SEMESTER 2, 2013-14

MODULES ON OFFER FROM THE COLLEGE OF SCIENCE

Understanding Course Codes/Levels

The structure of a module's code is made up of a sequence of letters and numbers. The module code starts with two letters which denote the Discipline teaching the module (e.g., AN – Anatomy, BI – Biochemistry, SI Physiology etc). The remainder of the module code is made up of three numbers.

The first number in the sequence indicates the year the module is delivered to e.g. PH101 is a physics course offered to first year domestic students. AN219 is an anatomy module offered to second year domestic students. BI319 is a biochemistry module offered to third year domestic students etc. Module codes starting with the numbers 4 or 5 are normally offered to 3rd and/or 4th year students. Visiting students are offered courses from 1st, 2nd, 3rd and 4th year.

Most courses available to visiting students are not at a foundation level and therefore require applicants to have previously studied in the discipline. The higher the first number in the sequence, the more advanced the course is.

Visiting students wishing to take science courses other than those offered to first year domestic students must have previously studied in the discipline. The more advanced the course on offer, the greater must be the applicant's previous familiarity with material in that discipline.

Code	Course	Sem	ECTS	Examination Arrangements
AN223	Embryology and Development	2	5	Two hour examination
AN226	Systems Histology	2	5	Two hour examination
BI206	Gene Technologies and molecular medicine	2	5	Two hour examination
BI207	Metabolism and cell signalling	2	5	Two hour examination
BI313	Cell Signalling	2	5	Two hour examination
BI317	Human Molecular Genetics	2	5	Two hour examination
BI321	Protein Biochemistry	2	5	Two hour examination
BPS203	Plants Diversity, Physiology and Adaptation	2	5	Two hour examination
BPS306	Applied Aquatic Plant Science	2	5	Two hour examination
BPS307	Plant Physiology and Systems Biology	2	5	Two hour examination
CH202	Organic Chemistry	2	5	Two hour examination
CH205	Analytical & Environmental Chemistry	2	5	Two hour examination
CH307	Inorganic Chemistry	2	5	Two hour examination
CH313	Physical Chemistry	2	5	Two hour examination
CH339	Validation in Enterprise	2	5	Two hour examination
CS209	Algorithms and Scientific Computing	2	5	Two hour examination
CT233	Information Systems	2	5	Two hour examination
EOS104.II	Introduction to Earth and Ocean Sciences B	2	5	Two hour examination
EOS222	Ancient Earth Environments	2	5	Two hour examination
EOS223	Introductory Palaeontology and Evolution	2	5	Two hour examination
EOS224	Crystallography and Mineralogy	2	5	Two hour examination
EOS225	Optical Microscopy of Minerals and Rocks	2	5	Two hour examination
EOS303	Ocean Dynamics	2	5	Two hour examination
EOS304	Aquatic Geochemistry	2	5	Two hour examination
EOS305	Introduction to Applied Field Hydrology	2	5	Two hour examination
EOS320	Applied and Environmental Geophysics	2	5	Two hour examination
MI203	Laboratory Skills in Microbiology II	2	5	Two hour examination
MI204	Microbes and the Environment	2	5	Two hour examination
MI322	Environmental Microbiology	2	5	Two hour examination
MI323	Food and Industrial Microbiology	2	5	Two hour examination
MI325	Microbial Infectious Diseases	2	5	Two hour examination
MP232	Mathematical Methods II	2	5	Two hour examination
MP237	Mechanics II	2	5	Two hour examination
MP307	Modelling II	2	5	Two hour examination
MP346	Mathematical Methods II	2	5	Two hour examination
MP403	Cosmology & General Relativity	2	5	Two hour examination
MP491	Nonlinear Systems	2	5	Two hour examination
PH101 *	Physics	1 & 2	15	Two hour examination each semester
PH108	Physics	2	5	Two hour examination
PH140	Engineering Physics	2	5	Two hour examination
PH217	Light, Atomic and Nuclear Physics	2	5	Two hour examination
PH218	Thermodynamics	2	5	Two hour examination
PH223	Observational Astronomy	2	5	Two hour examination
PH329	Physics of the Environment II	2	5	Two hour examination
PH335	Nuclear and Particle Physics	2	5	Two hour examination
PH336	Signal Analysis	2	5	Two hour examination
PH337	Thermal Physics	2	5	Two hour examination
PH338	Properties of Materials	2	5	Two hour examination

Code	Course	Sem	ECTS	Examination Arrangements
PH340	Biomedical Physics	2	5	Two hour examination
PH362	Stellar Astrophysics	2	5	Two hour examination
PH424	Electromagnetism and Special Relativity	2	5	Two hour examination
PH425	Lasers and Spectroscopy	2	5	Two hour examination
PH426 *	Problem Solving and Physics Research Skills	1 & 2	5	Departmental Assessment
PH429	Nanotechnology	2	5	Two hour examination
PH431	Medical Image Processing	2	5	Two hour examination
PH432	Project	2	10	Continuous Assessment
SI208	Cardiovascular Physiology	2	5	Two hour examination
SI212	Respiratory Physiology	2	5	Two hour examination
SI312	Endocrinology	2	5	Two hour examination
SI331	Renal Physiology	2	5	Two hour examination

** Year long module examined in Semester I and Semester 2 each year.

ANATOMY

Code	Module Title	Semester	ECTS	Examination Arrangements
AN223	Embryology and Development	2	5	Two hour examination

Study of embryonic and fetal development. The module will cover: fertillization, blastocyst development and implantation, placenta, early embryonic events that accompany the formation of the three germ layer and the folding of the embryo (gastrulation, neurulation, somitogenesis) and provide the basis for the body plan, and finally with the specific development of: CNS, CVS, Respiratory system, GIT, Urogenital tract, neck, and face.

Code	Module Title	Semester	ECTS	Examination Arrangements
AN226	Systems Histology	2	5	Two hour examination

This module describes the histological structure and function of various body systems. In particular the module will focus on the skin, respiratory system, cardiovascular system, female and male reproductive systems, endocrine system, lymphatic system, urinary system, gastrointenstinal system and vascular system.

Students will sit a 2 hour exam at the end of semester 1 based on cell biology. Continuous assessment will be carried out in the form of practical exams. And end of semester practical exam will also be carried out (departmental assessment).

The aim of this module is to facilitate an understanding of the organisation, histological structure and function of body systems including the skin, respiratory system, cardiovascular system, reproductive systems, endocrine system, lymphatic system, urinary system, gastrointestinal system and blood.

BIOCHEMISTRY

Code	Module Title	Semester	ECTS	Examination Arrangements
BI206	Gene Technologies and molecular medicine	2	5	Two hour examination

This course provides a grounding in current concepts in molecular biology and recombinant DNA technology and their applications in biomedicine. It also incorporates technical training in biochemical approaches to enzymology and in recombinant DNA work.

Code	Module Title	Semester	ECTS	Examination Arrangements
BI317	Human Molecular Genetics	2	5	Two hour examination

This course will provide a framework for understanding human molecular genetics. Students will develop an understanding of the structure of human chromosomes, the human genome and human genetic variation. They will also learn about chromosomal and genetic alterations associated with disease states, and the techniques used to identify genetic disease associations. Finally, students will develop an appreciation for the future impact of human molecular genetics on human health. In the post-genomic age, the importance of molecular genetics in human health is coming to the fore. This course will provide students with a detailed understanding of this rapidly advancing area of science and medicine.

Code	Module Title	Semester	ECTS	Examination Arrangements
BI321	Protein Biochemistry	2	5	Two hour examination

This course will provide students an understanding of the synthesis and turnover of proteins in the eukaryotic cell, the role of proteins as molecular tools with particular emphasis on enzymes, and the structure and function of key protein glycoconjugates including glycoproteins and proteoglycans. The practical course will include techniques for the purification of proteins, protein assays, protein gel electrophoresis and enzyme assays including enzyme inhibition.

BOTANY & PLANT SCIENCE

Code	Module Title	Semester	ECTS	Examination Arrangements
BPS203	Plants Diversity, Physiology and Adaptation	2	5	Two hour examination

This module introduces students to the diversity of extant land plants, while explaining processes shaping their evolution. Lifecycles, physiological adaptions and ecological significance of major plant groups are described. The student is taught to identify these, and is encouraged to examine strengths and limitations of different plant groups through lectures and practical investigations. The course is supported by the latest textbooks & includes a trip to the National Botanic Gardens.

Since colonising Earth's land surface 450 million years ago, plants have evolved to fill myriad habitats, diversifying into hundreds of thousands of species while shaping the world around us into complex evolving ecosystems.

In this module, the student is introduced to the processes which have shaped plant diversity over time and physiological adaptations that allow plants to thrive in different environments. The characteristics of the main living plant groups are explored via both lectures and practical investigations, with a particular emphasis on the diversity of plant life-cycles and reproductive strategies. The groups studied range from the bryophyte groups to the main flowering plant families and include an introduction to characters of significance for plant identification.

The module also emphasises the ecological and co-evolutionary interactions between different plant groups, and with other organisms (such as pollinators) . The module is supported by a scientific study visit to the National Botanic Gardens in Dublin.

The student is encouraged to develop critical reasoning skills with respect to the strengths and weaknesses of different plant groups, and to make use of the most recent supporting text-books. The student is also introduced to key references from primary research literature, as part of their ongoing scientific education, and to develop transferable skills in observation, data collection and collation of reports.

Overall, the course places the diversity of plants in an evolutionary and encourages the student to relate this to the ecological settings in which they are found.

Code	Module Title	Semester	ECTS	Examination Arrangements
BPS306	Applied Aquatic Plant Science	2	5	Two hour examination

Introduction to Algal Biotechnology including sustainable utilisation of natural resources and algal cultivation. Biological features of key species; Applications of algae and algal compounds; Species specific distribution of algal compounds, their metabolism, structure and important properties; Irish and international case studies.

Code	Module Title	Semester	ECTS	Examination Arrangements
BPS307	Plant Physiology and Systems Biology	2	5	Two hour examination

This module examines plant growth, development and interactions with the biotic and abiotic environment in a holistic manner taking into account regulation at the levels of gene expression, enzyme activities, and the role of specific metabolites. The course is taught through lectures and practicals enabling students to appreciate how plants can adapt in various environments.

Plants undergo many processes, such as the transition from vegetative growth to flowering, expansive cell growth, organ development, and fruit ripening, and have adapted to many different environmental challenges.

This module will examine the underlying processes that control these interactions in an integrated way taking into account modifications at the different system levels of gene expression, protein synthesis and activity of enzymes.

Students will be introduced into the key role of hormones and secondary metabolites in sensing changes in the environment and then transmitting information to various parts of the plants.

The distribution and importance of specific secondary metabolites will be discussed with respect to their influence on plant survival against abiotic (temperature, light) and biotic (competitiors, herbivores and pathogens) as well as their uses by humans where relevant.
The role of the circadian clock in the regulation of these varipous processes will also be discussed .
The course is taught through lectures which are supported by practicals designed to help students understand plant processes in a holistic manner.

CHEMISTRY

Code	Module Title	Semester	ECTS	Examination Arrangements
CH202	Organic Chemistry	2	5	Two hour examination

In this module the students will learn about organic chemical functional groups and their reactions & reactivity, building on the knowledge gained in year one. There will be a theory and practical component. The theory component will deal with mechanism, reactions, reactivity and structure. In the practical component basic synthetic and analytical techniques used in the organic chemistry laboratory will be introduced.

Code	Module Title	Semester	ECTS	Examination Arrangements
CH205	Analytical & Environmental Chemistry	2	5	Two hour examination

This is an introductory course to environmental and analytical chemistry. Analytical chemistry is vital in Industry, Environmental Monitoring, and Healthcare. Students need to understand the fundamental principles behind the analytical techniques and get practical, hands-on experience of these methods. The course comprises of lectures/practicals on: Atmospheric & Water Chemistry, Analytical Chemistry, Electrochemistry, Applied Spectroscopy, Separation Science and Bioanalytical techniques.

Code	Module Title	Semester	ECTS	Examination Arrangements
CH307	Inorganic Chemistry	2	5	Two hour examination

Insights into the specific roles of metals and ligands in the broad fields of coordination chemistry, material science and biochemistry are given. Specific areas to be discussed include organometallic complexes, inorganic kinetics and bioinorganic chemistry. Practicals related to this course are available in Experimental Chemistry II.

Code	Module Title	Semester	ECTS	Examination Arrangements
CH313	Physical Chemistry	2	5	Two hour examination

This course comprises lectures and tutorials, and expands upon the fundamentals of physical chemistry covered in years 1 and 2. Chemistry of molecular interactions, gas-solid interactions, thermodynamics of phase transitions, chemical kinetics, basic principles of electrode kinetics, spectroscopy and quantum chemistry are covered.The course emphasizes chemistry of interest to modern day chemists.

Code	Module Title	Semester	ECTS	Examination Arrangements
CH339	Validation in Enterprise	2	5	Two hour examination

This module covers pertinent topic concerning validatory requirements within the biopharma-, pharmaceutical and chemical industries.

COMPUTER SCIENCE

Code	Module Title	Semester	ECTS	Examination Arrangements
CS209	Algorithms and Scientific Computing	2	5	Two hour examination

Constructing algorithms using various approaches: Recursion, Brute Force, Divide and Conquer, Dynamic Programming. Computational Complexity. Big Oh notation. The halting problem. Algorithms for sorting and searching. Graph based algorithms. Programming in Python.

EARTH & OCEAN SCIENCE

Code	Course	ECTS	Examination Arrangements
EOS104.II	Introduction to Earth and Ocean Sciences B	5	Two hour examination

This module will introduce students to the breadth of topics covered in Earth & Ocean Sciences. It assumes no previous knowledge of subjects such as geography. It will outline the following: The Solar System; Earth's Structure; Oceanography; Hydrogeology; Earth's Crust; Tectonics; The Biosphere; Geo-environments and Natural Hazards. The lecture course will be linked to practical sessions in a choice of one out of four time-slots per week.

Structure

- Solar system, galaxies and stars, the Sun, the planets.
- Gravity and Earth rotation, seismic structure, magnetic field.
- Evolution of atmosphere, chemical and physical oceanography.
- Hydrogeology, the water cycle, ground water and its protection.
- Minerals and rocks, Geological time, surface processes.
- Seafloor spreading, plate tectonics, dating of rocks
- Evolution of organisms, fossils.
- Energy resources, Irish ore deposits, natural hazards.

Code	Course	Semester	ECTS	Examination Arrangements
EOS222	Ancient Earth Environments	2	5	Two hour examination

The course will cover: the principles of stratigraphy; origin of sediment; classification of sedimentary rocks; texture and composition of sandstones; transport of sediment; interpretation of depositional environments; Irish geological history; fluvial, shallow and deep marine environments; modern and ancient glaciations; extraplanetary sedimentology; biochemical sediments.

Code	Course	Semester	ECTS	Examination Arrangements
EOS223	Introductory Palaeontology and Evolution	2	5	Two hour examination

This module will introduce students to the science of palaeontology and will examine all of the major animal groups, who have left their mark in the fossil record.

Code	Course	Semester	ECTS	Examination Arrangements
EOS224	Crystallography and Mineralogy	2	5	Two hour examination

This module explores the morphology of crystals and the chemistry and atomic structures of the main rock forming minerals. A detailed study of forms and symmetry across the seven crystal systems is linked to the chemistry and structure of the major rock forming minerals in particular the members of Silicate group.

Code	Course	Semester	ECTS	Examination Arrangements
EOS225	Optical Microscopy of Minerals and Rocks	2	5	Two hour examination

This module demonstrates how the petrographic microscope is used to identify minerals and study the textures of igneous, metamorphic and sedimentary rocks in thin section. It uses the wave theory of light to explain how polarised light interacts with the crystal structure of rock forming minerals. Optical properties of minerals and rock textures are studied and recorded during practicals.

Code	Course	Semester	ECTS	Examination Arrangements
EOS303	Ocean Dynamics	2	5	Two hour examination

Introduction to dynamical oceanography, Newtons Laws of motion, scales and dimensions
Basic forces that drive and control ocean currents, turbulence, viscosity and diffusion
Scaling the equation of motions;- case studies theoretical and practical
Frictionless flows, geostrophic currents, estimating currents from density measurements
Wind driven circulation, Vorticity, Ekman pumping,
Large scale geochemical cycling, nutrient fluxes and transport
Shelf sea physics - heating/cooling effects, tides and coastal processes
Plankton dynamics

Code	Course	Semester	ECTS	Examination Arrangements
EOS304	Aquatic Geochemistry	2	5	Two hour examination

This course introduces students to the quantitative treatment of chemical processes in aquatic systems. It includes a brief review of chemical thermodynamics and photochemistry as it applies to natural waters. Specific topics covered include acid-base chemistry, precipitation-dissolution, coordination, and redox reactions. Emphasis is on equilibrium calculations as a tool for understanding the variables that govern the chemical composition of aquatic systems and the fate of pollutants.

Code	Course	Semester	ECTS	Examination Arrangements
EOS305	Introduction to Applied Field Hydrology	2	5	Two hour examination

Basic hydrological concepts: 15%
Key theories and concepts that define the discipline
Data collection and processing: 45%
How to access, collect and assess various data sets (rainfall, stream flow etc)
Applied field hydrology: 40%
Application of methods at the field and catchment scale using real-world data

Code	Course	Semester	ECTS	Examination Arrangements
EOS320	Applied and Environmental Geophysics	2	5	Two hour examination

This module will introduce students to a series of geophysical remote sensing techniques for exploring the near-surface of Earth. The results will be used to explain key chemical, geological, hydrogeological and physical processes beneath the surface and how these can aid the monitoring of geo-hazards and management of near-surface resources.

MICROBIOLOGY

Code	Course	Semester	ECTS	Examination Arrangements
MI203	Laboratory Skills in Microbiology II	2	5	Two hour examination

The identification of newly isolated microbes often relies on conducting a series of biochemical tests. Students will learn how to perform the key tests used for baterial identifiation. They will also learn how to transfer genetic material from one strain of bacteria to another using conjugation. To establish the degree of sensitivity to an antibiotic students will learn how to perform an MIC (Minimum Inhibitory Conecentrtaion) test. The module will be supplemented by 6 lectures that will provide the theoretical background necessary to understand the laboratory methodologies.

Code	Course	Semester	ECTS	Examination Arrangements
MI204	Microbes and the Environment	2	5	Two hour examination

Microbes impact almost every aspect of life on the planet. The are found almost everywhere that we have been able to look and underpin all the ecosystems that make the planet habitable for us. This module will address some the main areas microbes that microbes impact our lives, either directly by affecting our health, or indirectly by influencing the environment we live in. Organised as a series 24 one hour lectures it sets out to excite students about the hugely significant role that microbes have in all our everyday lives.

Code	Course	Semester	ECTS	Examination Arrangements
MI322	Environmental Microbiology	2	5	Two hour examination

Only a small proportion of the quintillion microbes living on Earth have been cultured - maybe 0.1% of them. However, there is a staggering breath of diversity within the microbial world - from photosynthesis, to methane-makers to rock-eaters. Students will learn about the strategies microbes use to grow and make energy. They will also consider the application of these strategies in cycling Nitrogen and Carbon. Next, they will consider the harnessing of those activities for environmental biotechnologies, including wastewater treatment and biomining gold. Finally, the need to link ecology (identity) of yet-to-be-cultivated microbes in the environment with their physiology (activity) will be discussed. In practical sessions, the microbes in environmental samples will be counted.

Code	Course	Semester	ECTS	Examination Arrangements
MI323	Food and Industrial Microbiology	2	5	Two hour examination

Characteristics of bacteria, fungi and viruses associated with foods; Factors affecting growth of micro-organisms in foods; methods of food preservation; food safety; food spoilage; HACCP; microbiology of specific foods. Bioreactor/fermenter design and batch, fed batch and continuous fermentations. Influence of strain selection, medium composition and process manipulation on productivity.

Code	Course	Semester	ECTS	Examination Arrangements
MI325	Microbial Infectious Diseases	2	5	Two hour examination

Introduction to how bacterial and viral pathogens cause disease. Important virulence mechanisms in representative pathogens. The clinical implications of microbial infections. Host responses to infection, immunization, vaccines, antibiotics and antibiotic resistance.

MATHS PHYICS

Code	Course	ECTS	Examination Arrangements
MP232	Mathematical Methods II	5	Two hour examination

This course is a continuation of "MP231-Mathematical Methods I"
Topics covered include:

1. Laplace Transforms;
2. Applications of Laplace transforms to the solution of Linear Ordinary Differential Equations;
3. Vector calculus; grad, div and curl;
4. Line integrals, conservative vector fields, surface integrals, triple integrals;
5. Integral theorems: Divergence theorem, Stokes' theorem.

Code	Course	ECTS	Examination Arrangements
MP237	Mechanics II	5	Two hour examination

1. An introduction to partial differential equations, the heat equation as a model for heat flow, boundary conditions, initial conditions, well-posed problems, separable variable solutions of the heat equation.

2. The wave equation as a model for the vibrations of a string, characteristic variables for the wave equation, the general solution of the one-dimensional wave equation, D'Alembert's solution, solution of the wave equation on a semi-infinite domain using characteristic variables, solution of the wave equation on a finite domain using the method of separation of variables.

3. Laplace's equation in two dimensions, solutions to Laplace's equation in rectangular domains using the method of separation of variables.

4. Introduction to the theory of special relativity, Einstein's two postulates of special relativity, the Lorentz transformation, length contraction, time dilation, the velocity transformation, relativistic mass, momentum and energy, the transformation law for momentum and energy.

Code	Course	ECTS	Examination Arrangements
MP307	Modelling II	5	Two hour examination

This course introduces the student to modelling techniques for three different real-world problem areas. The problems cover the topics queueing theory, population dynamics and control theory.

This is a course on mathematical modelling of some real-world systems. The topics covered include:
1) Queueing theory: Markov processes, ergodic systems and nearest-neighbourhood models.

2) Population dynamics: Fibonacci numbers, age-cohort models, Verhulst predator satiation, competetive species, Lotka-Volterra model, Ricker model and the Kermac-McKendrick model.

3) Control theory: stability analysis and pole-placing methods.

Code	Module Title	Semester	ECTS	Examination Arrangements
MP346	Mathematical Methods II	2	5	Two hour examination

This is a mathematical methods course, and amongst the topics considered are the heat equation, Laplace's equation, Sturm-Liouville theory, the Fourier transform, and the numerical solution of partial differential equations using finite difference techniques.

This is a follow on to the course Mathematical Methods MP345. Topics covered include:

I. The 1-dimensional heat equation. Introduction to Initial Value Boundary Value Problems. Solution for various boundary conditions and initial conditions.

II. Sturm-Liouville Systems. General properties and application to simple systems.
III. The 2-dimensional Laplace equation. Solution for various boundary conditions on a rectangular or rotationally symmetric region.
IV. The Fourier Transform. Properties, the inverse transform. Application to solving the 1-dimensional heat equation on an infinite region.
V. Finite difference methods. Application to numerically solving the 1-dimensional heat equation. Stability of numerical method.

Code	Module Title	Semester	ECTS	Examination Arrangements
MP403	Cosmology & General Relativity	2	5	Two hour examination

In the study of cosmology where gravitation is the dominant force over the large scales considered, general relativity is the basic component. This course introduces general relativity. Topics covered include geometry, geodesics, black holes, different model universes and cosmogony.

I. Introduction: review of Newtonian mechanics and Special Relativity;
II. Geometry: intrinsic and extrinsic definitions of curvature, the metric tensor, Gauss curvature formula;
III. Geodesics: the variational method, using the Euler-Lagrange equations to calculate geodesics;
IV. General Relativity: the postulates of General Relativity; Einstein's field equations, derivation of the Schwarzschild solution of Einstein's field equations using physical arguments;
V. Cosmology: the cosmological principle, derivation of the Robertson-Walker line element, object and event horizons, the Friedman equation, cosmogony.

Code	Module Title	Semester	ECTS	Examination Arrangements
MP491	Nonlinear Systems	2	5	Two hour examination

This course is an introductuion to the analysis of systems of nonlinear Ordinary Differential Equations (ODEs) and Maps.

This course is concerned with systems of nonlinear Ordinary Differential Equations (ODEs) and Maps. Topics covered include:

1. 1.1-dimensional differential equations: equilibria, stability, bifurcations;
2. 2-dimensional linear systems of ODEs: equilibria, stability, phase-plane portraits;
3. 2-dimensional nonlinear systems of ODEs: equilibria, linearisation, linear stability, phase-plane portraits;
4. 2-dimensional Hamiltonian systems: equilibria, stability, phase-plane portraits;
5. Limit cycles: Hopf bifurcations, stability;
6. 1-dimensional difference equations and maps cycles: fixed points, periodic orbits, stability, bifurcations.

PHYSICS

Code	Module Title	Semester	ECTS	Examination Arrangements
PH101 *	Physics	1 & 2	15	Two hour examination each semester

A one year introductory course in Physics consisting of lectures on topics such as the following: Mechanics, heat, sound, Electricity and magnetism, Light atomic and nuclear physics.
Students also attend a weekly laboratory session

***This is a full year course.**

Code	Module Title	Semester	ECTS	Examination Arrangements
PH108	Physics	2	5	Two hour examination

MECHANICS [7]: Introduction; Displacement; Speed and Velocity; Acceleration; Kinematics; Free fall; Force and Mass; Newton's Laws; Gravitation; Work; Energy; Energy; Power

FLUIDS [3]: Density; Pressure; Pascal's Principle; Archimedes' Principle; Fluids in Motion; Equation of continuity; Bernoulli's Equation; Viscous Flow

TEMPERATURE AND HEAT [3]: Specific Heat Capacity; Phase Change; Humidity; Convection; Conduction; Radiation

WAVE AND SOUND [3]: Nature of Waves; Sound; Intensity; Doppler Effect

ELECTRICITY AND MAGNETISM [7]: Electric Charge; Insulators and Conductors; Coulombs Law; Electric Fields; Electric Current; Resistance; Electric Power; Direct Current; Alternating Current; Circuits, Electric circuits; Magnetism

OPTICS [5]: Nature of Light; Electromagnetic Waves; Reflection; Mirrors; Image Formation; Refraction of Light; Lenses; Interference; Young's Double Slit Experiment; Diffraction

ATOMIC AND NUCLEAR [5]: Wave-particle Duality; Blackbody Radiation; The Photoelectric Effect; Models of the Atom; Photon Absorption and Emission; X-rays; Lasers; The Nucleus; Radioactivity

Code	Module Title	Semester	ECTS	Examination Arrangements
PH140	Engineering Physics	2	5	Two hour examination

The aim of this module is to equip the learner with basic knowledge, skills and competences associated with the fundamentals of a range of topics in engineering physics.
The Experimental Method:
Units, measurement, experimentation, units, significant figures
Heat and Temperature

Acoustics and Optics:
Waves, ultrasound
Electromagnetic waves: EM spectrum, doppler effect, polarisation
Geometrical optics: reflection and refraction, mirrors, thin lenses, optical instruments
Diffraction
Interference
Applications

Electricity and Magnetism:
Electric potential, current, energy, electric forces and fields
Ohm's Law
Insulators, conductors, semiconductors: diode: structure, behaviour
Applications

Atomic and Nuclear Physics:
Photoelectric effect, quantum theory
Line spectra
X-rays
Lasers

Nucleus, nuclear energy
Radioactivity
Applications

Assumptions:
Bohr atomic model (Chemistry)
Pre-requisite: mechanics is taught in SE 1 or early SEM 2 (applied Maths)

Code	Course	Semester	ECTS	Examination Arrangements
PH217	Light, Atomic and Nuclear Physics	2	5	Two hour examination

This module builds on content delivered in the general PH101 Physics course, given in First Year, to provide a more in-depth look at Light, Atomic Physics and Nuclear Physics. Students will learn to solve problems on various concepts (homework assignments), with tutorials and in-class problem solving examples.

Code	Course	Semester	ECTS	Examination Arrangements
PH218	Thermodynamics	2	5	Two hour examination

This module provides a thorough review of thermodynamics based on classical physics. It includes topics such as temperature & heat, thermal properties of matter, and first and second laws of thermodynamics. The module will also consider some computational methods with applications to thermodynamics problems.

Code	Module Title	Semester	ECTS	Examination Arrangements
PH223	Observational Astronomy	2	5	Two hour examination

This module provides a broad survey of how astronomers make observations of the universe. It addresses the telescopes, optical designs, instruments, detectors, observable quantities, natural limiting factors, and techniques of observational astronomy. It covers the full electromagnetic spectrum of wavelength regimes, from radio waves through to gamma rays, plus neutrino particles. It investigates what can we learn by observation in each of the main information domains – imaging (spatial), spectroscopy (energy), and time-resolved (temporal).

Telescope Systems: Telescope Optical Principles; Telescope designs; Telescope Mountings.

Light Detection & Detectors: Poisson statistics; Noise sources; Signal to Noise; Charged-Coupled Devices (CCDs) Stellar Photometry: Magnitude system; Photometric Systems & Colour Indices; Interstellar and Atmospheric effects.

Spectroscopy: Spectrograph designs; Spectral Resolution & Range; Calibration.

Observing Practice: Planning & Making observations; Image Processing basics.

Observing in the Infra-Red; IR Spectral Bands & Filters; IR Instruments; Adaptive Optics.

Observing in X-rays: X-ray Telescopes and Detectors; X-ray Emission Processes.

Radio Astronomy: Radio telescopes; Radio Interferometry.

Other Regimes: Ultraviolet (UV) Astronomy; Millimetre/Sub-Millimetre Astronomy; Gamma-ray and Cosmic Ray Astronomy; Neutrino Astronomy.

Code	Module Title	Semester	ECTS	Examination Arrangements
PH329	Physics of the Environment II	2	5	Two hour examination

This course responds to the need to understand the physics behind environmental challenges such as fossil fuel combustion and its associated atmospheric pollution burden, renewable energy technology, nuclear power, nuclear accidents and radiation protection.

Code	Course	Semester	ECTS	Examination Arrangements
PH335	Nuclear and Particle Physics	2	5	Two hour examination

In this module students learn how subatomic particles form nuclei, study nuclear properties, and radioactive decay, and see how nuclear energy may be released in fission and fusion processes. Students also study fundamental particles, which are the building blocks of nature, and consider the ways in which these particles interact with each other. Prior knowledge is assumed to the level of material covered in PH2X3 Light, Atomic & Nuclear Physics and PH3X3 Quantum Physics.

Code	Course	Semester	ECTS	Examination Arrangements
PH336	Signal Analysis	2	5	Two hour examination

This module introduces students to the concept of signals as information sources that are encountered throughout nature, mathematics, experimental science, and culture. We explore the various sub-classifications of signals (continuous/discrete; linear/non-linear; time invariant/variant; etc.), and their dimensionality (e.g., 1-d time-series, 2-d images). Methods are presented for the analysis of signals in Continuous Time, and Discrete Time; by decomposition into their frequency components in Fourier Series, and Fourier Transforms; by employing Laplace Transforms, and State Equations.

Code	Course	Semester	ECTS	Examination Arrangements
PH337	Thermal Physics	2	5	Two hour examination

This module provides a comprehensive microscopic interpretation of the laws of thermodynamics based on statistical mechanics and probability theory. Some principles of quantum physics are included.

Code	Course	Semester	ECTS	Examination Arrangements
PH338	Properties of Materials	2	5	Two hour examination

This course provides a comprehensive introduction to the physics of materials. The mechanical, thermal, electronic, and optical properties of "hard" and "soft" condensed matter are introduced using concepts primarily based on classical physics with some quantum concepts where appropriate.

Code	Course	Semester	ECTS	Examination Arrangements
PH340	Biomedical Physics	2	5	Two hour examination

This course is designed to demonstrate how imaging methods utilize physical principles to address problems in clinical diagnosis, patient management and biomedical research. This module also covers the physics of radiotherapy and future directions for imaging & therapy.

Code	Course	Semester	ECTS	Examination Arrangements
PH362	Stellar Astrophysics	2	5	Two hour examination

A comprehensive model for stellar structure and evolution is developed and used to understand star formation, evolution and destruction and the properties of extrasolar planets.

Code	Module Title	Semester	ECTS	Examination Arrangements
PH424	Electromagnetism and Special Relativity	2	5	Two hour examination

This module will be an in-depth course on Electromagnetism and Relativity, building on previous courses, in particular PH2X1 Electricity, Magnetism & Circuits and PH2X3 Light, Atomic & Nuclear Physics. The course will include continuous assessment (MCQ), with short problems involving basic concepts. Students will also learn to solve advanced problems on both electromagnetism and relativity (homework assignments), featuring more advanced and lengthy problems from David Griffiths' book "Electrodynamics".

Code	Module Title	Semester	ECTS	Examination Arrangements
PH425	Lasers and Spectroscopy	2	5	Two hour examination

This module will provide students with an in-depth introduction to several aspects of Photonics. Particular emphasis will be placed on atomic spectroscopy and the interaction of radiation with atoms. The operation of lasers and conditioning of laser radiation will also be developed.

Optical Spectroscopy of atoms, molecules and solids. Interaction of radiation and atoms. Stimulated and spontaneous processes. Line broadening. Optical modulation. Optical resonators and conditions for optical gain & laser action. Properties of typical gas, liquid & solid-state lasers.

Code	Module Title	Semester	ECTS	Examination Arrangements
PH426 *	Problem Solving and Physics Research Skills	1 & 2	5	Departmental Assessment

There are two components to this module:

1. Researched essay on an assigned Physics topic: Each student will be mentored by a supervisor, who will provide feedback to the student. Skills developed will include literature searching and structuring evidence-based scientific arguments to support viewpoints. Students will learn how to cite reference material correctly. Students will also be instructed on plagiarism and the ethics of scientific writing.

2. Problem solving: A lecture-based course will develop problem-solving skills including problem definition, solution searching, dimensional analysis and application of physics skills learned in the first three years of the programme. In particular, topics from different courses will be combined to widen students' appreciation of problem solving away from the tightly-defined context of lecture courses.

***This is a full year programme. Students must be enrolled for a full year to take this course.**

Code	Module Title	Semester	ECTS	Examination Arrangements
PH429	Nanotechnology	2	5	Two hour examination

This course provides a comprehensive review of the electronic and optical properties of nanostructures. The course describes the physics of low-dimensional structures using concepts based on quantum mechanics. The course also provides a comprehensive review of the bottom-up and top-down processing techniques used to fabricate nanostructures.

Structure of nanoscale materials: surface to volume atomic ratio, important length scales, confinement regimes, types of nanostructures. Optical absorption & emission in nanostructures. Quantum mechanical review for nanostructures. Application of quantum mechanics for problems involving for quantum wells, nanowires, and quantum dots using Cartesian, polar, and spherical coordinates. Application of non-degenerate, time independent, perturbation theory to a particle in a modified box. Density of states for nano-scale structures. Time-dependent perturbation theory, Fermi's golden rule. Two-level system. Optical transitions in nano-scale structures

Synthesis and characterisation: Top-down: Nanoelectronics, semiconductor wafers, dopant diffusion, ion implantation, and epitaxy, thin film dielectrics, lithography. Fabrication of bipolar and field effect integrated circuits. Nanophotonics Description of heterogeneous vapour phase epitaxy. Description of surface diffusion, surface alloys, strained epitaxy and self-assembled structures. Bottom-up: Nanobio synthesis and functionalisation of colloidal nanoparticles. Nanometrology: Scanning-probe, and electron microscopies, atomic-force microscopy and X-ray diffraction for atomic-scale metrology.

Code	Module Title	Semester	ECTS	Examination Arrangements
PH431	Medical Image Processing	2	5	Two hour examination

This module will provide students with an in-depth introduction to several aspects of modern Medical Image processing. It will cover modern 3D imaging modalities including Computed Tomography and Magnetic Resonance Imaging. The course will involve students carrying out sample image processing tasks on medical images using relevant software packages.

Image formats, histogram operations, spatial filtering. Fourier filtering, deconvolution. Basic image segmentation and object detection. Image registration, affine and other transforms. Principal component analysis. Computed tomography, Magnetic resonance imaging.

Code	Module Title	Semester	ECTS	Examination Arrangements
PH432	Project	2	10	Continuous Assessment

In this module, a student is assigned a research project, and carries out supervised research in the assigned topic over Semester 2. Each student prepares a detailed report, and makes a short presentation, on their project work. The report and presentation should be at a level corresponding to the presentation and publication of results at a scientific conference.

PHYSIOLOGY

Code	Module Title	Semester	ECTS	Examination Arrangements
SI208	Cardiovascular Physiology	2	5	Two hour examination

The course develops fundemental understanding of human cardiovascular function. The heart and blood vessels are described and their function discussed. The principles of the circulatory system are detailed, as well as some of the control mechanisms in health and disease.

This course aims to:

1. Provide a modern education in physiology for students with different intellectual interests and a variety of career aspirations.
2. Focus on a quality academic education including where appropriate the acquisition of technical skills.
3. Advance students' knowledge of fundamental principles in a range of physiological subjects.
4. Provide an educational environment within which students can develop an interest in and enthusiasm for their subject, and realise their potential by acquiring intellectual, scientific, technical and study skills appropriate to self-directed study and lifelong learning.
5. Foster learning through the study of the scientific literature, including original research papers.

Code	Module Title	Semester	ECTS	Examination Arrangements
SI212	Respiratory Physiology	2	5	Two hour examination

The course develops fundemental understanding of human respiratory physiology. The lung organs are described and their function discussed respectively. The principles of the respiratory system are detailed, as well as some of the control mechanisms in health and disease.

This course aims to:

1. Provide a modern education in physiology for students with different intellectual interests and a variety of career aspirations.
2. Focus on a quality academic education including where appropriate the acquisition of technical skills.
3. Advance students' knowledge of fundamental principles in a range of physiological subjects.
4. Provide an educational environment within which students can develop an interest in and enthusiasm for their subject, and realise their potential by acquiring intellectual, scientific, technical and study skills appropriate to self-directed study and lifelong learning.
5. Foster learning through the study of the scientific literature, including original research papers.

Code	Module Title	Semester	ECTS	Examination Arrangements
SI312	Endocrinology	2	5	Two hour examination

This module will provide students with a comprehensive introduction to the function of the endocrine system with an emphasis on human endocrinology. It will include an introduction hormonal classification and the molecular mechanisms of hormone action, hormone receptors and their signal transduction pathways. The structure and function of classical endocrine glands will be discussed and the pathophysiology of endocrine disorders will be discussed.

Code	Course	Semester	ECTS	Examination Arrangements
SI331	Renal Physiology	2	5	Two hour examination

The Renal Physiology module will provide students with a knowledge of the normal physiology of the mammalian renal system. Topics covered will include nephron organisation, clearance, filtration, reabsorption, secretion, salt, water and acid base balance and micturitation. Theoretical learning and understanding of will be aided by laboratory practicals investigating the physiology of osmoregulation and clearance.