



King Abdulaziz University
Faculty of Science
Department of Physics

Course Description for Medical Physics

Title

Code

Credits 3

General Physics I

PHYS 110

This unit covers physical quantities, dimensional analysis, vectors, motion in one dimension, motion in a plane, Newton's laws, friction, work and energy, linear momentum, impulse, center of mass and collisions, and rotational motion.

PRE-REQUISITES: None

Credits 4

General Physics II

PHYS 202

The course reveals the electric and magnetic concepts, including the charge and electric force, electric field, Gauss' law, electric potential, capacitance, electric current and resistance, DC circuits, magnetic force, magnetic field, induction and inductance, magnetism of matter and Maxwell's equations.

PRE-REQUISITES: PHYS 110, MATH 110

Credits 3

Introductory Biophysics

MPHY 205

The course introduces the fundamental concepts of living systems, cell structure and functions, concept of replication, DNA and protein structure, Brownian motion and diffusion, electrophoresis, descriptive models of liquids flow, electrophoresis and osmosis.

PRE-REQUISITES: PHYS 110, BIO 222

Credits 3

Modern Physics

MPHY 242

The course introduces the fundamental concepts like black body radiation, quantization of energy, photoelectric effect, the Compton Effect. It also introduces line spectra, X-ray spectrum and laser light. A brief introduction of Wave functions and Schrodinger equation.

PRE-REQUISITES: PHYS 202, MATH 202



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Code

Credits 3

Mathematical Methods for Medical Physics MPHY 255

This unit covers vector analysis, concepts of gradient, divergence, and curl of a vector, integral theorems, elements of complex algebra, determinants and matrices, Fourier and Laplace transformations, ordinary differential equations, special functions such as Bessel, Legendre, Beta, Gamma, and Laguerre functions with their applications are discussed within this course.

PRE-REQUISITES: PHYS 202, MATH 202

Credits 3

Health Physics MPHY 261

The physics of dose deposition, radiation dosimetry, elementary shielding and radiation protection devices, Description and proper use (calibration and maintenance) of health physics instrumentation, and the regulatory and administrative requirements of health physics programs. A systemic approach to the study of the human body from a medical imaging point of view: skeletal, respiratory, cardiovascular, digestive, and urinary systems, breast and women's issues, head and neck, and central nervous system.

PRE-REQUISITES: PHYS 110, BIO 222

Credits 1

General Physics Lab PHYS 281

The experiments and applications of this laboratory are described very closely in accordance to the topics of General Physics I.

PRE-REQUISITES: PHYS 110



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| Title | Code | Credits |
|--|-----------------|-----------|
| Concepts of Electronics | MPHY 313 | Credits 2 |
| <p>The course covers a range of topics such as electrical and electronic quantities, circuit principles, circuit components, DC and AC circuits, signal processing, diodes, transistors, operational amplifiers, electronic devices, digital electronics, and analogue electronics.</p> | | |
| PRE-REQUISITES: PHYS 202, MATH 202 | | |
| Bioelectronics | MPHY 314 | Credits 2 |
| <p>This unit covers ionic conduction, the metal-electrolyte double layer, models of the cell membrane; Electrical signal detection in biological systems: silicon, glass and metal electrodes; amplifier design. Bio-electronic device production: microelectronic fabrication methods as adapted to bioelectronics, hard and soft lithography, bio-compatibility of materials; Existing types of biosensors: micro-systems including sensing using optical techniques, field effect transistors, ion-selective and enzymatic sensitive electrodes, as well as impedance monitoring.</p> | | |
| PRE-REQUISITES: PHYS 313, PHYS 255 | | |
| Optics and Laser | MPHY 315 | Credits 3 |
| <p>This unit covers light rays – light waves – light propagation in matter – optical images – coherence and interference measurement – light and matter – Lasers – Laser dynamics – semiconductor laser – light sensors.</p> | | |
| PRE-REQUISITES: MPHY 344, MPHY 255 | | |



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| Title | Code | Credits |
|---|-----------------|-----------|
| Waves and Ultrasound | MPHY 323 | Credits 2 |
| <p>The structure of this course consists of the physics of ultrasound, transducer technology, diagnostic equipment technology, Doppler, bio-acoustics, basic acoustical physics and acoustical waves in human tissue with emphasis on ultrasound transmission in soft tissues, attenuation of ultrasound energy, interaction of ultrasound with tissues, mechanics of ultrasound production and display.</p> <p>PRE-REQUISITES: PHYS 202, MPHY 255</p> | | |
| Atomic and Molecular Spectra | MPHY 344 | Credits 2 |
| <p>Electromagnetic radiation and its interaction with atoms and molecules -General features of experimental methods - Molecular symmetry - Rotational spectroscopy -Vibrational spectroscopy - Electronic spectroscopy.</p> <p>PRE-REQUISITES: MPHY 242, MPHY 255</p> | | |
| Medical Statistics | MPHY 357 | Credits 2 |
| <p>The course explains the probability, permutation and combinations, measure of central tendency, standard deviation, and statistics of genetics, normal distribution, errors in quantities, errors in averages, T-test, Poisson distribution, Chi square test and experimental errors.</p> <p>PRE-REQUISITES: MPHY 242, MPHY 255</p> | | |



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Credits 3

Physics of Living Systems

MPHY 361

The course studies energetic and dynamics of biological systems, bioelectric properties of membranes, resting potential, Hodgkin-Huxley theory, cardiac flow, hemodynamic, mechanical properties of cells, tissues, organs, biophysical properties of skeleton, joints, muscles, and optics of the eye.

PRE-REQUISITES: MPHY 261

Credits 3

Nuclear and Radiation Physics

MPHY 363

The course concentrates on the basic concepts of nuclear models, semi-empirical mass formula, interaction of radiation with matter, nuclear detectors, nuclear structure and instability, radioactive decay processes, particle accelerators, fission and fusion processes.

PRE-REQUISITES: MPHY 242, MPHY 261

Credits 1

Bioelectronics Lab

MPHY 384

The course covers diffusion in semi-membrane, Nernst effect, Hauk's phenomenon, Electric Acoustic stimulation (combining both acoustic amplification and hearing implant technology), EEG Electroencephalography, Electrocardiography, ECG.

PRE-REQUISITES: MPHY 200, MPHY 313



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Credits 1

Nuclear and Spectroscopy Lab **MPHY 385**

The course covers number of experiments in modern physics and atomic spectra, such as Faraday Effect, Spectrophotometer, Thermal Radiation, Hydrogen Atom, Photoluminescence and Kerr Effect.

PRE-REQUISITES: MPHY 200, MPHY 242

Credits 2

Training I **PHYS 390**

In this training course, students will have several visits to university hospital to involve them in medical applications and the proper use of the medical devices.

PRE-REQUISITES: Approval of the Department

Credits 2

Computer and Image Modelling **MPHY 394**

This unit covers introduction to Computer Aided Detection (CAD) - Medical-Image Processing and Analysis for CAD Systems - Texture and Morphological Analysis of Ultrasound Images - Biomedical-Image Classification Methods and Techniques – Texture Characterization Using Autoregressive Models with Application to Medical Imaging - Locally Adaptive Wavelet Contrast Enhancement - Three-Dimensional Multi scale Watershed Segmentation of MR Images - A MRF-Based Approach for the Measurement of Skin Thickness - Graph-Based Analysis of Amino Acid Sequences - Estimation of Human Cortical Connectivity with Multimodal Integration of fMRI and High-Resolution EEG - Evaluation Strategies for Medical-Image Analysis and Processing Methodologies.

PRE-REQUISITES: CPIT 100, MPHY 205, MPHY 255



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| Title | Code | Credits |
|---|-----------------|-----------|
| Laser Applications in Medical Physics | MPHY 415 | Credits 3 |
| The course concentrates on light and Matter-Basics of Lasers-Interaction Mechanisms-Optical and Thermal Response of Tissue to Laser Radiation- Medical Applications of Lasers-Uses and Effects of Ultraviolet Radiation on Cells and Tissues-The Physics of Ultraviolet Laser Ablation-Low-Power Laser Effects-Laser safety. | | |
| PRE-REQUISITES: MPHY 315 | | |
| Magnetic Resonance and Medical Imaging | MPHY 434 | Credits 2 |
| This unit Introduces magnetic resonance imaging from the basic concepts to cutting edge applications. Basic physics of magnetic resonance, Resonance and detection, fundamentals of image formation, interpretation of images. | | |
| PRE-REQUISITES: MPHY 363 | | |
| Radiation Dosimetry | MPHY 464 | Credits 2 |
| The course introduces dosimetry in radiotherapy, diagnostics/imaging and nuclear medicine, how is the intensity of the radiation sources characterized (mA, fluence, activity), absorbed dose, exposure, linear energy transfer (LET), use of MC in dosimetry, The general framework for cavity Dosimetry, high-energy photon dosimetry and high-energy electron dosimetry. | | |
| PRE-REQUISITES: MPHY 363 | | |



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| Radiation Therapy Physics | MPHY 465 | Credits 3 |
| <p>The course introduces X-ray generators, tubes, and survey of mammography, fluoroscopy, image intensifiers, cine systems, radiodosimetry, image quality, CT scanners, ultrasound, and magnetic resonance imaging.</p> | | |
| PRE-REQUISITES: MPHY 363 | | |
| Radiation Protection | MPHY 467 | Credits 2 |
| <p>The course explains the measurement of radiation, scintillators, radiation biology, modes of radiation cell, cell survival, radiation and carcinogenesis, current models, risks, International Commission of radiation Protection (ICRP) system, radiation safety, and protection and legislation.</p> | | |
| PRE-REQUISITES: MPHY 363 | | |
| Calibration and Quality Control | MPHY 474 | Credits 2 |
| <p>The unit covers QC activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardised procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity and emission factor data, and methods. Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties, should be performed upon a finalised inventory following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the QC programme.</p> | | |
| PRE-REQUISITES: MPHY 363 | | |



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Credits 2

Physics of Biosensors MPHY 475

The course explains the definitions and classification of sensors, parameters of sensors, physical transducing principles for sensors, gravimetric sensors, electrical and electrochemical sensors, optical sensors, nanostructured materials for sensing, sensors based on inorganic and organic materials, organic vapor sensors based on Calixarenes, and composite membranes for biosensing.

PRE-REQUISITES: MPHY 313

Credits 2

Nanoscience in Medical MPHY 476
Physics

A Brief History of Nano revolution, Revolutionary Nanotechnologies, Solid State against Soft Matter in Nanotechnologies, Chemical Routes for Nanostructure Processing, Sol-Gel Deposition, Electrostatic Self-Assembly, Langmuir-Blodgett Technique, Spin Coating, Nano materials and diseases, Cancer therapy, Kidney therapy, Tissue engineering, Protein detection.

PRE-REQUISITES: MPHY 344

Credits 3

Physics of Drug Delivery MPHY 477

This course includes how to deliver a drug substance at the biological target site in a therapeutically optimal amount. This encompasses both the relationships between the chemical and physico-chemical characteristics of a drug substance, the pharmaceutical formulation, and the biological response. A basic understanding of the extent to which these factors affect the relative rate and amount of the drug which reaches the target site is of utmost importance in drug research and development.

PRE-REQUISITES: MPHY 363, MPHY 473



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| Title | Code | Credits |
|--|-----------------|-----------|
| Introductory Neurophysics | MPHY 478 | Credits 2 |
| <p>How to deliver a drug substance at the biological target site in a therapeutically optimal amount. This encompasses both the relationships between the chemical and physico-chemical characteristics of a drug substance, the pharmaceutical formulation, and the biological response. A basic understanding of the extent to which these factors affect the relative rate and amount of the drug which reaches the target site is of utmost importance in drug research and development.</p> | | |
| PRE-REQUISITES: MPHY 255, MPHY 361 | | |
| Theory of Heart | MPHY 479 | Credits 3 |
| <p>The course explains the macro and micro-structural properties of the heart, ionic models, background currents, activation and inactivation, pump and exchange currents, dynamics of cardiac oscillations, wave propagation in myocardium, and a clinical perspective of the heart.</p> | | |
| PRE-REQUISITES: MPHY 255, MPHY 361 | | |
| Imaging lab | MPHY 487 | Credits 2 |
| <p>The course includes different experiments relating to interference, diffraction and polarization of electromagnetic waves.</p> | | |
| PRE-REQUISITES: PHYS 200, MPHY 434, MPHY 394 | | |
| Training II | MPHY 490 | Credits 2 |
| <p>This training course will initiate a work plan for the student, preparing the desired experiment, making measurements and data analysis, and writing a final report.</p> | | |
| PRE-REQUISITES: Approval of the Department | | |



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| Title | Code | Credits 2 |
|--|-----------------|-----------|
| Special Topics in Medical Physics | MPHY 491 | |

This unit is the graduation project for senior students.

PRE-REQUISITES: Approval of the Department