# Payyanur College, Payyanur
# (Affiliated to Kannur University)

## Programme Outcomes (POs)

# MSc PROGRAMME (FOR SCIENCE)

## PROGRAMME OUTCOMES (PO)

**PO1. Advanced Knowledge & Skills:**

Postgraduate courses aim to provide students with in-depth knowledge and advanced skills related to their chosen field. The best outcome would be to acquire a comprehensive understanding of the subject matter and develop specialized expertise.

**PO2. Research & Analytical Abilities:**

Research and Analytical Abilities: Postgraduate programs often emphasize research and analytical thinking. The ability to conduct independent research, analyse complex problems, and propose innovative solutions is highly valued.

**PO3. Critical Thinking & Problem-Solving Skills:**

Developing critical thinking skills is crucial for postgraduate students. Being able to evaluate information critically, identify patterns, and solve problems creatively are important outcomes of these programs.

**PO4. Effective Communication Skills:**

Strong communication skills, both written and verbal, are essential in various professional settings. Postgraduate programs should focus on enhancing communication abilities to effectively convey ideas, present research findings and engage in academic discussions.

**PO5. Ethical & Professional Standards:**

Graduates should uphold ethical and professional standards relevant to their field. Understanding and adhering to professional ethics and practices are important outcomes of postgraduate education.

**PO6. Career Readiness:**

Postgraduate programs should equip students with the necessary skills and knowledge to succeed in their chosen careers. This includes practical skills, industry-specific knowledge, and an understanding of the job market and its requirements.

**PO7. Networking & Collaboration:**

Building a professional network and collaborating with peers and experts in the field are valuable outcomes. These connections can lead to opportunities for research collaborations, internships and employment prospects.

**PO8. Lifelong Learning:**

Postgraduate education should instill a passion for lifelong learning. The ability to adapt to new developments in the field, pursue further education, and stay updated with emerging trends is a desirable outcome.

# Programme Specific Outcomes (PSOs)

Name of the Programme: **MSc PHYSICS**

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

### CORE COURSES

The core courses in the M.Sc. Physics Programme are carefully curated to ensure that students acquire a solid foundation in classical and modern physics. The specific objectives of core courses include:

**PSO1.**

Understanding fundamental concepts and principles in classical mechanics, electrodynamics, quantum mechanics, mathematical physics and statistical mechanics.

**PSO2.**

Developing proficiency in solving complex physics problems using mathematical techniques and numerical methods.

**PSO3.**

Gaining insights into cutting-edge research and recent advancements in various fields of physics.

### ELECTIVE COURSES

The Programme offers elective courses that allow students to specialize in specific areas of interest within physics. The specific objectives of elective courses include:

**PSO4.**

Allowing students to explore advanced topics such as Astrophysics, Nonlinear Dynamics, Quantum Field Theory, Optics and photonics, plasma physics, Computational Physics, Microprocessors, Materials Sciences, Atmospheric physics and Electronic Instrumentation, among others.

**PSO5.**

Encouraging critical thinking and analytical skills in solving specialized physics problems.

**PSO6.**

Providing opportunities for students to develop expertise in their chosen fields and prepare them for further research or industry.

### MULTIDISCIPLINARY OPEN ELECTIVE COURSES

These courses are designed to foster interdisciplinary thinking and encourage students to explore areas beyond physics. The specific objectives of multidisciplinary open elective courses include:

**PSO7.**

Promoting a broader perspective and understanding of how physics interfaces with other scientific and non-scientific disciplines.

**PSO8.**

Encouraging creativity and innovation through the application of physics concepts to real-world challenges in various domains.

**PSO9.**

Developing communication skills to effectively collaborate with professionals from different backgrounds.

**INTERNSHIP/RESEARCH PROJECT:**

The internship or project component of the Programme aims to provide students with hands-on experience in applying theoretical knowledge to practical situations. The specific objectives of internships/projects include:

**PSO10.**

Offering opportunities to work on real-world problems in academia, research institutions, or industry settings.

**PSO11.**

Enhancing problem-solving and research skills by conducting independent investigations. Cultivating teamwork, project management, and presentation skills.

**INSTITUTIONAL/INDUSTRIAL VISITS**

The institutional and industrial visits are crucial for exposing students to the actual working environment of research institutions and industries. The specific objectives of these visits include:

**PSO12.**

Providing insights into the application of physics principles in real-life scenarios.

**PSO13.**

Facilitating interaction with professionals and researchers to gain practical knowledge and career insights.

**PSO14.**

Fostering networking opportunities for potential future collaborations or job prospects.

**EXPERIENTIAL LEARNING AND COMPUTATIONAL PHYSICS**

By incorporating experiential learning and computational physics as integral parts of the practical and project components, the specific objectives are:

**PSO15.**

Enabling students to gain hands-on experience in conducting experiments and simulations to reinforce theoretical concepts.

**PSO16.**

Developing proficiency in using computational tools and numerical methods for modelling and analysing complex physical systems.

**PSO17.**

Enhancing problem-solving skills and fostering a research-oriented mindset.

# Course Outcomes (COs)

Name of the Programme: **MSc PHYSICS**

## COURSE OUTCOMES (COs)

| Sl. No | Name of the Course | Outcomes |
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| 1. | **MSPHY01C02-MATHEMATICAL PHYSICS I** | **CO1:** Deal with particle mechanics at an advanced level.<br>**CO2:** Use the calculus of variations to characterize the function that extremizes a functional.<br>**CO3:** Understand the concept of constraints, principle of least action and formulation of Lagrange's method and apply Lagrange's equation for simple dynamical systems.<br>**CO4:** Understand Central force and its application in Kepler's problem.<br>**CO5:** Formulate and solve problems in classical mechanics using the Lagrangian, Hamiltonian and Hamilton-Jacobi formulations.<br>**CO6:** Apply the methods of classical mechanics to identify conserved quantities and normal modes.<br>**CO7:** Analyze motion of rigid bodies in non-inertial frames of reference using Euler angles and Euler's equations. |
| 2. | **MSPHY01C02-MATHEMATICAL PHYSICS I** | **CO1:** Provide a solid foundation in linear algebra: This includes a thorough understanding of vectors, matrices, linear transformations, eigenvalues, eigenvectors, and the concept of diagonalization. Students will also learn the basics of tensor analysis.<br>**CO2:** Understand infinite series and Fourier transforms: Students will be exposed to the concepts of infinite and power series, along with their convergence properties. Furthermore, they will learn about the Fourier series and Fourier transforms, including their properties and applications in physics.<br>**CO3:** Master special functions and orthogonal polynomials: The course aims to impart knowledge about special functions like Gamma and Beta functions, Legendre and Bessel functions, and the concept of orthogonal polynomials such as Hermite and Laguerre polynomials. Students will learn how these functions and polynomials are used to solve problems in physics. |

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| | | **CO4:** Develop expertise in ordinary and partial differential equations (ODEs and PDEs): Students will learn how to solve ODEs and PDEs, with a specific focus on systems of ODEs, the Laplace equation, and the wave equation. They will also gain an understanding of their applications in physics.<br>**CO5:** Apply mathematical methods to physical problems and promote computational skills: The course aims to develop students' ability to use these mathematical methods to analyse and solve problems in physics. The tutorial sessions will particularly focus on practical applications, enhancing problem- solving skills. As part of the course, students will use computational tools to solve complex problems, enhancing their computational physics skills. |
| 3. | **MSPHY01C03 - ELECTRODYNAMICS** | **CO1:** Understand the fundamental principles and concepts of classical electrodynamics.<br>**CO2.** Analyze and interpret electromagnetic fields, potentials, Maxwell's equations and their implications.<br>**CO3.** Describe the behaviour of electromagnetic waves in different media.<br>**CO4.** Understand the interaction of electromagnetic waves with matter, including reflection and transmission phenomena.<br>**CO5.** Understand the principles of electromagnetic radiation and waveguides.<br>**CO6.** Apply the principles of electrodynamics in the context of special relativity.<br>**CO7.** Enhance problem-solving and critical-thinking skills through tutorials and exercises<br>**CO8.** Acquire a solid foundation in electromagnetism, laying the groundwork for further research or specialization in related fields. |
| 4. | **MSPHY01C04- ELECTRONICS** | **CO1.** Explain the theory, working and applications of OPAMP (Module 1)<br>**CO2.**Understand the applications of the OPAMP with special reference to filters, oscillators etc (Module 2)<br>**CO3.** Appreciate combinational circuits, Sequential circuits, D/A & A/D converters (Module 3)<br>**CO4.** Apprehend the architecture of the 8085 Microprocessor. (Module 4) |

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| 5. | **MSPHY01C05 & MSPHY02C05 - PRACTICAL I - BASIC PHYSICS LABORATORY** | **CO1.** Develop proficiency in setting up and conducting physics experiments using various scientific instruments.<br>**CO2.** Understand the principles of instrumentation and calibration processes to ensure accurate measurements.<br>**CO3.** Develop the ability to troubleshoot experimental setups and address technical issues.<br>**CO4.** Develop skills in collecting and analysing experimental data, including the use of statistical tools and software for data processing.<br>**CO5.** Improve scientific writing skills to present experimental results in a clear and concise manner.<br>**CO6.** Encourage critical analysis of experimental results and drawing valid conclusions. |
| 6. | **MSPHY01C06 & MSPHY02C06- PRACTICAL II - ELECTRONICS LABORATORY** | **CO1.** Develop hands-on skills in using electronic equipments, tools and instruments commonly used in the electronics industry like oscilloscopes, signal generators, multimeters, soldering irons etc.<br>**CO2.** Gain proficiency in designing, building, and analysing electronic circuits, both analog and digital to perform specific functions like amplification, voltage regulation, signal generation, mathematical operations and digital operations using BJT/FET/ICS.<br>**CO3.** Learn how to identify and diagnose problems in electronic circuits and systems and develop effective strategies to debug and fix issues.<br>**CO4.** Improve scientific writing skills to present experimental results in a clear and concise manner.<br>**CO5.** Encourage critical analysis of experimental results and drawing valid conclusions.<br>**CO6.** Understand the importance of safety protocols when working with electronic components and systems. |
| 7. | **MSPHY02C08- QUANTUM MECHANICS-I** | **CO1.** Understand the Time-Independent Schrödinger Equation and its applications<br>**CO2.** Apply mathematical tools in Quantum Mechanics<br>**CO3.** Analyze the Theory of Angular Momentum<br>**CO4.** Recognize symmetries and conservation laws in quantum systems |

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| 8. | **MSPHY02C09-STATISTICAL MECHANICS** | **CO1:** Understand how a probabilistic description of nature at the microscopic level gives rise to deterministic laws at the macroscopic level.<br>**CO2:** Relate the concepts of entropy and temperature as defined in statistical mechanics to their more familiar versions in thermodynamics.<br>**CO3:** Solve for the thermal properties of classical and quantum gases and other condensed systems from a knowledge of their microscopic Hamiltonians.<br>**CO4:** Appreciate that interactions between particles can explain the various phases of matter observed in nature as in phase transitions. |
| 9. | **MSPHY02C10-MATHEMATICAL PHYSICS II** | **CO1:** Develop a foundational understanding of complex numbers and functions: including properties, analytical methods, and complex integration. Students should be able to apply these concepts to the study of physics, such as electrodynamics and quantum mechanics.<br>**CO2:** Laplace Transforms and Group Theory: Learn to use Laplace transforms in physics problems. Additionally, gain a thorough understanding of the principles of group theory, including groups, subgroups, and group representations. Students should be able to identify and work with special groups such as unitary, orthogonal, and homogeneous Lorentz groups.<br>**CO3:** Numeric Analysis: Equip students with the skills to conduct numerical analysis, such as error propagation, numerical integration and differentiation, and numerical methods for linear algebra. Students should be able to apply these techniques to solve ordinary and partial differential equations.<br>**CO4:** Probability and Statistics: Provide students with a solid understanding of data analysis and probability theory, including random variables, probability distributions, and statistical methods. Students should be able to apply these concepts to the fields of hypothesis testing, quality control, and regression.<br>**CO5:** Apply mathematical methods to physical problems and promote computational skills: The course aims to develop students' ability to use these mathematical methods to analyze and solve problems in physics. The tutorial sessions will particularly focus on practical applications, enhancing problem- solving |

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| | | skills. As part of the course, students will use computational tools to solve complex problems, enhancing their computational physics skills. |
| 10. | **MSPHY02C11: SPECTROSCOPY** | **CO1:** Understand structure of atom from the atomic spectra<br>**CO2:** Understand vector atom model through space quantization<br>**CO3:** Understand the influence of external magnetic and electric field on the atomic system<br>**CO4:** Understand the microwave and infrared spectroscopy techniques of the molecular system<br>**CO5:** Understand the electronic and Raman spectroscopy techniques of the molecular system<br>**CO6:** Understand nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy techniques<br>**C07:** Understand Mossbauer spectroscopy and its applications |
| 11. | **MSPHY03C13 QUANTUM MECHANICS II** | CO1. Demonstrate a thorough understanding of various approximation methods<br>CO2. Understand the time dependent perturbation theory and its applications<br>CO3. Analyse and interpret the theory of scattering,<br>CO4. Develop familiarity with relativistic quantum mechanics and then the importance of<br>the theory of field quantization. |
| 12. | **MSPHY03C14 CONDENSED MATTER PHYSICS** | **CO1.** Describe the basic properties of the nuclear force.<br>**CO2.** Explain the nucleon-nucleon scattering and its underlying principles.<br>**CO3.** Review the different nuclear models and nuclear reactions.<br>**CO4.** Discuss nuclear fission and its applications.<br>**CO5.** Describe different nuclear decays and explains the decay processes with theory.<br>**CO6.** Review the conservation laws governing interactions involving elementary particles<br>and discuss its internal structure. |
| 13. | **MSPHY03C16 PRACTICAL III** | **CO1.** Acquire skills in setting up and conducting physics experiments using various<br>advanced scientific instruments.<br>**CO2.** Understand the principles of instrumentation and calibration processes to ensure |

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| | | accurate measurements.<br>**CO3.** Gain proficiency in designing, building and analysing advanced electronic circuits.<br>**CO4.** Develop skills in collecting and analysing experimental data.<br>**CO5.** Improve scientific writing skills to present experimental results in a clear and concise manner.<br>**CO6.** Encourage critical analysis of experimental results and drawing valid conclusions. |
| **ELECTIVE COURSES** | | |
| 14. | **MSPHY03O01 RADIATION PHYSICS** | **CO1:** Understand different types of quantities and units for measurement of radiation<br>**CO2:** Understand various interaction mechanisms of radiation with matter<br>**CO3:** Understand radiation detection and measurement techniques and develop knowledge on different types of devices used.<br>**CO4:** Understand the principles of radiation protection. |
| 15. | **MSPHY04E01: ASTROPHYSICS** | **CO1:** Understand the different types of stars and their classification based on spectral characteristics and luminosity.<br>**CO2:** Explore the life cycles of stars, from their formation in nebulae to their eventual evolution into white dwarfs, neutron stars, or black holes.<br>**CO3:** Investigate the properties and dynamics of galaxies, including their morphology, distribution, and the role of dark matter.<br>**CO4:** Examine the expansion of the universe and the evidence for cosmic evolution, including redshift and cosmic microwave background radiation.<br>**CO5:** Introduce the basic principles of general relativity and their application to cosmology, including the Friedmann equations and the metric of the universe. |
| 16. | **MSPHY04E02: NON-LINEAR DYNAMICS** | **CO1:** Introduce basic concepts and definitions in nonlinear dynamics.<br>**CO2:** Develop skills in analytical methods such as fixed points, stability analysis, and bifurcation theory.<br>**CO3:** Apply numerical techniques for solving and analyzing nonlinear differential equations.<br>**CO4:** Examine applications of nonlinear dynamics in various fields such as physics, biology, ecology, and engineering. |

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| | | **CO5:** Analyze real-world systems exhibiting nonlinear behavior. |
| 17. | **MSPHY04E03: QUANTUM FIELD THEORY** | **CO1:** To understand the quantization of fields and the significance of field operators.<br>**CO2:** To explore the concept of symmetries and conservation laws in field theory.<br>**CO3:** Derive the Feynman rules from a given Lagrangian and calculate cross sections and decay rates.<br>**CO4:** Introduces the relativistic effects in quantum mechanics and learns to deal large degrees of freedom.<br>**CO5:** To study the interactions of scalar, fermionic and gauge fields.<br>**CO6:** Understand Quantum Field Theory applications in various branches of physics. |
| 18. | **MSPHY04E04: OPTICS AND PHOTONICS** | **CO1:** Understand the fundamental principles and concepts of optics and photonics.<br>**CO2:** Describe the fundamental principles of laser operation, including population inversion, stimulated emission, and optical feedback.<br>**CO3:** Understand the principles of nonlinear optics and the interaction of intense light with matter.<br>**CO4:** Explain phenomena such as second-harmonic generation, self-focusing, and third harmonic generation<br>**CO5:** Understand the principles of light propagation in optical fibers, including modes, dispersion, and attenuation.<br>**CO6:** Analyze the design and functioning of various types of optical fibers, including single mode and multi-mode fibers.<br>**CO7:** Understand the fundamental concepts of quantum optics. |
| 19. | **MSPHY04E05: PLASMA PHYSICS** | **CO1:** Define plasma and explain its unique properties and applications.<br>**CO2:** Gain proficiency in the fundamental equations governing plasma behavior.<br>**CO3:** Identify and analyze different types of waves in plasmas.<br>**CO4:** Understand the mechanisms behind various plasma instabilities.<br>**CO5:** Understand the concept of Landau Damping. |

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| 20. | **MSPHY04E06: COMPUTATIONAL PHYSICS** | **CO1:** Understand and apply various numerical methods and algorithms for solving complex physical problems.<br>**CO2:** Develop and implement computational programs using programming languages such as Python or C++ to solve physics problems.<br>**CO3:** Analyze and interpret computational results, including data visualization and error analysis.<br>**CO4:** Utilize advanced computational techniques, such as Monte Carlo methods, molecular dynamics simulations, and finite element methods, in solving problems in specific areas of physics.<br>**CO5:** Develop computational skills and problem-solving abilities to tackle interdisciplinary research problems at the intersection of physics, mathematics, and computer science. |
| 21. | **MSPHY04E07: MICROPROCESSORS AND DIGITAL SIGNAL PROCESSING** | **CO1:** Describe the architecture and instruction set of the Intel 8085 microprocessor and perform basic operations using assembly language.<br>**CO2:** Apply the principles of microprocessor timings to create efficient assembly programs and understand the machine cycles and timing diagrams.<br>**CO3:** lnterface memory and I/O devices with the 8085 microprocessor and utilize address decoding techniques for system design.<br>**CO4:** Design and develop applications using microcontrollers, particularly the 8051, and understand their internal architecture and stack operations.<br>**CO5:** Analyze discrete-time signals and systems using Z Transform, DTFT, and DFT, and design FIR and IIR filters for digital signal processing applications. |
| 22. | **MSPHY04E08: MATERIALS SCIENCE** | **CO1:** Classify and Describe Material Types: Clearly classify materials and describe their atomic structures, bonding types, and crystalline arrangements. Understand and explain the significance of imperfections in solids and their impact on material properties<br>**CO2:** Evaluate Mechanical Behaviour: Analyse and interpret stress-strain behaviour of materials. Evaluate the factors influencing elasticity, plasticity, hardness, toughness, and ductility. Understand the mechanisms of dislocation motion, strengthening, recovery, recrystallization, and grain growth.<br>**CO3:** Interpret Phase Diagrams: Utilize phase diagrams to determine phase equilibria and predict |

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| | | microstructure development Apply concepts such as the lever rule, solubility limits, and phase transformations to real-world material engineering problems. Understand the kinetics of nucleation and growth and their role in phase transformations.<br>**CO4:** Analyse Advanced Material Applications: Explain the structure and properties of ceramics, polymers, and composites. Identify and analyse the applications and importance of smart materials and nanotechnology. Assess the environmental and societal implications of material choices, emphasizing sustainable and green engineering practices. |
| 23 | **MSPHY04E09: ATMOSPHERIC PHYSICS** | **CO1:** This course will help the students to gain a basic understanding of the Earth's<br>atmosphere, its composition, structure, and variation.<br>**CO2:** Understand the role of radiation in heating and cooling the atmosphere.<br>**CO3:** Understand the properties of clouds and aerosols and their impact on climate.<br>**CO4:** Understand atmospheric waves and instabilities.<br>**CO5:** Learn about atmospheric radiation, atmospheric thermodynamics and<br>atmospheric instability and convection |
| 24. | **MSPHY04E10: ELECTRONIC INSTRUMENTATION** | **CO1.** Explain the Basic Concepts of Measurement and Transducers.<br>**CO2.** Understand different types of electronic test equipment.<br>**CO3.** Appreciate the working of thyristor and its application.<br>**CO4.** Apprehend the block diagrams of biomedical instrumentation devices. |
| 25. | **MSPHY04C19: RESEARCH METHODOLOGY AND SCIENTIFIC WRITING** | **CO1:** To address research questions or test hypotheses, quantitative or qualitative data must be gathered, analyzed, and interpreted using a systematic, scientific procedure known as research methodology.<br>**CO2:** A research technique helps researchers stay on track by restricting the scope of the study, much like a plan for carrying out research.<br>**CO3:** On completing the course, a student will be able to appreciate the scientific research methodology.<br>**CO4:** To develop the capability of the students to find research problems, to conduct research and to report the findings in an ethical manner, provide an introduction to technical writing, complex graphics, |

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| | | and computer presentations with LaTeX are the main concerns of the course. |