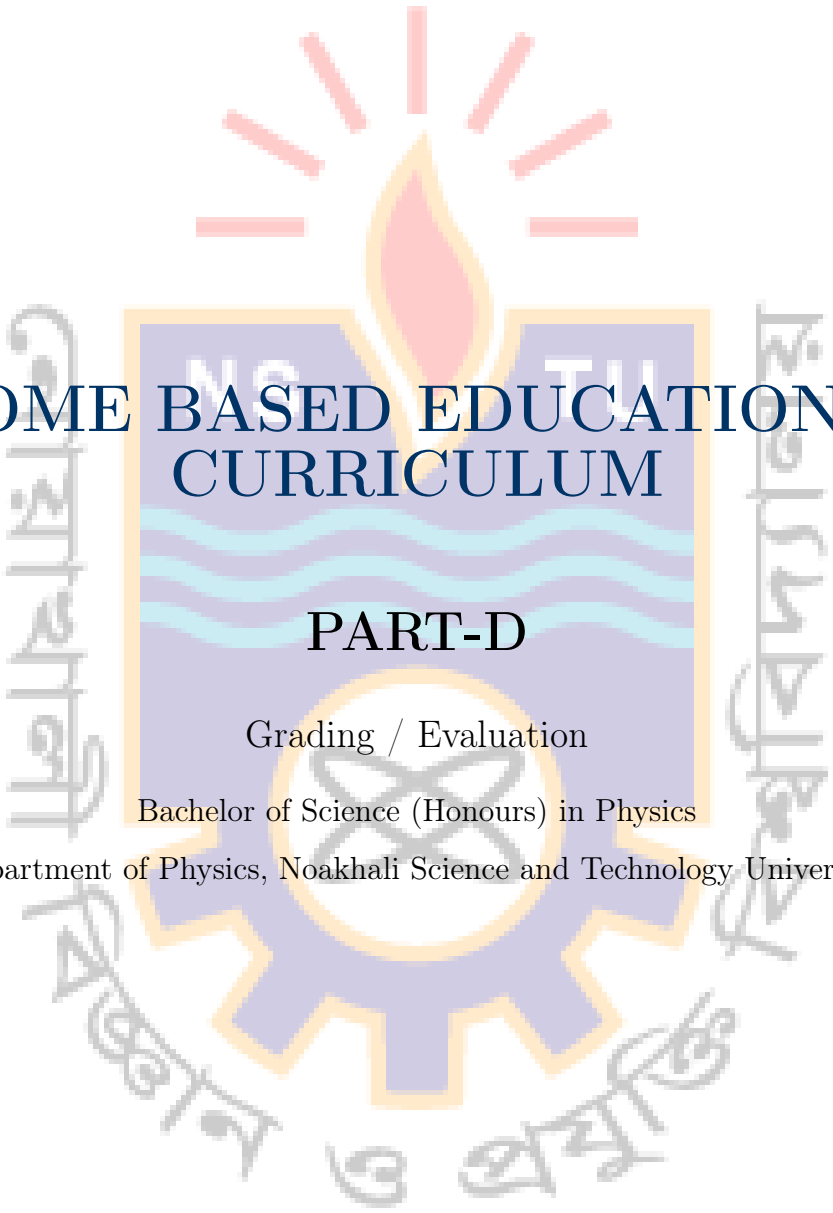
e. Teaching-Learning and Assessment Strategy:

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO 1	Review sessions, coursework discussion, self-study guidance	Oral Examination / Viva-voce
CLO 2	Interactive question-answer practice, tutorial review	Oral Examination / Viva-voce
CLO 3	Mock oral presentations, academic communication practice	Oral Examination / Viva-voce

f. Recommended Books / Reference Material:

Author(s)	Book Title	Publisher / Ed.
Prescribed textbooks and reference materials of Year IV Term II courses	—	—



The logo of Noakhali Science and Technology University is centered in the background. It features a shield with a blue and white wavy pattern, a red flame above it, and a gear below. The shield is flanked by Bengali text. Above the shield is a red sunburst.

OUTCOME BASED EDUCATION (OBE) CURRICULUM

PART-D

Grading / Evaluation

Bachelor of Science (Honours) in Physics

Department of Physics, Noakhali Science and Technology University

4 PART-D (Grading / Evaluation)

4.1 Grading / Evaluation

4.1.1 Grading Scale

Letter grades and corresponding grade points will be awarded in accordance with provisions shown below:

Numerical Grade	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	C-	2.00
Less than 40%	F	0.00
Incomplete	I	-
Withdrawn	W	-
Continuation	X	-

Distribution of Marks Thirty percent (30%) of marks shall be allotted to continuous assessment (5% attendance, 25% class tests, quizzes, assignments, term papers, etc.). The remaining 70% marks will be allotted to the Term final examination.

The distribution of marks for given theory courses will be as follows:

No.	Description	Marks
1	Attendance / Class participation	05
2	Homework assignment(s), term papers, quizzes, CTs	25
3	Final examination	70
Total		100

The class tests, quizzes, assignments, term-papers etc. carrying 25% will be arranged according to the following table:

No. of credit of the course	Total no. of assessments required	No. of best assessments to be considered
1	2	1
2 or more	3	2

Duration of a class test will be 20–45 minutes and it will preferably be taken during class hours.

The distribution of marks for a given sessional course will be as follows:

No.	Description	Marks
1	Attendance	10
2	Sessional Evaluation (Lab Report, Lab Final, Quiz, etc.)	70
3	Oral test / Viva-Voce / Final Jury	20
Total		100

In a similar manner, the distribution of marks for a given thesis/Monograph/Project paper course will be as follows:

No.	Description	Marks
1	Evaluation	60
2	Presentation	20
3	Viva-Voce	20
Total		100

There will be two examiners (including the Supervisor) to examine the thesis. Each examiner will evaluate the thesis separately and the average marks will be considered for grading. However, if the marks given by the first and second examiners vary 20% or more, a third examiner is to be appointed by the concerned Examination Committee from outside the University who will evaluate the thesis. Among these numbers, average of the closest two numbers will be considered for grading. However, if the marks given by the third examiner happen to stand at the middle of the marks given by the first two examiners, the average of the higher two marks will be considered for grading.

Basis for awarding marks for class attendance will be as follows:

Attendance Rate	Marks (Theory)	Marks (Sessional/Capstone)
90% or above	5	10
85% to below 90%	4.5	9
80% to below 85%	4	8
75% to below 80%	3.5	7
70% to below 75%	3	6
65% to below 70%	2.5	5
60% to below 65%	2	4
Below 60%	0	0

Earned Credits Only those courses in which a student obtains a 'D' (or C- under the standard scale) or a higher grade will be counted as credit earned by him/her.

Regular Grading & Repetition of Courses F Grade will not be counted for Grade Point Average (GPA) calculation but will be shown on the Grade Sheet. When a student repeats a course in which s/he previously obtained an F grade, s/he will be awarded the immediate lower grade obtained in the repeated course. However, if s/he obtains a D grade, that will be maintained.

While registering for a retake/re-retake theoretical course, a student must be given an option to decide if s/he intends to sit for continuous assessment of the course. If s/he opts to sit for continuous assessments, the fresh mark will be counted to prepare the result. However, class attendance and participation marks will be taken from the previous record.

Grade Improvement A student will be allowed only once to improve a maximum of 2 (two) theory courses for which s/he has obtained a C grade (GPA 2.25) or less in the previous term by registering for the term final examination of the immediate next term. Course registration for improvement examination is not necessary, but the courses must be cited in the exam application form with fees of TK 100/- for each. If the course grade does not improve, the previous course grade will sustain.

4.1.2 Grades

Grade-related issues are reported in section 20.1.

4.1.3 Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

Grade Point Average (GPA) is the weighted average of grade points obtained in all the courses completed by a student in a term. Cumulative Grade Point Average (CGPA) is calculated by the weighted average

of all courses completed up to date.

Performance Evaluation The performance of a student will be evaluated in terms of two indices: Term Grade Point Average (TGPA) and Cumulative Grade Point Average (CGPA).

Minimum Earned Credits and GPA Requirements for Obtaining Degree Students must complete their studies within a maximum of 6 years (12 terms) for a 4-year program (or 7 years for a 5-year program). Credit hour requirements for awarding Bachelor / Bachelor's (Hons) degrees cannot be less than 130 credits for a 4-year program (140 credits for 5-year programs) as per BNQF guidelines.

The minimum CGPA requirement for obtaining a Bachelor/Bachelor's (Hons) degree is 2.25.

Qualifying GPA for Promotion A student securing a GPA below 2.00 in a particular Term Examination will not be promoted to the higher Term. Such a student will repeat the courses of the whole year by re-admission with the students of the next session.

A student may take additional courses with the consent of his/her Head of Department to raise GPA up to a maximum of 15 additional credits in a 4-year program (18 credits in a 5-year program) beyond individual credit requirements during his/her entire period of study.

Application for Graduation and Award of Degree A student who has fulfilled all the academic requirements for a Bachelor/Bachelor's (Hons) degree will apply to the Controller of Examinations through his/her Head of Department for graduation. Provisional Degree will be awarded upon completion of credits and CGPA requirements.

Industrial/Professional Attachment Depending on department requirements, a student may have to complete a prescribed number of days of industrial/professional training/attachment/fieldwork as credit/non-credit requirements.

4.1.4 Course / Term Withdrawal

If any student cannot complete the Term Final Examination due to severe illness or serious accident, s/he may apply to the Dean through the Head of the concerned Department for total withdrawal from the Term within eight working days after the Term Final Examination. A medical certificate endorsed by the Chief Medical Officer of the University must support the application.

4.1.5 Backlog and Special Term

- (a) **Backlog Courses:** A student must register for backlog/retake core courses first, followed by fresh courses.
- (b) **Credit Limit & Minimum Earned Credit:** A student must register for at least 15 credits and up to a maximum of 25 credits per term. When registering for courses in 3rd year 2nd Term, earned credits up to 2nd year 2nd Term must be at least 36. Otherwise, studentship will stand canceled. No student is allowed a backlog course in the final year.
- (c) **Special Term:** A Special Term may be offered for final year students who have retake/re-retake course(s) up to a maximum credit limit of 15 credits. This is a Non-Taught Term starting 4 weeks after publishing 4th-year 2nd Term results and lasting not more than 2 weeks. Continuous assessment marks (30%) are carried over, and the Special Term Final Exam carries the remaining 70% marks.
- (d) **Internship / Research Study:** Conducted according to the course curriculum of the respective department.

Attendance

1. To be eligible for appearing at the final examination, each student must be present in at least 70% of classes for each theoretical and sessional course.
2. Students obtaining 60–69% attendance may be allowed to appear at the examination on payment of Tk. 1,000.00 as a fine.
3. Students with attendance below 60% shall not be allowed to appear at the final examination.
4. Course teachers will record and finalize attendance and submit it to the Department Head, who will forward it to the Registrar's office.

Deletion of Name and Re-admission The name of a student will be deleted from the University register if:

- (a) S/he fails to join classes within 15 working days of first-year admission.
- (b) S/he cancels admission through proper application.
- (c) Admission is canceled due to breach of discipline.
- (d) Non-payment of university dues within the stipulated time.

Deletion under (a) and (b) will not be considered for readmission. Expelled students may apply for readmission within six months after the expulsion period ends. If deleted due to non-payment (d), readmission is permitted in that session or within one year upon application.

Absence During a Term Absence from quizzes/class tests/fieldwork reduces points towards final grades. Absence in the Term Final Examination results in an 'F' grade. Absence up to three weeks due to illness requires a medical certificate endorsed by the Chief Medical Officer for make-up assessments.