
DEPARTMENT OF PHYSICS

FACULTY

- John Hagelin, Ph.D., Chair, Professor of Physics, Director of the Institute of Science, Technology and Public Policy, Trustee
- Kurt Kleinschnitz, Ph.D., Adjunct Assistant Professor of Physics
- Giovanni Santostasi, Ph.D., Adjunct Assistant Professor in Physics
- Richard Weller, Ph.D., Adjunct Assistant Professor of Physics and Mathematics
- Richard Wolfson, Ph.D., Adjunct Assistant Professor of Physics
- Johan Svenson, M.A., Adjunct Instructor of Mathematics and Physics

INTRODUCTION

It is said that, if you understand the laws of physics, you are halfway to understanding the world. It's in that spirit — of physics as the basic core of many of today's scientific disciplines — that Maharishi University of Management offers an exciting and comprehensive minor program in physics.

The physics minor provides a calculus-based survey of the fundamental branches of classical and modern physics, enabling students in other disciplines to appreciate and enliven the connection of physical law to their own disciplines, while gaining valuable training in scientific experimentation and problem solving.

The experience and the study of human consciousness and of its higher states is an integral part of the physics curriculum at Maharishi University of Management. The most creative physicists have always emphasized human consciousness as the foundation for the scientific method used in physics. More importantly, an exciting momentum has built up over the past 30 years, as theoretical physicists have reached several decisive milestones toward a completely unified theory of all the known force and matter fields of nature. Inspired by Maharishi Mahesh Yogi, the physicists at Maharishi University of Management have discussed and proposed that this completely unified field at the basis of the whole universe is the same as the Unified Field of Consciousness, the experience of which has been recorded in the ancient Vedic literature and revived today through the advanced technologies of consciousness, the Transcendental Meditation and TM-Sidhi programs.

Now, with the increasingly widespread recognition that consciousness is much more than a localized offshoot of brain functioning, the spotlight is even brighter on physics as a

leading discipline in the field of consciousness studies. That same light is also focused on MUM, now taking a leadership role in the field of consciousness studies, especially as we begin to explore the true potential of higher states of consciousness. Which means our physics program is in the exciting and unique position of being able to explore new territory – the rich and fertile connections between consciousness, brain research and the study of physics.

DEPARTMENTAL REQUIREMENTS

Graduation Requirements for the Minor in Physics

To graduate with a minor in physics, students must successfully complete the following five courses

- PHYS 210 Introduction to Classical Mechanics
- PHYS 224 Introduction to Solids, Fluids, and Thermodynamics
- PHYS 230 Introduction to Electromagnetism
- PHYS 244 Introduction to Harmonics, Waves, and Optics
- PHYS 250 Introduction to Modern Physics

COURSES

All courses are 4 credits unless otherwise indicated.

PHYS 110 Foundations of Physics and Cosmology: Discovery of the Unified Field and Its Practical Applications for Perfection in Life

This course gives a deep and non-mathematical understanding of the differences between classical and quantum physics. It explains the meaning and mechanics of unification and symmetry, and the main concepts of unified quantum field theories and superstring theory. It shows that at the basis of the universe lies a completely unified field, a self-interacting entity from which all particles and forces arise through the process of spontaneous symmetry breaking. The course gives students experience and understanding of the interconnectedness between the laws of physics, the universe, and themselves.

PHYS 207 Classical Physics: Analysis and Synthesis

The course presents topics from classical physics including motion, force, momentum, equilibrium, work, energy, fluids, solids, and heat. Included are laboratory sessions, weekly seminar sessions, and reviews of current scientific papers. Case studies will emphasize applications from the life sciences and medicine. Computational skills relevant to scientific literacy will be emphasized. (Lab fee \$50) *Prerequisite:* MATH 162

PHYS 208: Thermodynamics, Harmonics, Waves, Electricity, and Magnetism: Unity at the Basis of Diversity

The course presents thermodynamics, periodic motion, waves, sound, light, and optics. Emphasis is on application over derivation, development of rapid estimating skills, and real-world problem solving relevant to the life sciences. Laboratory sessions, weekly seminar sessions, and reviews of current scientific papers help students develop a physics sensibility and scientific literacy. (Lab fee \$50) *Prerequisite:* PHYS 207

PHYS 209: Optics, Quantum Physics, Nuclear Physics, and Elementary Particles

The course presents optics, quantum theory, atomic structure, nuclear structure, and physical chemistry. Laboratory sessions, weekly seminar sessions, and reviews of current scientific papers help students develop a physics sensibility and scientific literacy. Real-world problem solving relevant to the life sciences will be presented. (Lab fee \$50) *Prerequisite:* PHYS 208

PHYS 210 Introduction to Classical Mechanics

Classical mechanics provides an accurate description of the objects and phenomena of everyday experience, and constitutes the basis of most of engineering, science, and technology. This course introduces the classical laws governing motion of particles and extended bodies in space and time, beginning with their active formulation in terms of force and acceleration and then deriving the equivalent formulation in terms of conservation of energy, momentum, and angular momentum. Topics include motion, Newton's laws, gravitation, and conservation laws. *Prerequisite:* MATH 281

PHYS 224 Introduction to Solids, Fluids, and Thermodynamics

This course introduces the general principles of statics, fluid mechanics, and thermodynamics. It develops the fundamental principles of conservation of energy and entropy, which underlie the behavior of all physical systems. Topics include statics and elasticity, pressure, fluid flow, temperature and heat, kinetic theory of gases, and heat engines. *Prerequisites:* MATH 282 and PHYS 210

PHYS 230 Introduction to Electromagnetism

Electrical forces largely determine the observable properties of matter in the whole range of science from atomic theory to cell biology. The integration of electricity and magnetism constitutes the first unified field theory, anticipating contemporary approaches by more than a century. This course introduces electric and magnetic forces, electric current, and electromagnetic interactions, along with the concepts of electric and magnetic fields and electric potential used to understand and describe them. Topics include Coulomb's and Gauss's laws, the Biot-Savart law and Ampere's law, Faraday's

law, and Maxwell's equations. *Prerequisites:* MATH 282 and PHYS 210 (PHYS 224 is also recommended but not required.)

PHYS 244 Introduction to Harmonics, Waves, and Optics

Wave behavior has applications in every area of physics, including sound, light, mechanical vibrations and waves, electrical signals, thermal behavior, and quantum physics. This course introduces common characteristics and mathematical representations of oscillations and standing and traveling waves and applies them to the investigation of sound and physical and geometrical optics. Topics include simple harmonic motion; resonance; mathematical representations of traveling waves; wave properties such as refraction, diffraction, interference, and polarization; and optical phenomena related to lenses and mirrors. *Prerequisites:* MATH 286 and MATH 308 (PHYS 210 is also recommended but not required.)

PHYS 250 Introduction to Modern Physics

Quantum mechanics and Einstein's theory of relativity are the major themes of this course. Topics include special relativity, the birth of quantum mechanics, Schrödinger's equation, wave mechanics of one-dimensional problems, and the hydrogen atom. *Prerequisites:* PHYS 230 and PHYS 244

PHYS 270 Introduction to Astronomy

In this course students learn about sky maps, astronomical observation, and the whole universe. Topics include the history of astronomy, sky charts, telescopes, spectroscopy, sun and planets, stellar formation and evolution, black holes, galaxies, cosmology, and the early universe. *Prerequisite:* PHYS 250

PHYS 290 The Evolution of Physics: From Einstein to Maharishi

Some of the most extraordinary, mind-expanding concepts of the past century have emerged from modern physics. This course is an engaging, minimally mathematical course, emphasizing the profound principles and concrete examples from physics that best illuminate the foundations of Maharishi Vedic Science. Topics will include the Principle of Least Action, Einstein's Relativity Theory, the Meissner Effect, quantum measurement theory, the EPR paradox, Bell's theorem, and quantum teleportation.

PHYS 294 Quantum Neuroscience

Investigation of the neural correlates of consciousness is an area of active research in neuroscience and consciousness studies today. Many researchers understand that consciousness is more than just a localized offshoot of the brain and that, therefore, it is plausible that the neural correlates of consciousness will involve a level of matter beyond classical physics. The investigation of the neural correlates of consciousness will likely involve advanced physics, including quantum theory. Hence quantum neuroscience has

become a lively field of research. A review of contemporary publications in the field will demonstrate the need for Maharishi's quantum mechanical, consciousness-based understanding of the human experience and physiology. The course will draw on evidence of the quantum theoretical nature of neurophysiology from the most advanced research in brain integration.

PHYS 297 Philosophy of Science

Understanding foundational issues underlying the scientific method is essential for the contemporary thinker and, especially, for the practicing scientist. The scientific method is the systematic, repeatable, empirical approach to acquiring knowledge, involving the discovery and testing of hypotheses against the experimental evidence. The issue of alternative explanations for a given empirical result, including the null hypothesis, is examined from both an abstract, philosophical perspective and the pragmatic perspective of working scientists and statisticians. The important contrast between normal science and paradigm-change is studied with reference to the reaction in the wider scientific community to the Maharishi Effect research. Finally, we examine the significance for the philosophy of science of Maharishi's principle that *knowledge is structured in consciousness and knowledge is different in different states of consciousness*.

PHYS 313 Classical Mechanics I

Students explore the formal structure of Newtonian mechanics with application to single-particle systems. Topics include kinematics, dynamics, the harmonic oscillator, three-dimensional motion, constraints, non-inertial systems, central force problems, and scattering. *Prerequisite:* MATH 304, MATH 308, and PHYS 210

PHYS 314 Classical Mechanics II

This course extends the principles of classical mechanics to many-particle systems, introducing the concept of generalized coordinates and the Lagrangian formulation. Topics include center-of-mass and relative coordinates, collisions, rigid body dynamics, Lagrangian mechanics and Hamilton's principle, Hamilton's equations, oscillating systems and normal coordinates, continuous systems, and the wave equation. *Prerequisite:* PHYS 313

PHYS 330 Electromagnetism I

PHYS 331 Electromagnetism II

Students apply the calculus of vector fields to the study of electromagnetic fields and their sources. Maxwell's equations and their application to relativistic and non-relativistic phenomena are examined in detail, along with the principles of physical optics. *Prerequisite:* MATH 304, MATH 308, and PHYS 230

PHYS 340 Relativity Theory I**PHYS 341 Relativity Theory II**

This course discusses special relativity and introduces general relativity, including Riemannian geometry, Mach's Equivalence Principle, Einstein's field equation, the Newtonian limit, experimental tests, black holes, and the structure of space-time.

Prerequisite: PHYS 250

PHYS 360 Quantum Mechanics I

This first course in the sequence includes wave mechanics, one-dimensional potential, operator methods and the Dirac formulation, the harmonic oscillator, Schrödinger and Heisenberg representations, the classical limit, and the WKB approximation.

Prerequisites: MATH 286 and PHYS 314

PHYS 361 Quantum Mechanics II

This course includes identical particles, quantum paradoxes and interpretations, angular momentum, central potentials and the hydrogen atom, electrons in electromagnetic fields, spin and general two-state systems, addition of angular momenta, the EPR paradox, and Bell's theorem. *Prerequisite:* PHYS 360

PHYS 362 Quantum Mechanics III

Topics included in this course include perturbation theory, the variational method, fine structure, atoms and molecules, emission and absorption of radiation scattering theory, density matrices, and measurement theory. *Prerequisite:* PHYS 361

PHYS 370 Thermodynamics and Statistical Mechanics

Thermodynamics studies the transformations of energy in macroscopic systems. It is chiefly concerned with the general laws governing the transformation of heat into work and the effect of these laws on the thermal properties of bulk matter. Statistical mechanics derives these laws, as well as the more fundamental properties of bulk matter, from the dynamical behavior of underlying microscopic constituents. *Prerequisites:* PHYS 224 and PHYS 250

PHYS 375 Astrophysics

Topics include stellar structure, energy generation in stars, white dwarfs, neutron stars, black holes, the dynamics of star formation, the structure of the universe, cosmology, and the Big Bang. *Prerequisite:* MATH 282, PHYS 270

PHYS 380 Mathematical Methods for Physicists I

PHYS 381 Mathematical Methods for Physicists II

PHYS 382 Mathematical Methods for Physicists III

The intelligence of nature is encoded and expressed in the language of mathematics. This course is designed to develop and refine the mathematical skills needed for successful study in physics and related sciences. By making these mathematical skills second nature, the mind is freed to comprehend the deeper principles of natural law embedded in the formulas and equations. *Prerequisite:* MATH 282

PHYS 390 Methods of Experimental Physics I

PHYS 391 Methods of Experimental Physics II

This course focuses on experimental research methods, giving students experience in designing and performing laboratory experiments. In addition to laboratory work in traditional areas such as mechanics and electromagnetism, students will be encouraged to design and carry out experiments in the EEG laboratory. *Prerequisite:* PHYS 250

PHYS 399 Directed Study

(variable credits) *Prerequisite:* consent of the Department faculty.

PHYS 420/CS 420 Numerical Analysis

Scientific and engineering computer application requires advanced numerical techniques of manipulating and solving complex systems of equations with great efficiency and minimum error. Topics include numerical solution of linear equations, curve fitting, interpolation and polynomial equations, numerical integration and differentiation, solution of nonlinear equations, and error analysis. *Prerequisite:* MATH 282

PHYS 425 Computational Physics I

PHYS 426 Computational Physics II

This course presents methods and principles for the application of computational tools to scientific and engineering problems. Students will gain practical experience in the sophisticated application of readily available and easy-to-use mathematical software and database tools to model physical systems and solve advanced physics problems.

Prerequisite: MATH 282

PHYS 460 Introduction to Quantum Field Theory I

PHYS 461 Introduction to Quantum Field Theory II

These courses present an overview of the physical concepts and computational methods of quantum field theory, including the analysis of quantum electrodynamics using Feynman diagrams, beginning with electron-positron annihilation. The quantization of fields is explained. Many-body theory is considered, along with condensed matter physics and nuclear physics. The standard model is elucidated, and the importance of

symmetry transformations for the unification of the four forces is considered. Advanced topics include the study of Hagelin's Flipped SU(5) grand unified theory based on the superstring, and attention is given to hidden sector matter as providing a natural mechanism for quantum coherent phenomena in biological systems. *Prerequisite:* PHYS 361

PHYS 499 Directed Study

(variable credits) *Prerequisite:* consent of the Department faculty.