COURSES OFFERED BY DEPARTMENT OF FUNDAMENTAL PROBLEMS IN TECHNOLOGY

Current Research in Biomedical Sciences: A and B

Dr Hab. Eng. Malgorzata Kotulska, Prof. PWr

The seminar is focused on presenting the cutting-edge science in biomedical, biophysical, and biochemical sciences, theoretical and experimental. By the assumption, the course scope is very broad and invites PhD students from different faculties, however each edition will put special impact to topics within interest of the students currently participating in the class. The course participants will present a seminar and lead a discussion related to the topic in English. The course will also include talks from distinguished senior scientists who are experts in these fields who will be invited by the class instructor.

Information theory for computer scientists Dr. Hab. Eng. Marek Klonowski, Prof. Pwr

We present some fundamental principles of information theory with applications to computer science. We plan to describe fundamental notions (conditional information, mutual information, Kullback-Leibler distance) and how they can be used in coding methods, data distortion theory, copression and distributed algorithms. We plan also explain methods related to Kolmogorov complexity and their application to complexity theory.

Microscopic Measurements in Biomedical Engineering

Dr Hab. Marta Kopaczyńska, Prof. PWr

The interdisciplinary course for PhD students from different faculties concerns an advanced level of development trends and the most important new developments in the field of microscopy methods for the study of the cells and biological materials. Particularly, the following modern nanoscopic imaging techniques will be presented: fluorescence microscopy (STED, PALM STORM), multi-photon microscopy, FRET, FLIC, TIRFM, FLIM, atomic force microscopy (AFM), transmission electron microscopy (TEM) and techniques of nanomanipulation such as optical tweezers.

Introduction into Photovoltaics Prof. Dr Hab. Ewa Popko

The solar energy emitted by sun - free and non-carbon has driven scientists for decades to develop photovoltaic devices (PV) solar cells that catch sunlight and convert it directly to electricity. Today, the solar power industry is manufacturing and installing solar modules worldwide at record-setting numbers. In the lecture the review on the PV state of art will be given. In the introductory part of the lecture the attendee will get knowledge about fundamentals of solar radiation. The solar cell's working principle will be explained. Next, solar cell performance, parameters and standard design will be described. Silicon solar cells have dominated PV market since 1954 and currently claim about 90% of the solar-cell market. These solar cells belong to the most matured 1st generation solar cells (wafer based crystalline and multi-crystalline silicon and GaAs solar cells). Due to the economy, the IInd generation of solar cells emerged in search for cheap, efficient solar cells. Thin film solar cells: amorphous silicon, CdTe, CIGS and CIS solar cells, kesterites belong to this class of PV solar cells. Emerging photovoltaic technologies based on dye-sensitized solar cells, organic compounds, perovskite materials, and quantum dots garner intense coverage in the science press. These types of solar cells - IIIrd generation of PV solar cells- sit in the spotlight because they promise to be less expensive and well suited to many more applications than conventional. But where do these emerging photovoltaic technologies stand today? Are they limited to university research labs? Are they being developed by technology incubators and start-up companies? What is the state of art of solar cells' research and development (R@D) and the road map of PV market?

Expanding Universe   Prof. Dr. Hab. Andrzej Radosz

This course is divided into the three parts. In the first part, the story of the Big Bang hypothesis is presented. It starts from the so-called "night sky paradox" (XVIII/XIX c.) that could not be solved within classical physics approach. It was resolved in the 20's of the XX c. due to the Hubble's discovery: "recession of the galaxies" and due to the theoretical proposal, FLRW (Friedman-Lemaitre-Robertson-Walker) approach, formulated within General Theory of Relativity (GTR). The key element was G. Gamov's (1948) idea. It was an idea of a very hot early universe dominated by radiation, then followed by a cold universe dominated by matter. The transition between these two was accompanied by the release of black body radiation. The discovery of such a radiation (1965), so-called "relic radiation" (or CMB - Cosmic Microwave Background) ended the controversies concerning the universe: homogeneous and isotropic Universe is expanding according to the Big Bang scenario (developed within GTR). In the second part we present and discuss thermodynamic and dynamic aspects of expanding universe. The only time-dependent quantity in this scheme is a scale parameter and it is inversely proportional to the temperature of CMB. Big Bang scenario is then presented as a history observed backward in time: starting from a current "galaxy" era, one reaches a separation instant followed by radiation dominated phase. The early stages in a very dense and very hot universe are: a lepton's era, a hadron's era, electro-weak unification, a "desert" range, GUT and an inflation era. The earliest stage is the so-called Planck's era: one reaches an initial, quantum stage of expansion where space and time arrived. In this part of the course we discuss the related questions of entropy and matter-antimatter asymmetry. The question of the origin of the elements is presented: in the expanding universe only two first elements, hydrogen and helium were formed. The other elements were formed due to star evolution (and decay). In the third part of the course we discuss the problems of accelerating expansion. The key feature for the expansion within closed, open or flat scenario is a value of the energy density. In the light of the recent discoveries this quantity involves apart of a luminous matter component also exotic dark matter quantity and even more intriguing component, dark energy. Facts and hypothesis concerning those features are presented.

Nanomedicine   Prof. Dr Hab. Eng. Marek Langner

Nanomedicine is a branch of pharmacology, which is concern with supramolecular devices designed to detect the diseased tissue and/or deliver a pharmaceutical in selected locations. The lecture presents the design process of nanomedical devices based on multi-scale models along with experimental methods, which are capable to test the feasibility of the design. In addition to the necessary information on pharmacokinetics and pharmacodynamics examples of nano-medical devices are presented and discussed.

Frontiers of biological sciences. **Prof. Dr Hab. Eng. Marek Langner**

The modern biological sciences are founded on the Central Dogma of Biology. This general statement on transformation of biological information and the way this information translates to a specific functions performed by molecular devices is a new challenge of modern biological science. The lecture presents the new concepts necessary to understand current perception of biological sciences including such as molecular machines, molecular crowding or emerging properties along with necessary concepts needed to understand functioning complex multi-molecular ensembles. The application of modern biological concepts is demonstrated by examples of cellular processes executed by large sets of molecular machines in highly structured biological space.

Modelling of physical processes and phenomena using Computer Algebra Systems
Prof. Dr. Hab. Eng. Mituś

Computer algebra systems offer advanced mathematical tools for a simplification of both symbolic and numeric calculations in research studies of a student and scientific worker. The goal of the course is to teach the PhD student how to use chosen mathematical methods (derivatives, integrals, ordinary differential equations, partial differential equations, variational calculus and linear algebra) offered by computer algebra system *Maple* and to use those methods for a practical solving of chosen problems in mathematical physics like, e.g. linear and non-linear oscillators, phase portraits of dynamical systems, chaos and others.