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No. HEC/CD/NCRC/PHYSICS/2025/7134

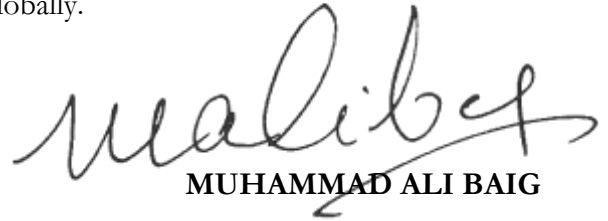
February 11, 2025

SUBJECT: REVISED CURRICULA FOR DEGREE PROGRAMS IN PHYSICS

The Higher Education Commission (HEC) of Pakistan, as mandated by its law, provides guidance to Higher Education Institutions (HEIs) on curricula for tertiary education levels in alignment with the National Qualifications Framework (NQF). To address evolving academic trends and market demands, HEC, in collaboration with the Pakistan Academy of Sciences (PAS), has revised the curricular standards for Physics degree programs at NQF levels 5, 6 and 7. These updated standards are intricately aligned with HEC's Undergraduate Education Policy V 1.1 (2023) and Graduate Education Policy (2023), ensuring coherence with national priorities and adherence to international benchmarks.

2. The revised curricula for Physics degree programs, incorporating an option for advanced electives, are hereby notified. Universities offering these programs are advised to align their Physics curricula with these updated standards as a minimum requirement. Additionally, the respective departments must develop course contents in accordance with the prescribed framework, ensuring that the programs address both national and local industry needs. The finalized course contents should be submitted electronically to this office at the earliest. An electronic copy of the revised curricula is available on HEC's official website.

3. Through effective implementation of these standards, HEC envisions a future where Pakistani graduates in Physics excel in scientific discovery and technological innovation, making substantial contributions to socio-economic progress both nationally and globally.

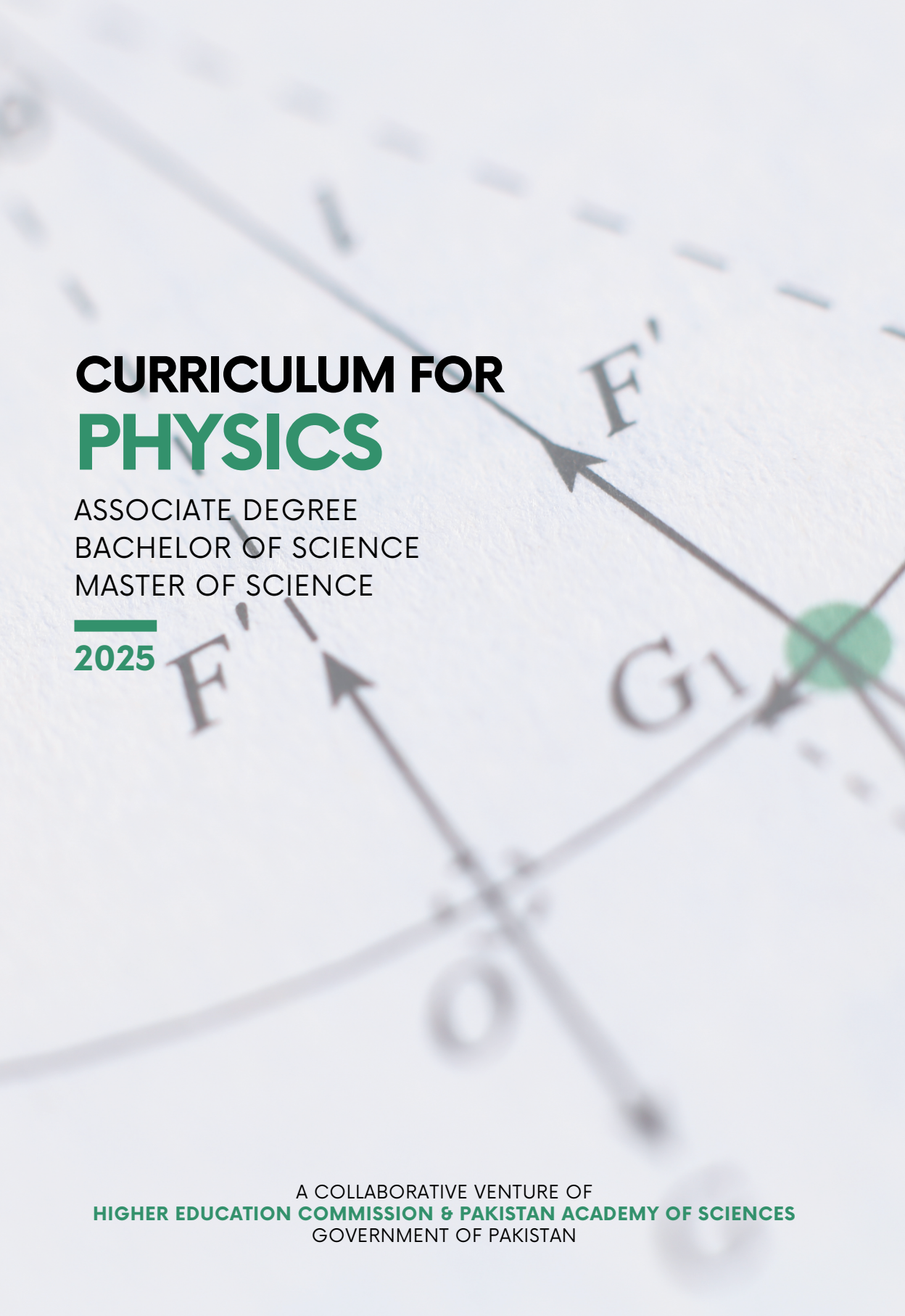

MUHAMMAD ALI BAIG

Vice Chancellors/Rectors/Heads

All Public/Private Sector Universities/DAIs

Copy for information to:

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- ii. ES to Chairman, Higher Education Commission, Islamabad
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CURRICULUM FOR PHYSICS

ASSOCIATE DEGREE
BACHELOR OF SCIENCE
MASTER OF SCIENCE

2025

A COLLABORATIVE VENTURE OF
HIGHER EDUCATION COMMISSION & PAKISTAN ACADEMY OF SCIENCES
GOVERNMENT OF PAKISTAN



CURRICULUM FOR
PHYSICS
DEGREE PROGRAMS

2025

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Preface

The curriculum serves as a comprehensive blueprint for the teaching-learning process that students must navigate to achieve specific academic objectives. This encompasses clearly defined prior learning requirements, program objectives, scheme of studies, and course learning outcomes. As knowledge rapidly evolves and new fields emerge, it is crucial to continually develop and revise curricula to ensure they remain current, relevant, and impactful.

As mandated by its law through Clause 10-1 (a), (l), (s), and (v), the Higher Education Commission (HEC) of Pakistan has been developing and periodically updating curricula through its National Curriculum Revision Committees (NCRCs). These committees are generally composed of subject matter experts, researchers, and representatives from accreditation bodies, professional councils, and industry stakeholders. In response to the evolving needs, HEC, in collaboration with the Pakistan Academy of Sciences (PAS), has undertaken the task to develop robust standards for the curricula of degree programs in Physics at levels 5, 6 and 7 of the National Qualifications Framework. These standards are meticulously structured in accordance with the HEC's Undergraduate Education Policy V 1.1 (2023) and Graduate Education Policy (2023), ensuring alignment with both national priorities and international educational standards.

The degree programs in Physics are designed to equip students with cutting-edge knowledge and practical skills, fostering innovation and research to address the emerging and unique challenges in the field of Physics. It is hoped that these curricular standards, prescribed by subject experts from across the country, will not only contribute towards meeting the national educational and economic requirements but will also elevate the competency levels of our graduates in the field of Physics.

With the support of universities in implementing these standards, HEC envisions a future where Pakistani graduates in Physics are at the forefront of scientific discovery and technological innovation, driving progress and contributing to the betterment of society both nationally and internationally.

Dr. Amjad Hussain

Director General
Academics Division

Guiding Principles

MINIMUM STANDARDS

The curricular standards and guidelines prescribed in this document are mandatory at minimum level. Universities or the concerned departments may however set higher standards provided that the standards prescribed herein are not reduced or compromised.

COURSE SEQUENCE, TITLES & CREDITS

For Bachelor of Science and Master of Science in Physics, the sequence of courses prescribed in this document is logically arranged and is suggestive only. The concerned department may rearrange the sequence and alter the course titles and credit hours provided that the essence of the courses prescribed herein remains intact. The concerned department may also add more courses as and when required subject to approval of university's relevant statutory body.

COURSE LEARNING OUTCOMES

The course learning outcomes (CLOs) prescribed in this document represent the minimum level of competency and understanding expected from students. While these standards must not be compromised, departments are encouraged to enhance the rigor of the CLOs by incorporating additional learning outcomes, provided these do not alter the essence of the prescribed standards. In this document, CLOs are exclusively developed for major and interdisciplinary courses, whereas for electives, CLOs are not prescribed as these are advanced or specialized courses. The development of CLOs for electives is the responsibility of the concerned department, taking into account the course's advanced nature and relevance to the program. For General Education courses as prescribed in the HEC Undergraduate Education Policy V 1.1. including the course of Pakistan Studies, departments may adopt the CLOs prescribed in the HEC-developed model courses, as available on its website.

COURSE SYLLABUS

This document serves as a comprehensive guideline delineating the CLOs for each course as prescribed for the Bachelor of Science and Master of Science in Physics as minimum standards. The concerned department is required to meticulously prepare, modify, and tailor the syllabus of each course, ensuring alignment with the stipulated learning outcomes. It is in this regard imperative that the concerned department utilizes instructional, reference, and reading materials that it deems appropriate to effectively meet the CLOs.

GENERAL EDUCATION

For Bachelor of Science in Physics, the courses prescribed for General Education including the course of "Pakistan Studies" must mandatorily be offered with the same titles and credit hours as prescribed in the HEC Undergraduate Education Policy V 1.1. The concerned department may adopt and follow the learning outcomes and study contents developed by HEC for these courses as available on its website. The requirement of General Education is not applicable to Master of Science in Physics.

REQUIREMENT OF INTERNSHIP

Internship of 3 credit hours is a mandatory degree award requirement for Bachelor of Science

in Physics. Internship of 6 to 8 weeks (preferably undertaken during semester or summer break) must be graded by a faculty member in collaboration with the supervisor in the field. This requirement cannot be substituted with additional course work, capstone or project work.

REQUIREMENT OF CAPSTONE

It is a mandatory degree award requirement of 3 credit hours for Bachelor of Science in Physics. The capstone is a multifaceted body of work that serves as a culminating academic and intellectual experience for students. It must be supervised and graded by a faculty member as per the protocols prescribed by the concerned department. This requirement cannot be substituted with additional course work or internship.

ASSOCIATE DEGREE IN PHYSICS

The eligibility criteria and the first-four semesters of the Bachelor of Science in Physics as prescribed in this document guide the admission requirement and the structure of Associate Degree in Physics, respectively. Field experience / internship is not a mandatory requirement for the Associate Degree in Physics.

LABORATORY REQUIREMENTS

The departments offering degree programs in Physics are required to adhere to the laboratory requirements as specified in this document, as minimum standards. The concerned department is expected to enhance the laboratory standards as and when required and maintain / upgrade the same from time to time in order to ensure quality education and research in the field of Physics.

ENTRY & EXIT PROVISIONS

Pathway for Graduates with Associate Degree

- a) Students having completed Associate Degree in Physics or any discipline related to the field of Physics shall be required to complete deficiency courses up-to a maximum of 18 credit hours (if required) as determined by the admitting university / department. In case where the deficiency courses are of more than 18 credit hours, the concerned university may decide not to offer admission in accordance with its screening, admission and merit calculation criteria approved by its statutory bodies.
- b) The minimum eligibility for admission in the fifth semester in this case is 2.00/4.00 CGPA obtained in the prior qualification i.e., Associate Degree. The admitting university may, however, set higher eligibility criteria for admission in the fifth semester of Bachelor of Science in Physics.

Pathway for Graduates with Conventional BSc / Equivalent Degree Programs

- a) Students having completed two-year conventional BSc / equivalent degree programs are allowed admission in the fifth semester of Bachelor of Science in Physics in which case, such students shall be required to complete deficiency courses up-to a maximum of 21 credit hours as determined by the admitting university / department. In case where the deficiency courses are of more than 21 credit hours, the concerned university may decide not to offer admission in accordance with its screening, admission and merit calculation criteria approved by its statutory bodies.
- b) The minimum eligibility for admission in the fifth semester in this case is 45% cumulative

score obtained in the prior qualification i.e., two-year conventional BSc / equivalent degree programs. The admitting university may however set higher eligibility criteria for admission in the fifth semester of Bachelor of Science in Physics.

Exiting from Bachelor of Science in Physics with the Associate Degree

Exit from Bachelor of Science in Physics with Associate Degree in the same discipline is allowed in accordance with the provisions of HEC Undergraduate Education Policy V 1.1. and only in such circumstances where no other remedy is available to safeguard the academic career of the student.

CURRICULUM FOR BACHELOR OF SCIENCE (BS) PHYSICS

BS Physics

PROGRAM DESCRIPTION

The Bachelor of Science in Physics program is designed in accordance with the Higher Education Commission's (HEC) Undergraduate Education Policy V 1.1, offering students a comprehensive education in Physics, with an emphasis on both theoretical understanding and practical application. The program spans eight semesters and provides a balanced curriculum that begins with general education courses, ensuring a strong foundation in mathematics, natural sciences, and critical thinking. As students progress, they will study specialized courses that cover key areas of Physics, including classical mechanics, quantum mechanics, electrodynamics, and thermodynamics, as well as emerging fields such as materials science. Throughout the program, students will engage in hands-on laboratory work, enhancing their technical skills and enabling them to apply theoretical concepts to real-world situations. While designing this program, emphasis is placed on the development of analytical and problem-solving abilities, with the aim of preparing students for careers in industry, education, and technology sectors.

STANDARD NOMENCLATURE

To ensure uniformity, the standard nomenclature of all four-year undergraduate degree programs in Physics must be **"Bachelor of Science in Physics"**.

PROGRAM LEARNING OUTCOMES

By the completion of Bachelor of Science in Physics, the graduates will be able to:

- a) Demonstrate a comprehensive understanding of basic concepts related to core subjects in physics, including but not limited to classical mechanics, quantum mechanics, electromagnetism, statistical mechanics and thermodynamics.
- b) Effectively apply mathematical and computational techniques to analyze and solve complex physical problems in both theoretical and experimental contexts.
- c) Communicate scientific knowledge and research findings effectively, demonstrating a commitment to continuous learning and professional development in the field of Physics.

ELIGIBILITY & ADMISSION CRITERIA

Higher Secondary School Certificate (involving 12 years of schooling) or an IBCC equivalent qualification with a subject of Mathematics or Physics is the basic eligibility requirement for admission in the Bachelor of Science in Physics. The admitting university may set minimum eligibility scores and may conduct entry / admission test through its own testing body or an external testing services provider of repute as per the screening, admission and merit calculation criteria approved by its statutory bodies.

PROGRAM STRUCTURE

The Bachelor of Science in Physics is structured in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1. and comprises of minimum 134 credit hours spread over 8 regular semesters. Universities may offer courses up-to maximum of 144 credit hours provided that the total number of credit hours are reasonably set to achieve the Program Learning Objectives (PLOs) without putting undue burden on students.

Minimum Credit Hours	134
General Education	32 credit hours (13 courses)
Discipline Related Courses / Major	78 credit hours (26 courses)
Interdisciplinary / Allied Courses	18 credit hours (6 courses)
Internship	3 credit hours
Capstone Project	3 credit hours
Program Duration	Minimum: 4 years (8 regular semesters) Maximum: 6 years (12 regular semesters) The maximum limit is further extendable in accordance with HEC semester rules
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)
Course Load (per semester)	15-18 credit hours for regular semesters Up-to 8 credit hours for summer semesters (for remedial/deficiency/failure/repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours) per week throughout the semester
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work / project requires lab contact of 3 hours per week throughout the semester

SEMESTER 1			
S.N.	Course	Credit Hours	Category
1	Introductory Mechanics	3 (2-1)	Major
2	Calculus – I	3 (3-0)	Major

3	Quantitative Reasoning – I *	3 (3-0)	General Education
4	Natural Science **	3 (2-1)	General Education
5	Functional English *	3 (3-0)	General Education
6	Applications of Information & Communication Technologies (ICT) *	3 (2-1)	General Education
TOTAL CREDIT HOURS: 18			

SEMESTER 2			
S.N.	Course	Credit Hours	Category
1	Waves & Optics	3 (2-1)	Major
2	Calculus – II	3 (3-0)	Major
3	Quantitative Reasoning – II *	3 (3-0)	General Education
4	Expository Writing *	3 (3-0)	General Education
5	Pakistan Studies *	2 (2-0)	General Education
6	Social Sciences ***	2 (2-0)	General Education
7	Islamic Studies * (Ethics for non-Muslim students)	2 (2-0)	General Education
TOTAL CREDIT HOURS: 18			

SEMESTER 3			
S.N.	Course	Credit Hours	Category
1	Electricity & Magnetism	3 (2-1)	Major
2	Heat & Thermodynamics	3 (2-1)	Major
3	Differential Equations	3 (3-0)	Major

4	Linear Algebra	3 (3-0)	Interdisciplinary
5	Arts & Humanities ****	2 (2-0)	General Education
6	Ideology & Constitution of Pakistan *	2 (2-0)	General Education
TOTAL CREDIT HOURS: 16			

SEMESTER 4			
S.N.	Course	Credit Hours	Category
1	Modern Physics	3 (2-1)	Major
2	Vector Calculus	3 (3-0)	Major
3	Classical Mechanics	3 (3-0)	Major
4	Environmental Physics	3 (3-0)	Interdisciplinary
5	Civics & Community Engagement *	2 (2-0)	General Education
6	Entrepreneurship *	2 (2-0)	General Education
TOTAL CREDIT HOURS: 16			

SEMESTER 5			
S.N.	Course	Credit Hours	Category
1	Electronics – I	3 (2-1)	Major
2	Mathematical Methods of Physics – I	3 (3-0)	Major
3	Electromagnetic Theory	3 (3-0)	Major
4	Medical Physics	3 (3-0)	Interdisciplinary
5	Computational Physics	3 (2-1)	Interdisciplinary

6	Scientific Inquiry & Research Methods	3 (3-0)	Interdisciplinary
TOTAL CREDIT HOURS: 18			

SEMESTER 6			
S.N.	Course	Credit Hours	Category
1	Electronics – II	3 (2-1)	Major
2	Quantum Mechanics – I	3 (3-0)	Major
3	Mathematical Methods of Physics – II	3 (3-0)	Major
4	Electrodynamics & Special Relativity	3 (3-0)	Major
5	Condensed Matter Physics	3 (3-0)	Major
TOTAL CREDIT HOURS: 15			

SEMESTER 7			
S.N.	Course	Credit Hours	Category
1	Atomic & Molecular Physics	3 (2-1)	Major
2	Quantum Mechanics – II	3 (3-0)	Major
3	Nuclear Physics	3 (2-1)	Major
4	Elective – I *****	3	Major
5	Elective – II *****	3	Major
TOTAL CREDIT HOURS: 15			

SEMESTER 8			
S.N.	Course	Credit Hours	Category
1	Statistical Mechanics	3 (3-0)	Major

2	Elective – III *****	3	Major
3	Elective – IV *****	3	Major
4	Artificial Intelligence in Physics	3 (2-1)	Interdisciplinary
5	Capstone	3	Capstone
TOTAL CREDIT HOURS: 15			

- * HEC designed model courses may be adopted and used by the university.
- ** The university / concerned department may offer any course in the broader category of **“Natural Sciences”** which should have relevance to the purpose of the degree program.
- *** The university / concerned department may offer any course in the broader category of **“Social Sciences”** including but not limited to a course of Psychology, Sociology, Anthropology etc.
- **** The university / concerned department may offer any course in the broader category of **“Arts & Humanities”** including but not limited to a course of regional or international language such as Chinese, Arabic, French, Spanish etc.
- ***** The university / concerned department may offer any advanced course in the field of Physics as an **elective**, where required as per the available academic, human and infrastructural resources. **Credit combination** (reflecting balance of theory and lab / field work) must be arranged in accordance with the nature of the course.

DEGREE AWARD REQUIREMENTS

The following minimum requirements are prescribed for award of Bachelor of Science in Physics:

- All courses in the General Education category with titles and credit hours as prescribed in the HEC Undergraduate Education Policy V 1.1. including the course of “Pakistan Studies” must be completed.
- Minimum of 134 credit hours as prescribed in this document must be completed.
- Capstone of 3 credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement cannot be substituted with additional coursework or internship.
- Internship of 3 credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement cannot be substituted with additional coursework, capstone, research or project work.
- CGPA must not be below 2.00/4.00 at the time of completion of the degree program. The university may however set higher standard in this regard.
- The minimum duration to complete the degree program is 8 regular semesters and the maximum duration is 12 regular semesters. The maximum duration may further be extended in accordance with HEC semester guidelines. Summer semester is not considered as a regular semester.

CURRICULUM FOR MASTER OF SCIENCE (MS) PHYSICS

MS Physics

PROGRAM DESCRIPTION

The Master of Science in Physics is designed in alignment with the HEC Graduate Education Policy 2023, offering a comprehensive and advanced understanding of the core areas of Physics. This program is structured to deepen students' knowledge of fundamental and contemporary Physics, with a strong emphasis on research and the latest technological advancements. Students will engage in a rigorous curriculum that integrates theoretical studies with experimental and computational techniques, fostering critical thinking and problem-solving skills. Through this interdisciplinary approach, students will be prepared to address complex physical phenomena and contribute to advancements in various fields, including academia, industry, and research institutions. The program is designed with an emphasis on developing independent research capabilities, enabling students to explore and solve challenging problems in Physics. Graduates of this degree program will be equipped with the skills necessary to pursue careers in research, education, and high-tech industries, contributing to scientific innovation and addressing critical challenges facing Pakistan and the global community.

STANDARD NOMENCLATURE

To ensure uniformity, the standard nomenclature of all graduate degree programs (NQF-7) in Physics must be **“Master of Science in Physics”**.

PROGRAM LEARNING OUTCOMES

By the completion of Master of Science in Physics, the graduates will be able to:

- a) Critically analyze and synthesize advanced concepts and current research in the field of Physics.
- b) Apply advanced theoretical, computational and experimental techniques to conduct independent research in Physics.
- c) Demonstrate the ability to effectively communicate scientific findings and theoretical concepts in Physics.

ELIGIBILITY & ADMISSION CRITERIA

- a) An undergraduate degree (involving 16 years of education) in Physics is the basic eligibility requirement for admission in the Master of Science in Physics.
- b) Candidates having undergraduate degrees (involving 16 years of education) in any discipline other than but relevant to the discipline of Physics are also eligible for admission to the program subject to completion of deficiency courses up-to a maximum of 9 credit hours to be determined by the concerned department in accordance with the provisions of the HEC Graduate Education Policy (2023).
- c) In addition to the basic eligibility, the admitting university is further required to conduct a rigorous admission test as an eligibility condition for admission to the program, with a passing score of 50% **(OR)** accept the GRE / HAT General / equivalent tests, with a passing score of 50%. The admitting university may also set minimum eligibility scores (above 50%)

as per the screening, admission and merit calculation criteria approved by its statutory bodies.

PROGRAM STRUCTURE

The standard program structure for Master of Science in Physics is as under:

Minimum Credit Hours	30
Minimum Coursework Requirement	24 credit hours (8 courses)
Thesis Requirement (mandatory)	6 credit hours
Program Duration	Minimum: 1.5 Years (3 regular semesters) Maximum: 4 Years (8 regular semesters) Note: In case a student is unable to secure an MS within the prescribed timeframe and claims for extension in duration, the university may constitute appropriate authority and determine the causes of delay. In the event of force majeure (i.e., delay on account of circumstance beyond the control of student), the university may grant an extension in the period of award of MS degree in accordance with the duration limiting factor(s) and shall also take corrective measures in case the delay is caused by process or administrative reasons.
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)
Course Load (per semester)	9-12 credit hours for regular semesters Up-to 8 credit hours for summer semesters (for remedial / deficiency / failure / repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours)
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work requires lab / field contact of 3 hours per week throughout the semester.

SEMESTER 1			
S.N.	Course	Credits	Category
1	Advanced Quantum Mechanics *	3 (3-0)	Core
2	Advanced Mathematical Physics *	3 (3-0)	Core
3	Elective – I **	3	Elective
4	Elective – II **	3	Elective
TOTAL CREDIT HOURS: 12			

SEMESTER 2			
S.N.	Course	Credits	Category
1	Advanced Electrodynamics *	3 (3-0)	Core
2	Techniques of Experimental & Computational Physics *	3 (3-0)	Core
3	Elective – III **	3	Elective
4	Elective – IV **	3	Elective
TOTAL CREDIT HOURS: 12			

SEMESTER 3			
S.N.	Course	Credits	Category
	Thesis ***	6	Research
TOTAL CREDIT HOURS: 6			

* These are the **mandatory courses** for the program.

- ** The university / concerned department may offer any advanced course in the field of Physics as an **elective**, where required as per the available academic, human and infrastructural resources. **Credit combination** (reflecting balance of theory and lab / field work) must be arranged in accordance with the nature of the course.
- *** Research work for **thesis** must be conducted by students individually in accordance with the university's policy as approved through its statutory bodies provided that the same is in accordance with the HEC Graduate Education Policy (2023).

DEGREE AWARD REQUIREMENTS

The following minimum requirements are prescribed for award of Master of Science in Physics:

- a) Minimum of 24 credit hours including 12 credit hours for core courses and 12 credit hours for elective courses as prescribed in this document must be completed.
- b) In addition to coursework of 24 credit hours, research thesis of minimum 6 credit hours must also be completed individually as mandatory requirement of the degree program. Requirement of research work / thesis cannot be substituted with additional course work.
- c) CGPA must not be below 2.50/4.00 at the time of completion of the degree program. The university may however set higher standard in this regard.
- d) The minimum duration required to complete the degree is 3 regular semesters which may be extended up to maximum of eight 8 semesters. Summer / winter semester is not considered as a regular semester.

COURSE LEARNING OUTCOMES FOR BS & MS PHYSICS

Arranged in Alphabetical Order

Course Learning Outcomes

(Arranged in Alphabetical Order)

ADVANCED ELECTRODYNAMICS

By the end of this course, students will be able to:

- Exhibit expertise in applying principles of electrodynamics to investigate and solve advanced and complex electromagnetic phenomena.
- Critically analyze practical implications of different electrodynamic concepts and applications as used in contemporary research in Physics.
- Integrate advanced electrodynamic concepts to formulate solutions for boundary – value problems.

ADVANCED MATHEMATICAL PHYSICS

By the end of this course, students will be able to:

- Demonstrate proficiency in utilizing advanced mathematical methods and techniques to formulate and solve intricate problems in Physics.
- Assess the relevance, limitations, and applications of various mathematical tools in addressing contemporary challenges in theoretical and applied Physics.
- Integrate advanced mathematical concepts to model complex physical systems, analyze outcomes, and make informed predictions in the domain of mathematical Physics.

ADVANCED QUANTUM MECHANICS

By the end of this course, students will be able to:

- Demonstrate mastery in applying principles and techniques of quantum mechanics to solve complex problems.
- Critically evaluate and interpret the implications of quantum mechanical methods in various modern Physics research contexts.
- Apply approximate methods of quantum mechanics to address advanced problems.

ARTIFICIAL INTELLIGENCE IN PHYSICS

By the end of this course, the students will be able to:

- Understand the fundamental principles and algorithms of Artificial Intelligence relevant to solving physics problems.
- Apply AI techniques to model and simulate complex physical systems and phenomena.
- Evaluate the effectiveness of AI tools in optimizing and enhancing experimental and theoretical research in physics.

ATOMIC & MOLECULAR PHYSICS

By the end of this course, the students will be able to:

- Describe the structure and properties of atoms and molecules.
- Apply quantum mechanical principles to explain atomic and molecular spectra.
- Analyze interactions between radiation and matter at the atomic level.

CALCULUS – I

By the end of this course, the students will be able to:

- Solve problems involving limits, continuity, and derivatives of functions.
- Apply differentiation techniques to analyze real-world physical scenarios.

- Integrate elementary functions and apply them to compute areas and volumes.

CALCULUS – II

By the end of this course, the students will be able to:

- Solve integrals involving trigonometric, exponential, and logarithmic functions.
- Analyze sequences and series for convergence.
- Apply multivariable calculus to solve problems in physics.

CLASSICAL MECHANICS

By the end of this course, the students will be able to:

- Apply Newton's laws of motion to analyze the dynamics of particles and rigid bodies.
- Solve problems in Lagrangian and Hamiltonian mechanics.
- Analyze systems under conservative and non-conservative forces.

COMPUTATIONAL PHYSICS

By the end of this course, the students will be able to:

- Implement numerical methods to solve physical problems.
- Develop and use computational algorithms for simulating physical systems.
- Independently program computers using leading edge tools.

CONDENSED MATTER PHYSICS

By the end of this course, the students will be able to:

- Describe the crystal structure and properties of solids.
- Analyze the electronic properties of materials using quantum mechanics.
- Explain phenomena such as superconductivity, magnetism, and semiconductors.

DIFFERENTIAL EQUATIONS

By the end of this course, the students will be able to:

- Solve ordinary differential equations (ODEs) relevant to physical systems.
- Analyze systems of differential equations in modeling physical phenomena.
- Apply partial differential equations (PDEs) to problems in physics.

ELECTRICITY & MAGNETISM

By the end of this course, the students will be able to:

- Apply electrostatics and magnetostatics to solve various problems.
- Explain fundamental laws in electricity and magnetism especially with regards to Maxwell's Law.
- Describe the interaction between charged particles and electromagnetic fields.

ELECTRODYNAMICS & SPECIAL RELATIVITY

- By the end of this course, the students will be able to:
- Apply the principles of electrodynamics to analyze electromagnetic waves.
- Solve problems involving the interaction of light and matter.
- Explain the fundamental concepts of special relativity and their application to physical problems.

ELECTROMAGNETIC THEORY

By the end of this course, the students will be able to:

- Apply laws of electrostatics and magnetostatics in the presence of medium.
- Apply Maxwell's equations to problems in electromagnetism.
- Analyze the propagation of electromagnetic waves in various media.

ELECTRONICS – I

By the end of this course, the students will be able to:

- Analyze basic electronic circuits involving diodes, transistors, and operational amplifiers.
- Design and construct simple analog circuits.
- Apply the principles of electronics to solve practical problems.

ELECTRONICS – II

By the end of this course, the students will be able to:

- Analyze advanced electronic circuits and systems including digital circuits.
- Design and implement complex electronic systems for specific applications.
- Evaluate the performance and functionality of digital systems.

ENVIRONMENTAL PHYSICS

By the end of this course, the students will be able to:

- Analyze physical principles underlying environmental processes and phenomena.
- Apply concepts of energy, radiation, and thermodynamics to environmental systems.
- Evaluate the impact of human activities on the environment using physical models.

HEAT & THERMODYNAMICS

By the end of this course, the students will be able to:

- Apply the laws of thermodynamics to analyze heat engines and refrigerators.
- Analyze the properties of ideal and real gases using kinetic theory.
- Solve problems involving heat transfer and thermal equilibrium.

INTRODUCTORY MECHANICS

By the end of this course, the students will be able to:

- Apply the basic principles of mechanics to solve problems involving motion.
- Analyze the dynamics of systems under the influence of forces.
- Describe the conservation of momentum and energy in mechanical systems.

LINEAR ALGEBRA

By the end of this course, the students will be able to:

- Solve systems of linear equations using matrix methods.
- Apply vector spaces and linear transformations to physical problems.
- Analyze eigenvalues and eigenvectors in the context of physical systems.

MATHEMATICAL METHODS OF PHYSICS – I

By the end of this course, the students will be able to:

- Apply complex analysis to solve physical problems.
- Use Fourier analysis to solve differential equations in physics.
- Apply linear algebra and vector and tensor calculus to physical systems.

MATHEMATICAL METHODS OF PHYSICS – II

By the end of this course, the students will be able to:

- Solve advanced differential equations relevant to physics.
- Apply special functions in the solution of physical problems.
- Use variational principles and other mathematical techniques in physical contexts.

MEDICAL PHYSICS

By the end of this course, the students will be able to:

- Describe the applications of physics in medical diagnostics and therapy.

- Analyze the interaction of radiation with biological tissues.
- Apply the principles of medical imaging and radiation therapy.

MODERN PHYSICS

By the end of this course, the students will be able to:

- Describe the basic concepts of quantum mechanics and relativity.
- Apply quantum mechanical principles to atomic and subatomic systems.
- Analyze the experimental basis and implications of modern physics theories.

NUCLEAR PHYSICS

By the end of this course, the students will be able to:

- Describe the structure and properties of atomic nuclei.
- Analyze nuclear reactions and decay processes.
- Apply principles of nuclear physics to energy production and radiation detection.

QUANTUM MECHANICS – I

By the end of this course, the students will be able to:

- Apply the Schrödinger equation to simple quantum systems.
- Analyze the behavior of particles in potential wells and barriers.
- Describe the principles of quantum mechanics and their application to physical systems.

QUANTUM MECHANICS – II

By the end of this course, the students will be able to:

- Solve advanced quantum mechanical problems involving angular momentum.
- Analyze the quantum behavior of multi-particle systems.
- Apply approximation methods of quantum mechanics to various problems.

SCIENTIFIC INQUIRY & RESEARCH METHODS

By the end of this course, the students will be able to:

- Design and conduct scientific experiments to test hypotheses.
- Analyze and interpret experimental data using statistical methods.
- Communicate scientific findings through written reports and presentations.

STATISTICAL MECHANICS

By the end of this course, the students will be able to:

- Apply the principles of statistical mechanics to explain macroscopic properties of systems.
- Analyze the behavior of systems in thermodynamic equilibrium.
- Solve problems involving the distribution of particles and energy in statistical systems.

TECHNIQUES OF EXPERIMENTAL & COMPUTATIONAL PHYSICS

By the end of this course, students will be able to:

- Demonstrate advanced proficiency in utilizing experimental and computational techniques to investigate and analyze various physical systems.
- Critically evaluate the efficacy, limitations, and applications of various experimental and computational tools and methods in contemporary research in Physics.
- Integrate experimental and computational approaches to design, execute, and interpret advanced experiments and simulations, leading to data-driven conclusions.

VECTOR CALCULUS

By the end of this course, the students will be able to:

- Apply vector calculus to solve problems in mechanics and electromagnetism.

- Analyze the behavior of vector fields using gradient, divergence, and curl.
- Use vector integrals to solve physical problems involving line, surface, and volume integrals.

WAVES & OPTICS

By the end of this course, the students will be able to:

- Analyze the propagation of mechanical and electromagnetic waves.
- Apply the principles of interference, diffraction, and polarization to optical systems.
- Solve problems involving wave behavior in various media.

LABORATORY REQUIREMENTS FOR BS & MS PHYSICS

List of Essential and Desirable Equipment and Apparatus

Laboratory Requirements

Following subject / course specific equipment and instruments are required for Physics laboratories:

Atomic & Molecular Physics

- Planck Constant apparatus (essential)
- Zeeman effect apparatus (desirable)
- Quantum Hall apparatus (essential)
- Electrons Spin resonance apparatus (essential)
- Hydrogen discharge spectrum (desirable)
- Sodium lamp (essential)
- Polarization of light equipment / apparatus (essential)

Computational Physics

- High performing computer systems (essential)
- Software/computing programs relevant to the contents of the course (essential)

Electricity & Magnetism

- Oscilloscope (essential)
- Function Generator (essential)
- Electromagnets (essential)
- Transformer (essential)
- Carey Foster Bridge (essential)
- Galvanometer and voltmeter (essential)
- Potentiometer and Ballistic Galvanometer (essential)
- BH Curve Apparatus (essential)
- RLC Acceptor and Rejector (essential)
- Earth Magnetic field apparatus (desirable)
- Dielectric constant apparatus (essential)

Electronics – I & II

- Kirchoff laws apparatus (essential)
- Rectifiers and amplifiers (essential)
- Semiconductor diode and transistors (essential)
- Oscilloscope and function generator (essential)
- Digital multimeters and power supplies (essential)
- Transformers (essential)
- Operational amplifiers (essential)
- Digital Logic Kits (essential)
- Multi vibrators (essential)
- Oscillators (essential)
- Arduino Base apparatus (essential)
- LED LDR apparatus (essential)

Heat & Thermodynamics

- Thermal conductivity apparatus (essential)
- Expansion Coefficient apparatus (essential)
- Thermistor and Thermocouples (essential)
- Calorimeter (essential)
- Stefan Constant Apparatus (desirable)
- Heat Engine Apparatus (desirable)

Introductory Mechanics

- Projectile Motions Apparatus (essential)
- Simple/ Torsional/Compound Pendulum (essential)
- Fly Wheel (essential)
- Free Fall Apparatus (essential)
- Maxwell Needle (essential)
- Barton Apparatus (essential)
- Travelling Microscope (essential)
- Spherometer (essential)
- Conservation Law related Apparatus (essential)

Modern Physics

- Black body radiation apparatus (essential)
- Photoelectric effect apparatus (essential)
- Photocell (essential)
- Neon flash bulb (essential)
- Ionization potential apparatus (essential)
- e/m apparatus (essential)
- Millikan Oil Drop Apparatus (desirable)
- DC Power supply (essential)
- Speed of light apparatus (essential)
- Frank-Hertz Apparatus (desirable)

Nuclear Physics

- GM Tubes (essential)
- Wilson Cloud Chamber (desirable)
- Alpha Beta and Gamma sources (essential)
- Radiation detector (essential)
- Cosmic Rays apparatus (desirable)
- PM Tubes (essential)

Waves and Optics

- Kundt tube apparatus (essential)
- Ripple tank (essential)
- Fresnel apparatus (essential)
- Sextant apparatus (essential)
- Polarimeter (essential)

- Michelson interferometer (desirable)
- Diffraction Grating (essential)
- Newton's Ring apparatus (desirable)
- Cathode Ray Oscillation (essential)
- Sonometer (essential)
- Speed of sound apparatus (essential)
- Refractive index apparatus (essential)



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