

University of Pretoria Yearbook 2025

BSc in Physics (02133203)

Department Physics

Minimum duration of study 3 years

Total credits 430

NQF level 07

Programme information

Those students registered for the BSc (Physics) programme and who have opted to select any of the dual major fields of study offered within this programme must take note of the following:

- Their Academic Record will list all the modules that they have completed towards a second major field of study (based on final year modules completed).
- Their Degree certificate will only print the officially approved programme name:

Bachelor of Science
Physics

Admission requirements

Important information for all prospective students for 2025

The admission requirements below apply to all who apply for admission to the University of Pretoria with a **National Senior Certificate (NSC) and Independent Examination Board (IEB) qualifications**. [Click here](#) for this Faculty Brochure.

Minimum requirements			
Achievement level			
English Home Language or English First Additional Language	Mathematics	Physical Sciences	APS
NSC/IEB	NSC/IEB	NSC/IEB	
5	5	5	34

Life Orientation is excluded when calculating the APS.

Applicants currently in Grade 12 must apply with their final Grade 11 (or equivalent) results.

Applicants who have completed Grade 12 must apply with their final NSC or equivalent qualification results.

Please note that meeting the minimum academic requirements does not guarantee admission.

Successful candidates will be notified once admitted or conditionally admitted.

Unsuccessful candidates will be notified after 30 June.

Applicants should check their application status regularly on the UP Student Portal at [click here](#).

Applicants with qualifications other than the abovementioned should refer to the International undergraduate prospectus 2025: Applicants with a school leaving certificate not issued by Umalusi (South Africa), available at [click here](#).

International students: [Click here](#).

Transferring students

A transferring student is a student who, at the time of applying at the University of Pretoria (UP) is/was a registered student at another tertiary institution. A transferring student will be considered for admission based on NSC or equivalent qualification and previous academic performance. Students who have been dismissed from other institutions due to poor academic performance will not be considered for admission to UP.

Closing dates: Same as above.

Returning students

A returning student is a student who, at the time of application for a degree programme is/was a registered student at UP, and wants to transfer to another degree at UP. A returning student will be considered for admission based on NSC or equivalent qualification and previous academic performance.

Note:

- Students who have been excluded/dismissed from a faculty due to poor academic performance may be considered for admission to another programme at UP, as per faculty-specific requirements.
- Only ONE transfer between UP faculties and TWO transfers within a faculty will be allowed.
- Admission of returning students will always depend on the faculty concerned and the availability of space in the programmes for which they apply.

Closing date for applications from returning students

Unless capacity allows for an extension of the closing date, applications from returning students must be submitted before the end of August via your UP Student Centre.

Other programme-specific information

1.1 Requirements for specific modules

A candidate who:

- a. does not qualify for STK 110, must enrol for STK 113 and STK 123;
- b. registers for Mathematical Statistics (WST) and Statistics (STK) modules must take note that WST and STK modules, except for STK 281, may not be taken simultaneously in a programme; a student must take one and only one of the following options:
 - WST 111, WST 121, WST 212, WST 211, WST 221, WST 311, WST 312, WST 322, WST 321, and STK 353
 - or
 - WST 111, WST 121, WST 212, WST 211, WST 221, WST 311, WST 312, WST 322, STK 320, STK 353.
 - or
 - STK 110, STC 122, STK 210, STK 220, WST 212, STK 310, STK 320, STK 353.
- c. registers for a module presented by another faculty must take note of the timetable clashes, prerequisites for that module, subminimum required in examination papers, supplementary examinations, etc.

1.2 Fundamental modules

- a. It is compulsory for all new first-year students to satisfactorily complete the Academic orientation (UPO 102) and to take Academic information management modules (AIM 111 and AIM 121) and Language and study skills (LST 110). Please see curricula for details.
- b. Students who intend to apply for admission to MBChB or BChD in the second semester, when places become available in those programmes, may be permitted to register for up to 80 module credits and 4 core modules in the first semester during the first year provided that they obtained a final mark of no less than 70% for Grade 12 Mathematics and achieved an APS of 34 or more in the NSC.

Promotion to next study year

A student will be promoted to the following year of study if he or she passed 100 credits of the prescribed credits for a year of study, unless the Dean on the recommendation of the relevant head of department decides otherwise. A student who does not comply with the requirements for promotion to the following year of study, retains the credit for the modules already passed and may be admitted by the Dean, on recommendation of the relevant head of department, to modules of the following year of study to a maximum of 48 credits, provided that it will fit in with both the lecture and examination timetable.

General promotion requirements in the faculty

All students whose academic progress is not acceptable can be suspended from further studies.

- A student who is excluded from further studies in terms of the stipulations of the abovementioned regulations, will be notified in writing by the Dean or Admissions Committee at the end of the relevant semester.
- A student who has been excluded from further studies may apply in writing to the Admissions Committee of the Faculty of Natural and Agricultural Sciences for re-admission.
- Should the student be re-admitted by the Admissions Committee, strict conditions will be set which the student must comply with in order to proceed with his/her studies.
- Should the student not be re-admitted to further studies by the Admissions Committee, he/she will be informed in writing.
- Students who are not re-admitted by the Admissions Committee have the right to appeal to the Senate Appeals Committee.
- Any decision taken by the Senate Appeals Committee is final.

Curriculum: Year 1

Minimum credits: 142

Fundamental = 14

Core = 64

Elective = 64

Additional information:

Students must select elective modules with a total number of at least 64 credits according to the following streams. (Deviations allowed with permission from the head of department):

- **Mathematics as second major:** Due to the modules prescribed for the BSc (Physics) module, taking mathematics as a second major in 3rd year is possible for all options. Please select one of the options below.
- **Second major in applied mathematics or mathematical statistics:** WTW 115, WTW 152, WTW 162, WTW 123, WST 111, WST 121 (64 credits)
- **Second major in chemistry or applied mathematics:** CMY 117, CMY 127, WTW 162, WTW 123, WTW 115, WTW 152 (64 credits)
- **Second major in chemistry or mathematical statistics:** CMY 117, CMY 127, WST 111, WST 121 (64 credits)
- **Second major in chemistry or geology:** CMY 117, CMY 127, GLY 155, GLY 163 (64 credits)
- **Second major in chemistry or meteorology:** WKD 155 (16, S1), BME 120 (16, S2), GMC 110 (10, S2), [one of SCI 154 (16, S1), WST 111 (16, S1) or CMY 117 (16, S1)] and [one of WTW 123 (8, S2), WTW 162 (8, S2), CMY 127 (16, S2, prerequisite CMY 117)] (32 + 34 (or 42) = 66 (or 74) credits).
- **Second major in chemistry with interest in biophysics:** CMY 117, CMY 127, MLB 111, GTS 161, BOT 161 (64 credits)
- **Second major in chemistry with interest in astronomy:** CMY 117, CMY 127, WTW 162, WTW 123, SCI 154 (64 credits)
- **Second major in applied mathematics with an interest in astronomy:** WTW 115, WTW 152, WTW 162, WTW 123, SCI 154, COS 132 (64 credits) note: semesters unbalanced – Year credits: S1:80, S2:48
- **Computational physics:** WTW 123, COS 132, COS 110, COS 122, COS 151 (64 credits note: semesters unbalanced – Year credits: S1:56, S2: 72)

Fundamental modules

Academic information management 111 (AIM 111)

Module credits	4.00
NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Economic and Management Sciences Faculty of Humanities Faculty of Law Faculty of Health Sciences Faculty of Natural and Agricultural Sciences Faculty of Theology and Religion
Prerequisites	No prerequisites.



Contact time 2 lectures per week

Language of tuition Module is presented in English

Department Information Science

Period of presentation Semester 1

Module content

Find, evaluate, process, manage and present information resources for academic purposes using appropriate technology.

Academic information management 121 (AIM 121)

Module credits 4.00

NQF Level 05

Service modules

Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Economic and Management Sciences
Faculty of Humanities
Faculty of Law
Faculty of Health Sciences
Faculty of Natural and Agricultural Sciences
Faculty of Theology and Religion
Faculty of Veterinary Science

Prerequisites No prerequisites.

Contact time 2 lectures per week

Language of tuition Module is presented in English

Department Informatics

Period of presentation Semester 2

Module content

Apply effective search strategies in different technological environments. Demonstrate the ethical and fair use of information resources. Integrate 21st-century communications into the management of academic information.

Language and study skills 110 (LST 110)

Module credits 6.00

NQF Level 05

Service modules Faculty of Natural and Agricultural Sciences
Faculty of Veterinary Science

Prerequisites No prerequisites.

Contact time 2 lectures per week

Language of tuition Module is presented in English

Department Unit for Academic Literacy



Period of presentation Semester 1

Module content

The module aims to equip students with the ability to cope with the reading and writing demands of scientific disciplines.

Academic orientation 102 (UPO 102)

Module credits 0.00

NQF Level 00

Language of tuition Module is presented in English

Department Natural and Agricultural Sciences Dean's Office

Period of presentation Year

Core modules

First course in physics 114 (PHY 114)

Module credits 16.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education

Prerequisites A candidate must have passed Mathematics and Physical Science with at least 60% in the Grade 12 examination

Contact time 1 practical per week, 1 discussion class per week, 4 lectures per week

Language of tuition Module is presented in English

Department Physics

Period of presentation Semester 1

Module content

SI-units. Significant figures. Waves: intensity, superposition, interference, standing waves, resonance, beats, Doppler. Geometrical optics: Reflection, refraction, mirrors, thin lenses, instruments. Physical optics: Young-interference, coherence, diffraction, polarisation. Hydrostatics and dynamics: density, pressure, Archimedes' principle, continuity, Bernoulli. Heat: temperature, specific heat, expansion, heat transfer. Vectors. Kinematics of a point: Relative, projectile, and circular motion. Dynamics: Newton's laws, friction. Work: point masses, gasses (ideal gas law), gravitation, spring, power. Kinetic energy: Conservative forces, gravitation, spring. Conservation of energy. Conservation of momentum. Impulse and collisions. System of particles: Centre of mass, Newton's laws. Rotation: torque, conservation of angular momentum, equilibrium, centre of gravity.

First course in physics 124 (PHY 124)

Module credits 16.00

NQF Level 05



Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education

Prerequisites (WTW 114 GS or WTW 158 GS or WTW 134) and PHY 114 GS

Contact time 1 practical per week, 1 discussion class per week, 4 lectures per week

Language of tuition Module is presented in English

Department Physics

Period of presentation Semester 2

Module content

Simple harmonic motion and pendulums. Coulomb's law. Electric field: dipoles, Gauss' law. Electric potential. Capacitance. Electric currents: resistance, resistivity, Ohm's law, energy, power, emf, RC-circuits. Magnetic Field: Hall-effect, Bio-Savart. Faraday's and Lenz's laws. Oscillations: LR-circuits. Alternating current: RLC-circuits, power, transformers. Introductory concepts to modern physics. Nuclear physics: Radioactivity.

Calculus 114 (WTW 114)

Module credits 16.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Economic and Management Sciences
Faculty of Humanities

Prerequisites 60% for Mathematics in Grade 12

Contact time 1 tutorial per week, 4 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 1

Module content

*This module serves as preparation for students majoring in Mathematics (including all students who intend to enrol for WTW 218 and WTW 220). Students will not be credited for more than one of the following modules for their degree: WTW 114, WTW 158, WTW 134, WTW 165.

Functions, limits and continuity. Differential calculus of single variable functions, rate of change, graph sketching, applications. The mean value theorem, the rule of L'Hospital. Definite and indefinite integrals, evaluating definite integrals using anti-derivatives, the substitution rule.

Mathematics 124 (WTW 124)

Module credits 16.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Economic and Management Sciences

Prerequisites	WTW 114
Contact time	4 lectures per week, 1 tutorial per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 2

Module content

*Students will not be credited for more than one of the following modules for their degree: WTW 124, WTW 146, WTW 148 and WTW 164. This module serves as preparation for students majoring in Mathematics (including all students who intend to enrol for WTW 218, WTW 211 and WTW 220).

The vector space R^n , vector algebra with applications to lines and planes, matrix algebra, systems of linear equations, determinants. Complex numbers and factorisation of polynomials. Integration techniques and applications of integration. The formal definition of a limit. The fundamental theorem of Calculus and applications. Vector functions and quadratic curves.

Elective modules

Biometry 120 (BME 120)

Module credits 16.00

NQF Level 05

Service modules
Faculty of Engineering, Built Environment and Information Technology
Faculty of Natural and Agricultural Sciences
Faculty of Veterinary Science

Prerequisites At least 4 (50-59%) in Mathematics in the Grade 12 examination, or at least 50% in both Statistics 113, 123

Contact time 4 lectures per week, 1 practical per week

Language of tuition Module is presented in English

Department Statistics

Period of presentation Semester 2

Module content

Simple statistical analysis: Data collection and analysis: Samples, tabulation, graphical representation, describing location, spread and skewness. Introductory probability and distribution theory. Sampling distributions and the central limit theorem. Statistical inference: Basic principles, estimation and testing in the one- and two-sample cases (parametric and non-parametric). Introduction to experimental design. One- and twoway designs, randomised blocks. Multiple statistical analysis: Bivariate data sets: Curve fitting (linear and non-linear), growth curves. Statistical inference in the simple regression case. Categorical analysis: Testing goodness of fit and contingency tables. Multiple regression and correlation: Fitting and testing of models. Residual analysis. Computer literacy: Use of computer packages in data analysis and report writing.

Plants and society 161 (BOT 161)

Module credits 8.00



NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education
Prerequisites	MLB 111 GS
Contact time	2 lectures per week, fortnightly practicals
Language of tuition	Module is presented in English
Department	Department of Plant and Soil Sciences
Period of presentation	Semester 2

Module content

Botanical principles of structure and function; diversity of plants; introductory plant systematics and evolution; role of plants in agriculture and food security; principles and applications of plant biotechnology; economical and valuable medicinal products derived from plants; basic principles of plant ecology and their application in conservation and biodiversity management.

This content aligns with the United Nation's Sustainable Development Goals of No Poverty, Good Health and Well-being, Climate Action, Responsible Consumption and Production, and Life on Land.

General chemistry 117 (CMY 117)

Module credits 16.00

NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Health Sciences Faculty of Veterinary Science
Prerequisites	A candidate must have Mathematics for at least 60% and 60% for Physical Sciences.
Contact time	4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 1

Module content

General introduction to inorganic, analytical and physical chemistry. Atomic structure and periodicity. Molecular structure and chemical bonding using the VSEPR-model. Nomenclature of inorganic ions and compounds. Classification of reactions: precipitation, acid-base, redox reactions and gas-forming reactions. Mole concept and stoichiometric calculations concerning chemical formulas and chemical reactions. Principles of reactivity: energy and chemical reactions. Physical behaviour gases, liquids, solids and solutions and the role of intermolecular forces. Rate of reactions: Introduction to chemical kinetics.

General chemistry 127 (CMY 127)

Module credits 16.00

NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Health Sciences Faculty of Veterinary Science
Prerequisites	Natural and Agricultural Sciences students: CMY 117 GS or CMY 154 GS Health Sciences students: none
Contact time	1 practical per week, 4 lectures per week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 2

Module content

Theory: General physical-analytical chemistry: Chemical equilibrium, acids and bases, buffers, solubility equilibrium, entropy and free energy, electrochemistry. Organic chemistry: Structure (bonding), nomenclature, isomerism, introductory stereochemistry, introduction to chemical reactions and chemical properties of organic compounds and biological compounds, i.e. carbohydrates and aminoacids. Practical: Molecular structure (model building), synthesis and properties of simple organic compounds.

Program design: Introduction 110 (COS 110)

Module credits	16.00
NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Economic and Management Sciences Faculty of Natural and Agricultural Sciences
Prerequisites	COS 132 AND (COS 151 OR 12130009 OR 12136009) AND Maths level 5
Contact time	3 lectures per week, 1 practical per week, 1 tutorial per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 2

Module content

The focus is on object-oriented (OO) programming. Concepts including inheritance and multiple inheritance, polymorphism, operator overloading, memory management (static and dynamic binding), interfaces, encapsulation, reuse, etc. will be covered in the module. The module teaches sound program design with the emphasis on modular code, leading to well structured, robust and documented programs. A modern OO programming language is used as the vehicle to develop these skills. The module will introduce the student to basic data structures, lists, stacks and queues.

Operating systems 122 (COS 122)

Module credits	16.00
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NQF Level	05
Prerequisites	COS 132, admission to relevant programme
Contact time	1 practical per week, 1 tutorial per week, 3 lectures per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 2

Module content

Fundamental concepts of modern operating systems in terms of their structure and the mechanisms they use are studied in this module. After completing this module, students will have gained, as outcomes, knowledge of real time, multimedia and multiple processor systems, as these will be defined and analysed. In addition, students will have gained knowledge on modern design issues of process management, deadlock and concurrency control, memory management, input/output management, file systems and operating system security. In order to experience a hands-on approach to the knowledge students would have gained from studying the abovementioned concepts, students will have produced a number of practical implementations of these concepts using the Windows and Linux operating systems.

Imperative programming 132 (COS 132)

Module credits	16.00
NQF Level	05
Service modules	Faculty of Economic and Management Sciences Faculty of Natural and Agricultural Sciences
Prerequisites	APS of 30 and level 5 (60-69%) Mathematics
Contact time	1 tutorial per week, 1 practical per week, 3 lectures per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 1

Module content

This module introduces imperative computer programming, which is a fundamental building block of computer science. The process of constructing a program for solving a given problem, of editing it, compiling (both manually and automatically), running and debugging it, is covered from the beginning. The aim is to master the elements of a programming language and be able to put them together in order to construct programs using types, control structures, arrays, functions and libraries. An introduction to object orientation will be given. After completing this module, the student should understand the fundamental elements of a program, the importance of good program design and user-friendly interfaces. Students should be able to conduct basic program analysis and write complete elementary programs.

Introduction to computer science 151 (COS 151)

Module credits	8.00
NQF Level	05



Service modules Faculty of Education
Faculty of Natural and Agricultural Sciences

Prerequisites APS of 30 and level 5 (60-69%) Mathematics.

Contact time 2 lectures per week, 1 practical per week

Language of tuition Module is presented in English

Department Computer Science

Period of presentation Semester 1

Module content

This module introduces concepts and terminology related to the computer science discipline. General topics covered include the history of computing, machine level representation of data, Boolean logic and gates, basic computer systems organisation, algorithms and complexity and automata theory. The module also introduces some of the subdisciplines of computer science, such as computer networks, database systems, compilers, information security and intelligent systems. The module also focuses on modelling of algorithms.

Introduction to geology 155 (GLY 155)

Module credits 16.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology

Prerequisites A candidate must have passed Mathematics with at least 60% in the Grade 12 examination.

Contact time 1 practical per week, 4 lectures per week

Language of tuition Module is presented in English

Department Geology

Period of presentation Semester 1

Module content

Solar system; structure of solid matter; minerals and rocks; introduction to symmetry and crystallography; important minerals and solid solutions; rock cycle; classification of rocks. External geological processes (gravity, water, wind, sea, ice) and their products (including geomorphology). Internal structure of the earth. The dynamic earth – volcanism, earthquakes, mountain building – the theory of plate tectonics. Geological processes (magmatism, metamorphism, sedimentology, structural geology) in a plate tectonic context. Geological maps and mineral and rock specimens. Interaction between man and the environment, and nature of anthropogenic climate change.

Earth history 163 (GLY 163)

Module credits 16.00

NQF Level 05

Prerequisites GLY 155

Contact time 1 practical per week, 4 lectures per week

Language of tuition Module is presented in English

Department Geology

Period of presentation Semester 2

Module content

This module will give an overview of earth history, from the Archaean to the present. Important concepts such as the principles of stratigraphy and stratigraphic nomenclature, geological dating and international and South African time scales will be introduced. A brief introduction to the principles of palaeontology will be given, along with short descriptions of major fossil groups, fossil forms, ecology and geological meaning. In the South African context, the major stratigraphic units, intrusions and tectonic/metamorphic events will be detailed, along with related rock types, fossil contents, genesis and economic commodities. Anthropogenic effects on the environment and their mitigation. Practical work will focus on the interpretation of geological maps and profiles.

Cartography 110 (GMC 110)

Module credits 10.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology

Prerequisites No prerequisites.

Contact time 1 practical per week, 3 lectures per week

Language of tuition Module is presented in English

Department Geography Geoinformatics and Meteorology

Period of presentation Semester 2

Module content

History, present and future of cartography. Introductory geodesy: shape of the earth, graticule and grids, datum definition, elementary map projection theory, spherical calculations. Representation of geographical data on maps: Cartographic design, cartographic abstraction, levels of measurement and visual variables. Semiotics for cartography: signs, sign systems, map semantics and syntactics, explicit and implicit meaning of maps (map pragmatics). Critique maps of indicators to measure United Nations Sustainable Development Goals in South Africa.

Introductory genetics 161 (GTS 161)

Module credits 8.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Veterinary Science

Prerequisites MLB 111 GS

Contact time fortnightly tutorials, 2 lectures per week

Language of tuition Module is presented in English



Department Biochemistry, Genetics and Microbiology

Period of presentation Semester 2

Module content

Chromosomes and cell division. Principles of Mendelian inheritance: locus and alleles, dominance interactions, extensions and modifications of basic principles.. Probability studies. Sex determination and sex linked traits. Pedigree analysis. Genetic linkage and chromosome mapping. Chromosome variation.

Molecular and cell biology 111 (MLB 111)

Module credits 16.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Health Sciences
Faculty of Veterinary Science

Prerequisites A candidate who has passed Mathematics with at least 60% in the Grade 12 examination

Contact time 4 lectures per week, 1 practical/tutorial per week

Language of tuition Module is presented in English

Department Biochemistry, Genetics and Microbiology

Period of presentation Semester 1

Module content

Introduction to the molecular structure and function of the cell. Basic chemistry of the cell. Structure and composition of prokaryotic and eukaryotic cells. Ultrastructure and function of cellular organelles, membranes and the cytoskeleton. General principles of energy, enzymes and cell metabolism. Selected processes, e.g. glycolysis, respiration and/or photosynthesis. Introduction to molecular genetics: DNA structure and replication, transcription, translation. Cell growth and cell division.

Exploring the universe 154 (SCI 154)

Module credits 16.00

NQF Level 05

Prerequisites Prohibited combination SCI 164

Contact time 4 lectures per week

Language of tuition Module is presented in English

Department Physics

Period of presentation Semester 1

Module content

Students from all faculties are welcome to join us in our exploration of the universe from an earth-bound perspective. We reflect on the whole universe from the sub microscopic to the vast macroscopic and mankind's modest position therein. To what degree is our happiness determined by stars? Echoes from ancient firmaments - the astronomy of old civilisations. The universe is born with a bang. Stars, milky ways and planets are formed. Life is breathed into the landscape on earth, but is there life elsewhere? The architecture of the universe - distance measurements, structure of our solar system and systems of stars. How does it look like on neighbouring planets? Comets and meteorites. Life cycles of stars. Spectacular exploding stars! Exotica like pulsars and black holes.

Atmospheric structure and processes 155 (WKD 155)

Module credits	16.00
NQF Level	05
Prerequisites	At least 50% for mathematics in grade 12.
Contact time	1 practical per week, 4 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

Introduction to weather and climate. Climate of South Africa. Urban and rural climate. Meteorological instruments. Motion of the earth. Atmospheric mass and pressure. Energy and heat budget. Moisture in the atmosphere. Cloud development. Climate change. ENSO. Electromagnetic spectrum and remote sensing in meteorology. Synoptic weather systems of South Africa.

Mathematical statistics 111 (WST 111)

Module credits	16.00
NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Economic and Management Sciences Faculty of Natural and Agricultural Sciences
Prerequisites	At least 5 (60-69%) in Mathematics in the Grade 12 examination
Contact time	4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Statistics
Period of presentation	Semester 1

Module content

Aims of data analysis (descriptive, inferential and predictive). Stages of conducting a data analysis. Sources and types of data. Reproducible research. Characterisation of a set of measurements: Graphical and numerical methods. Random sampling. Probability theory. Discrete and continuous random variables. Probability distributions. Generating functions and moments.

Mathematical statistics 121 (WST 121)

Module credits 16.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Economic and Management Sciences
Faculty of Natural and Agricultural Sciences

Prerequisites WST 111 or WST 133, 143 and 153

Contact time 1 practical per week, 4 lectures per week

Language of tuition Module is presented in English

Department Statistics

Period of presentation Semester 2

Module content

Sampling distributions and the central limit theorem. Statistical inference: Point and interval estimation. Hypothesis testing with applications in one and two-sample cases. Introductory methods for: Linear regression and correlation, analysis of variance, categorical data analysis and non-parametric statistics. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.

Discrete structures 115 (WTW 115)

Module credits 8.00

NQF Level 05

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Economic and Management Sciences

Prerequisites 50% for Mathematics in Grade 12

Contact time 2 lectures per week, 1 tutorial per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 1

Module content

Propositional logic: truth tables, logical equivalence, implication, arguments. Mathematical induction and well-ordering principle. Introduction to set theory. Counting techniques: elementary probability, multiplication and addition rules, permutations and combinations, binomial theorem, inclusion-exclusion rule.



Numerical analysis 123 (WTW 123)

Module credits	8.00
NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	WTW 114
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 2

Module content

Non-linear equations, numerical integration, initial value problems for differential equations, systems of linear equations. Algorithms for elementary numerical techniques are derived and implemented in computer programmes. Error estimates and convergence results are treated.

Mathematical modelling 152 (WTW 152)

Module credits	8.00
NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	50% for Mathematics in Grade 12
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 1

Module content

The module serves as an introduction to computer programming as used in science. Modelling of dynamical processes using difference equations; curve fitting and linear programming are studied. Applications are drawn from real-life situations in, among others, finance, economics and ecology.

Dynamical processes 162 (WTW 162)

Module credits	8.00
NQF Level	05
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	WTW 114
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

*Students will not be credited for more than one of the following modules for their degree: WTW 162 and WTW 264.

Introduction to the modelling of dynamical processes using elementary differential equations. Solution methods for first order differential equations and analysis of properties of solutions (graphs). Applications to real life situations.

Curriculum: Year 2

Minimum credits: 144

Core = 96

Elective = 48

Additional information:

Students must select elective modules with a total number of at least 48 credits according to the following streams (deviations allowed with permission from the head of department):

- **Mathematics as second major:** Due to the modules prescribed for the BSc (Physics) module, taking mathematics as a second major in 3rd year is possible for all options.
- **Second major applied mathematics:** WTW 286 (12, S1), WTW 221 (12, S2) and PHY 210 (24, S2) (48 credits). WTW 285 (12, S2) may be taken additionally.
- **Second major statistics:** WST 211, WST 221, WST 212 (60 credits)
- **Second major in chemistry:** CMY 282, CMY 283, CMY 284, CMY 285 (48 credits).
- **Second major in geology:** GLY 253, GLY 263 (48 credits).
- **Second major in meteorology:** WKD 261 (12, S2), WKD 254 (12, S2), ENV 201 (14, S1), WKD 263 (14, S1), WKD 265 (12, S2) (28 + 36 = 64 credits). Note: due to the excess credits in the second year it is recommended that students doing a second major in meteorology enrol for ENV 201 in their third year of study.
- **Interest in astronomy:** PHY 210, WTW 221, WTW 286 (48 credits) **note:** semester unbalanced: Year credits S1: 60, S2: 84)
- **Interest in computational physics:** COS 210, COS 212, COS 226, COS 284 (56 credits) **note:** 24 + 32 = 56 credits = excess of 8 credits in second semester.

Core modules

Waves, thermodynamics and modern physics 255 (PHY 255)

Module credits	24.00
NQF Level	06
Service modules	Faculty of Education
Prerequisites	[PHY114 and PHY124] or [PHY171] or [PHY143 and PHY153 and PHY163] and [WTW211#] and [WTW218#]
Contact time	1 practical per week, 4 lectures per week, 2 discussion classes per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 1

Module content

Vibrating systems and waves

Simple harmonic motion (SHM). Superposition (different frequencies, equal frequencies). Perpendicular vibrations (Lissajous figures). Damped SHM. Forced oscillations. Resonance. Q-value. Transverse wave motion. Plane wave solution using method of separation of variables. Reflection and transmission at a boundary. Normal and eigenmodes. Wave packets. Group velocity.

Modern physics

Special relativity: Galilean and Lorentz transformations. Postulates. Momentum and energy. 4 vectors and tensors. General relativity. Quantum physics. Failure of classical physics. Bohr model. Particle-wave duality. Schrödinger equation. Piece-wise constant potentials. Tunneling. X-rays. Laser. Nuclear physics: Fission. Fusion. Radioactivity.

Heat and thermodynamics

Heat. First Law. Kinetic theory of gases. Mean free path. Ideal, Clausius, Van der Waals and virial gases. Entropy. Second Law. Engines and refrigerators. Third Law. Thermodynamic potentials: Enthalpy Helmholtz and Gibbs free energies, Chemical potential. Legendre transformations (Maxwell relations). Phase equilibrium. Gibbs phase rule.

Modelling and simulation (practical sessions)

Introduction to programming in a high level system: Concept of an algorithm and the basic logic of a computer programme. Symbolic manipulations, graphics, numerical computations. Applications: Selected illustrative examples.

Error Analysis (practical sessions)

Experimental uncertainties. Propagation of uncertainties. Statistical analysis of random uncertainties. Normal distribution. Rejection of data. Least-squares fitting. Covariance and correlation.

General physics 263 (PHY 263)

Module credits	24.00
NQF Level	06
Service modules	Faculty of Education
Prerequisites	PHY 255 GS and WTW 218 GS and WTW 220# and WTW 248#
Contact time	4 lectures per week, 2 discussion classes per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 2

Module content

Classical mechanics

Fundamental concepts, energy and angular momentum, calculus of variations and Lagrangian mechanics, conservative central forces and two body problems, scattering, mechanics in rotating reference frames, many body systems.

Physical Optics

Maxwell's equations, wave equation and plane wave solution, coherence, interference, diffraction, polarisation.

Physics of Materials

Classification of materials. Atomic bonding. Crystallography. Defects. Material strength.

Phase diagram's, Ceramics. Polymers. Composites. Fracture. Electrical and magnetic properties.

Semiconductors. Smart materials Nanotechnology.

Experiments

Linear algebra 211 (WTW 211)

Module credits 12.00

NQF Level 06

Service modules

Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Economic and Management Sciences

Prerequisites WTW 124

Contact time 2 lectures per week, 1 tutorial per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 1

Module content

This is an introduction to linear algebra on R^n . Matrices and linear equations, linear combinations and spans, linear independence, subspaces, basis and dimension, eigenvalues, eigenvectors, similarity and diagonalisation of matrices, linear transformations.

Calculus 218 (WTW 218)

Module credits 12.00

NQF Level 06

Service modules

Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Economic and Management Sciences

Prerequisites WTW 114 and WTW 124

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics



Period of presentation Semester 1

Module content

Calculus of multivariable functions, directional derivatives. Extrema and Lagrange multipliers. Multiple integrals, polar, cylindrical and spherical coordinates.

Analysis 220 (WTW 220)

Module credits 12.00

NQF Level 06

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Economic and Management Sciences

Prerequisites WTW 114 and WTW 124, WTW 211 and WTW 218

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

*This module is recommended as an elective only for students who intend to enrol for WTW 310 and/or WTW 320. Students will not be credited for more than one of the following modules for their degree: WTW 220 and WTW 224.

Properties of real numbers. Analysis of sequences and series of real numbers. Power series and theorems of convergence. The Bolzano-Weierstrass theorem. The intermediate value theorem and analysis of real-valued functions on an interval. The Riemann integral: Existence and properties of the interval.

Vector analysis 248 (WTW 248)

Module credits 12.00

NQF Level 06

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education

Prerequisites WTW 218

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

Vectors and geometry. Calculus of vector functions with applications to differential geometry, kinematics and dynamics. Vector analysis, including vector fields, line integrals of scalar and vector fields, conservative vector fields, surfaces and surface integrals, the Theorems of Green, Gauss and Stokes with applications.



Elective modules

Physical chemistry 282 (CMY 282)

Module credits	12.00
NQF Level	06
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	2 practicals every other week, 1 tutorial every other week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 1

Module content

Theory: Classical chemical thermodynamics, gases, first and second law and applications, physical changes of pure materials and simple compounds. Phase rule: Chemical reactions, chemical kinetics, rates of reactions.

Analytical chemistry 283 (CMY 283)

Module credits	12.00
NQF Level	06
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	2 lectures per week, 2 practicals every other week, 1 tutorial every other week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 2

Module content

Statistical evaluation of data in line with ethical practice, gravimetric analysis, aqueous solution chemistry, chemical equilibrium, precipitation-, neutralisation- and complex formation titrations, redox titrations, potentiometric methods, introduction to electrochemistry. Examples throughout the course demonstrate the relevance of the theory to meeting the sustainable development goals of clean water and clean, affordable energy.

Organic chemistry 284 (CMY 284)

Module credits	12.00
NQF Level	06
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	2 practicals every other week, 1 tutorial every other week, 2 lectures per week



Language of tuition Module is presented in English

Department Chemistry

Period of presentation Semester 1

Module content

Resonance, conjugation and aromaticity. Acidity and basicity. Introduction to ^{13}C NMR spectroscopy. Electrophilic addition: alkenes. Nucleophilic substitution, elimination, addition: alkyl halides, alcohols, ethers, epoxides, carbonyl compounds: ketones, aldehydes, carboxylic acids and their derivatives Training in an ethical approach to safety that protects self, others and the environment is integral to the practical component of the course.

Inorganic chemistry 285 (CMY 285)

Module credits 12.00

NQF Level 06

Service modules Faculty of Education

Prerequisites CMY 117 and CMY 127

Contact time 1 tutorial every other week, 2 practicals every other week, 2 lectures per week

Language of tuition Module is presented in English

Department Chemistry

Period of presentation Semester 2

Module content

Atomic structure, structure of solids (ionic model). Coordination chemistry of transition metals: Oxidation states of transition metals, ligands, stereochemistry, crystal field theory, consequences of d-orbital splitting, electrochemical properties of transition metals in aqueous solution. Fundamentals of spectroscopy and introduction to IR spectroscopy. During practical training students learn to acquire and report data ethically. Practical training also deals with the misuse of chemicals and appropriate waste disposal to protect the environment and meet the UN sustainable development goals.

Theoretical computer science 210 (COS 210)

Module credits 8.00

NQF Level 06

Prerequisites COS 110 and COS 151, admission to relevant programme

Contact time 1 practical per week, 2 lectures per week

Language of tuition Module is presented in English

Department Computer Science

Period of presentation Semester 1

Module content

This module introduces students to a framework for investigating both computability and complexity of problems. Topics include, but are not limited to: finite-state machines, regular expressions and their application in a language such as awk, the Halting problem, context-free grammars, P vs NP problem, NP-complete class, reduction techniques, regular languages, DFAs and NFAs, Lattices, Church-Turing thesis.

Data structures and algorithms 212 (COS 212)

Module credits	16.00
NQF Level	06
Service modules	Faculty of Natural and Agricultural Sciences
Prerequisites	COS 110, admission to relevant programme
Contact time	4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 1

Module content

Data abstraction is a fundamental concept in the design and implementation of correct and efficient software. In prior modules, students are introduced to the basic data structures of lists, stacks and queues. This module continues with advanced data structures such as trees, hash tables, heaps and graphs, and goes into depth with the algorithms needed to manipulate them efficiently. Classical algorithms for sorting, searching, traversing, packing and game playing are included, with an emphasis on comparative implementations and efficiency. At the end of this module, students will be able to identify and recognise all the classical data structures; implement them in different ways; know how to measure the efficiency of implementations and algorithms; and have further developed their programming skills, especially with recursion and polymorphism.

Concurrent systems 226 (COS 226)

Module credits	16.00
NQF Level	06
Prerequisites	COS 122 and COS 212
Contact time	1 practical per week, 4 lectures per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 2

Module content

Computer science courses mostly deal with sequential programs. This module looks at the fundamentals of concurrency; what it means, how it can be exploited, and what facilities are available to determine program correctness. Concurrent systems are designed, analysed and implemented.

Computer organisation and architecture 284 (COS 284)

Module credits	16.00
NQF Level	06
Prerequisites	COS 212 GS, admission to relevant programme
Contact time	4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 2

Module content

This module provides the foundations on which other modules build by enabling a deeper understanding of how software interacts with hardware. It will teach the design and operation of modern digital computers by studying each of the components that make up a digital computer and the interaction between these components. Specific areas of interest, but not limited to, are: representation of data on the machine-level; organisation of the machine on the assembly level; the architecture and organisation of memory; inter- and intra-component interfacing and communication; data paths and control; and parallelism. Topic-level detail and learning outcomes for each of these areas are given by the first 6 units of 'Architecture and Organisation' knowledge area as specified by the ACM/IEEE Computer Science Curriculum 2013.

The concepts presented in the theory lectures will be reinforced during the practical sessions by requiring design and implementation of the concepts in simulators and assembly language using an open source operating system.

Environmental sciences 201 (ENV 201)

Module credits	14.00
NQF Level	06
Prerequisites	ENV 101 or WKD 155 or BOT 161 or ZEN 161.
Contact time	2 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

Introduces basic concepts and interrelationships required to understand our atmosphere, with a strong focus on an introduction to weather and climate. A key component of the course is an introduction to climate change, including the science of climate change, introducing climate change projections, and climate change impacts. A key focus of the second part of the course will be climate change implications for the attainment of SDGs and Aichi targets on the African continent, under a range of plausible scenarios.

Process geomorphology 252 (GGY 252)

Module credits	12.00
NQF Level	06

Service modules	Faculty of Education Faculty of Humanities
Prerequisites	GGY 166 or GLY 155
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

Physical processes that influence the earth's surface and management. Specific processes and their interaction in themes such as weathering; soil erosion; slope, mass movement and periglacial processes. Practical laboratory exercises and assignments are based on the themes covered in the module theory component.

Geomorphology of the built environment 265 (GGY 265)

Module credits	12.00
NQF Level	06
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	No prerequisites.
Contact time	4 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Quarter 3

Module content

*This module is for Architecture and Landscape Architecture students only.

The theory component covers geomorphological aspects of the built environment including landscape identification; weathering or deterioration of natural stone and application to design and preservation of buildings and monuments; slope hydrology and stability conditions; soil erosion processes and construction impacts; drainage modification in urban areas; wetland identification, human impacts and rehabilitation; recreational impacts and management. In addition to the theory a field-based project is undertaken.

Geographic data analysis 220 (GIS 220)

Module credits	14.00
NQF Level	06
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	GMC 110 and (STK 110 OR BME 120)
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology

Period of presentation Semester 2

Module content

The nature of geographical data and measurement. Application of statistics in the geographical domain. Probability, probability distributions and densities, expected values and variances, Central Limit theorem. Sampling techniques. Exploratory data analysis, descriptive statistics, statistical estimation, hypothesis testing, correlation analysis and regression analysis. Examples used throughout the course are drawn from South African and African case studies and taught within the framework of the UN Sustainable Development Goals.

Sedimentology 253 (GLY 253)

Module credits 24.00

NQF Level 06

Prerequisites CMY 117, CMY 127, GLY 155, GLY 163, and one of WTW 134, WTW 114 or BME 120.

Contact time 4 lectures per week, 2 practicals per week

Language of tuition Module is presented in English

Department Geology

Period of presentation Semester 1

Module content

This module introduces the basic principles and concepts of sedimentology. Building on existing knowledge on stratigraphy and mineralogy from the first year, sediments will be followed from their origin (precursor rocks that experienced weathering and erosion) through diverse modes of transport to their final place of deposition on land and in the sea. The formation of sedimentary textures and structures and their interpretation in terms of sedimentary environments, as well as post-depositional diagenetic processes, will be discussed. Furthermore, some economic aspects of sedimentology will be covered, such as placer deposits and conventional and renewable energy sources. Later parts in the course will concentrate on basin-forming processes and provide an overview of modern basin analysis. An introduction to sequence stratigraphy and sedimentary geochemistry will be offered as part of this, both of which are important applications of sedimentology for interpreting sea level variations and climatic changes.

Practical sessions: During the hands-on practicals, participants will learn how to classify rocks using a wide spectrum of different techniques while developing an appreciation of the processes that result in the formation of sediments, sedimentary rocks, and entire sedimentary sequences.

This will include presenting the fundamentals of optical mineralogy and how to examine some of the major minerals that comprise sedimentary rocks in thin sections using transmitted light microscopy. Further aspects of the practical sessions will focus on grain size/sieve analysis and basic statistical analysis. Sedimentary geochemistry will be used to identify the degrees of alteration and help interpret climatic and environmental conditions during the time of sediment emplacement. Furthermore, field data acquisition from sedimentary rocks, interpretation of sedimentary profiles and core logs, and writing of reports and oral presentations will be practiced.

Remote sensing 220 (GMA 220)

Module credits 14.00



NQF Level	06
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	GMC 110
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

This module aims to provide students with a working knowledge and skills to learn methods and techniques for collecting, processing and analysing remotely sensed data. Throughout the module, emphasis will be placed on image processing, image analysis, image classification, remote sensing and applications of remote sensing in geographical analysis and environmental monitoring. The module is composed of lectures, readings, practical exercises research tasks and a project or assignments of at least 64 notional hours. In particular, the practical exercises and research tasks incorporate South African examples using satellite remotely-sensed data, as well as field spectral data measurements, to promote understanding of the state of land cover and land use types (e.g. spanning agricultural resources, water resources, urbanization) and how changes over time could impact on the changing climate in accordance with the United Nation's Sustainable Development Goals.

Astronomy for physicists 210 (PHY 210)

Module credits	24.00
NQF Level	06
Prerequisites	PHY 114, PHY 124
Contact time	4 lectures per week, 1 practical per week, 1 discussion class per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 2

Module content

Introduction to the universe: distance and time scales. Solar System overview. Techniques of astronomy: telescopes and optics, basic radio receiver. Solar system: gas giants, terrestrial planets, small bodies. Stellar evolution and death. Interstellar medium: gas, dust, molecules and masers. Supernova and Pulsars: galaxies and the Milky Way, galactic evolution and classification. Quasars, apparent superluminal motion, black holes. Big Bang, and the age of the universe. Expansion of the universe. SKA, MeerKAT, SALT, HESS and history of astronomy in SA. Other current topics in astronomy.

Programming in meteorology 254 (WKD 254)

Module credits	12.00
NQF Level	06
Prerequisites	WKD 155 and WKD 263.

Contact time	1 practical per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 2

Module content

Meteorological data acquisition. Manipulation of multidimensional meteorological data sets. Spatial representation and interpretation of weather data. Application and interpretation of dynamic equations.

Physical meteorology 261 (WKD 261)

Module credits	12.00
NQF Level	06
Prerequisites	(WTW 114 or WTW 158 or WTW 134 or WTW 165) and (WKD 155 or ENV 201)
Contact time	1 tutorial every 2nd week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 2

Module content

Basic thermodynamic laws for dry and humid air. The equation of state. Adiabatic processes and temperature lapse rates. The Clausius-Clapeyron equation. Cloud microphysics. The physical basis of climate change. Practical application and Areological diagrams.

Introduction to dynamic meteorology 263 (WKD 263)

Module credits	14.00
NQF Level	06
Prerequisites	WTW 124
Contact time	1 tutorial per week, 4 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

Mathematical methods for meteorology, second law of motion in spherical coordinates. Acceleration in rotating co-ordinates, fundamental forces, momentum equation. Three dimensional flow balance, conservation of mass, heat equation, thermodynamic energy equation. Introduction to finite difference methods. Numerical estimation of the geostrophic wind, vorticity and divergence. Advection of temperature. Development of a two-dimensional temperature advection model.



Satellite meteorology 265 (WKD 265)

Module credits	12.00
NQF Level	06
Prerequisites	GMA 220, WKD 155 or ENV 201
Contact time	1 tutorial every 2nd week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 2

Module content

Display formats of remote sensed data, projections and color schemes. Common channels available from meteorological satellite sensors, including visible, near infra-red, water vapour and infra-red. Channel combination, channel differencing and RGB images. Image selection for observation of synoptic and mesoscale weather systems, natural hazards and clouds.

Mathematical statistics 211 (WST 211)

Module credits	24.00
NQF Level	06
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Economic and Management Sciences Faculty of Natural and Agricultural Sciences
Prerequisites	WST 111, WST 121, WTW 114 GS and WTW 124 GS
Contact time	4 lectures per week, 2 practicals per week
Language of tuition	Module is presented in English
Department	Statistics
Period of presentation	Semester 1

Module content

Set theory. Probability measure functions. Random variables. Distribution functions. Probability mass functions. Density functions. Expected values. Moments. Moment generating functions. Special probability distributions: Bernoulli, binomial, hypergeometric, geometric, negative binomial, Poisson, Poisson process, discrete uniform, uniform, gamma, exponential, Weibull, Pareto, normal. Joint distributions: Multinomial, extended hypergeometric, joint continuous distributions. Marginal distributions. Independent random variables. Conditional distributions. Covariance, correlation. Conditional expected values. Transformation of random variables: Convolution formula. Order statistics. Stochastic convergence: Convergence in distribution. Central limit theorem. Sources and types of data and characteristics of extremely large or complex data sets. Practical applications. Practical statistical modelling and analysis using statistical computer packages and the interpretation of the output.

Applications in data science 212 (WST 212)

Module credits	12.00
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NQF Level	06
Prerequisites	WST 111, WST 121 or STK 110, STC 122
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Statistics
Period of presentation	Semester 1

Module content

Introduction to Databases. Database design and use. Data preparation and extraction: basic SQL queries, SQL joins and subqueries. Statistical modelling using database structures. Aims of data analysis (descriptive, inferential and predictive). Stages of conducting a data analysis to solve real-world problems. Sources and types of data and characteristics of extremely large or complex data sets. Introductory machine learning concepts: bias/variance trade-off, model complexity, cross-validation, regularisation, overfitting/underfitting, precision, recall, F1 score, ROC curve and confusion matrix. Data visualisation, data wrangling, supervised learning (linear, local and logistic regression) and unsupervised learning (k-means clustering). Statistical concepts are demonstrated and interpreted through practical coding and simulation within a data science framework.

Mathematical statistics 221 (WST 221)

Module credits	24.00
NQF Level	06
Service modules	Faculty of Natural and Agricultural Sciences
Prerequisites	WST 211
Contact time	4 lectures per week, 2 practicals per week
Language of tuition	Module is presented in English
Department	Statistics
Period of presentation	Semester 2

Module content

Stochastic convergence: Asymptotic normal distributions, convergence in probability. Statistics and sampling distributions: Chi-squared distribution. Distribution of the sample mean and sample variance for random samples from a normal population. T-distribution. F-distribution. Beta distribution. Point estimation: Method of moments. Maximum likelihood estimation. Unbiased estimators. Uniform minimum variance unbiased estimators. Cramer-Rao inequality. Efficiency. Consistency. Asymptotic relative efficiency. Bayes estimators. Sufficient statistics. Completeness. The exponential class. Confidence intervals. Test of statistical hypotheses. Reliability and survival distributions. Aims of data analysis (descriptive, inferential and predictive). Stages of conducting a data analysis. Reproducible research. Practical applications. Practical statistical modelling and analysis using statistical computer packages and the interpretation of the output.

Linear algebra 221 (WTW 221)

Module credits	12.00
NQF Level	06



Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Economic and Management Sciences
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Prerequisites	WTW 211 and WTW 218
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Contact time	2 lectures per week, 1 tutorial per week
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Language of tuition	Module is presented in English
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Department	Mathematics and Applied Mathematics
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Period of presentation	Semester 2
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Module content

Abstract vector spaces, change of basis, matrix representation of linear transformations, orthogonality, diagonalisability of symmetric matrices, some applications.

Techniques of analysis 224 (WTW 224)

Module credits	12.00
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NQF Level	06
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Prerequisites	WTW 124 and WTW 211 GS and WTW 218 GS
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Contact time	1 tutorial per week, 2 lectures per week
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Language of tuition	Module is presented in English
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Department	Mathematics and Applied Mathematics
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Period of presentation	Semester 2
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Module content

*This module does not lead to admission to WTW 310 or WTW 320. Students will not be credited for more than one of the following modules for their degree: WTW 220 and WTW 224.

Sequences of real numbers: convergence and monotone sequences. Series of real numbers: convergence, integral test, comparison tests, alternating series, absolute convergence, ratio and root tests. Power series: representation of functions as power series, Taylor and Maclaurin series. Application to series solutions of differential equations.

Differential equations 256 (WTW 256)

Module credits	8.00
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NQF Level	06
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Service modules	Faculty of Engineering, Built Environment and Information Technology
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Prerequisites	WTW 158 and WTW 164
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Contact time	2 lectures per week, 1 tutorial per week
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Language of tuition	Module is presented in English
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Department	Mathematics and Applied Mathematics
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Period of presentation	Semester 1
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Module content

Theory and solution methods for linear differential equations as well as for systems of linear differential equations. Theory and solution methods for first order non-linear differential equations. The Laplace transform with application to differential equations. Application of differential equations to modelling problems.

Numerical methods 263 (WTW 263)

Module credits 8.00

NQF Level 06

Service modules Faculty of Engineering, Built Environment and Information Technology

Prerequisites WTW 164

Contact time 2 lectures per week, 1 tutorial per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

Numerical integration. Numerical methods to approximate the solution of non-linear equations, systems of equations (linear and non-linear), differential equations and systems of differential equations. Direct methods to solve linear systems of equations.

Discrete structures 285 (WTW 285)

Module credits 12.00

NQF Level 06

Service modules Faculty of Engineering, Built Environment and Information Technology

Prerequisites WTW 115

Contact time 2 lectures per week, 1 tutorial per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

Setting up and solving recurrence relations. Equivalence and partial order relations. Graphs: paths, cycles, trees, isomorphism. Graph algorithms: Kruskal, Prim, Fleury. Finite state automata.

Differential equations 286 (WTW 286)

Module credits 12.00

NQF Level 06

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Economic and Management Sciences

Prerequisites	WTW 114, WTW 124, WTW 162, WTW 211#
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 1

Module content

*Students will not be credited for more than one of the modules for their degree: WTW 264, WTW 286
Theory and solution methods for ordinary differential equations and initial value problems: separable and linear first-order equations, linear equations of higher order, systems of linear equations. Application to mathematical models. Numerical methods applied to nonlinear systems. Qualitative analysis of linear systems.

Curriculum: Final year

Minimum credits: 144

Core = 72

Elective = 72

Additional information:

Students who want to register PHY 353 and PHY 363 must make sure, before registration, that a suitable project and supervisor has been confirmed with the head of department.

Students must select elective modules with a total number of at least 72 credits from the following streams (deviations allowed with permission from the head of department):

- **Mathematics as second major:** WTW 310, WTW 320, WTW 381 and WTW 389 (72 credits).
- **Applied Mathematics as second major:** At least four of WTW 310, WTW 382, WTW 383, 386 and WTW 387 (72 of 90 credits).
- **Mathematical statistics as second major:** WST 311, WST 312, WST 321, STK 353 (79 credits) Unbalanced: 36 + 43
- **Chemistry as second major:** CMY 382, CMY 383, CMY 384, CMY 385 (72 credits).
- **Geology as second major:** GLY 370 and GLY 367 (72 credits)
- **Meteorology as second major:** WKD 370, WKD 315, WKD 316 (72 credits). Note: due to the excess credits in the second year it is recommended that students doing a second major in physics enrol for ENV 201 in their third year of study.
- **Astronomy, astrophysics and high energy physics:** PHY 300, PHY 310, WTW 383 (72 credits)
- **Interest in computational physics:** COS 314, COS 344, COS 333, COS 330 (72 credits).

Core modules

Electronics, electromagnetism and quantum mechanics 356 (PHY 356)

Module credits	36.00
NQF Level	07
Service modules	Faculty of Education
Prerequisites	PHY 255 GS and PHY 263 GS and WTW 211 GS and WTW 218 GS and WTW 248 GS
Contact time	4 lectures per week, 2 discussion classes per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 1

Module content

Electronics

Thévenin and Norton equivalent circuits, superposition principle, RC, LC and LRC circuits. Semiconductor diode. Bipolar transistor. Operational amplifiers. Computer controlled instrumentation.

Electromagnetism

Electrostatics: Coulomb's law, divergence and curl of E , Gauss' law, Laplace's equation, image charge problems, multipole expansion.

Magnetostatics: Lorentz force, Biot-Savart law, divergence and curl of magnetic field strength, Ampère's law, magnetic vector potential, multipole expansion, boundary conditions.

Electrodynamics: Electromotive force, electromagnetic induction, Maxwell's equations, wave equation.

Electric and magnetic fields in matter: Polarisation, electric displacement and Gauss's law in dielectrics, linear dielectrics. Magnetisation (diamagnets, paramagnets, ferromagnets), auxiliary field H and Ampère's law in magnetised materials, linear and nonlinear media.

Quantum mechanics

The Schrödinger equation, the statistical interpretation of the wave function, momentum, the uncertainty principle, the time-independent Schrödinger equation, stationary states, the infinite square well potential, the harmonic oscillator, the free particle, the Delta-Function potential, the finite square well potential, Hilbert spaces, observables, eigen functions of a Hermitian operator, Dirac notation, the Schrödinger equation in spherical coordinates, the hydrogen atom, angular momentum spin.

Statistical mechanics, solid state physics and modelling 364 (PHY 364)

Module credits 36.00

NQF Level 07

Service modules Faculty of Education

Prerequisites PHY 356 and WTW 211 and WTW 218 and WTW 248 GS

Contact time 2 discussion classes per week, 2 practicals per week, 4 lectures per week

Language of tuition Module is presented in English

Department Physics

Period of presentation Semester 2

Module content

Statistical mechanics

Isolated systems in thermodynamical equilibrium. Systems in equilibrium with a heat bath: the canonical ensemble, Gibbs' entropic formula, classical statistical mechanics, energy equipartition theorem, thermodynamic potentials, paramagnetism.

The classical limit of perfect gases: non-distinguishable character of quantum particles, the equation of state of the classical ideal gas. Quantum perfect gases: Black body radiation, the grand canonical ensemble, Fermi-Dirac distribution, the free electron gas in metals, the Bose-Einstein distribution, Bose-Einstein condensation.

Solid state physics

Crystal structures, the reciprocal lattice, x-ray diffraction, lattice vibration, the Debye model, characteristics of solids, the free electron model, Pauli paramagnetism, electronic heat capacity, the relaxation time, electrical conduction, the classical Hall effect, thermal conduction in metals, failures of the free electron model, the independent electron model, band theory of solids.

Computational Physics and modelling. Assessment will be done through a portfolio of project reports. The topics for the projects will be selected from various sub-disciplines of Physics.

Elective modules

Physical chemistry 382 (CMY 382)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Education
Prerequisites	CMY 282, CMY 283, CMY 284 and CMY 285
Contact time	2 practicals every other week, 2 lectures per week, 1 discussion classes every other week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 1

Module content

Theory: Molecular quantum mechanics. Introduction: Shortcomings of classical physics, dynamics of microscopic systems, quantum mechanical principles, translational, vibrational and rotational movement. Atomic structure and spectra: Atomic hydrogen, multiple electron systems, spectra of complex atoms, molecular structure, the hydrogen molecule ion, diatomic and polyatomic molecules, structure and properties of molecules. Molecules in motion: Viscosity, diffusion, mobility. Surface chemistry: Physisorption and chemisorption, adsorption isotherms, surface tension, heterogeneous catalytic rate reactions, capillarity.

Analytical chemistry 383 (CMY 383)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Education
Prerequisites	CMY 282, CMY 283, CMY 284 and CMY 285

Contact time	2 practicals every other week, 1 tutorial every other week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 2

Module content

Separation methods: Extraction, multiple extraction, chromatographic systems. Spectroscopy: Construction of instruments, atomic absorption and atomic emission spectrometry, surface analysis techniques. Mass spectrometry. These techniques are discussed in terms of their use in environmental analysis and the value they contribute to meeting the UN sustainable development goals (#3,6 & 11). Instrumental electrochemistry. The relevance of electrochemistry to providing affordable and clean energy (UN SDG#7) is addressed.

Organic chemistry 384 (CMY 384)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Education
Prerequisites	CMY 282, CMY 283, CMY 284 and CMY 285
Contact time	2 lectures per week, 2 practicals every other week, 1 tutorial every other week
Language of tuition	Module is presented in English
Department	Chemistry
Period of presentation	Semester 2

Module content

Theory: NMR spectroscopy: applications. Aromatic chemistry, Synthetic methodology in organic chemistry. Carbon-carbon bond formation: alkylation at nucleophilic carbon sites, aldol and related condensations, Wittig and related reactions, acylation of carbanions (Claisen condensation). Practical: Laboratory sessions are designed to develop the rational thinking behind the design of organic chemistry experiments. An industrial project specifically prepares students for work in SA industry context and honours projects. As part of this practical programme the UN sustainable development goals must be considered in evaluating the best industrial process.

Inorganic chemistry 385 (CMY 385)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Education
Prerequisites	CMY 282, CMY 283, CMY 284 and CMY 285
Contact time	1 tutorial every other week, 2 practicals every other week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Chemistry



Period of presentation Semester 1

Module content

Theory: Structure and bonding in inorganic chemistry. Molecular orbital approach, diatomic and polyatomic molecules, three-centre bonds, metal-metal bonds, transition metal complexes, magnetic properties, electronic spectra, acid-base concepts, non-aqueous solvents, special topics.

Artificial intelligence 314 (COS 314)

Module credits 18.00

NQF Level 07

Prerequisites COS 110, admission to relevant programme

Contact time 2 lectures per week, 1 practical per week

Language of tuition Module is presented in English

Department Computer Science

Period of presentation Semester 1

Module content

The main objective of this module is to introduce a selection of topics from artificial intelligence (AI), and to provide the student with the background to implement AI techniques for solving complex problems. This module will cover topics from classical AI, as well as more recent AI paradigms. These topics include: search methods, game playing, knowledge representation and reasoning, machine learning, neural networks, genetic algorithms, artificial life, planning methods, and intelligent agents. In the practical part of this module, students will get experience in implementing

- (1) game trees and evolving game-playing agents;
- (2) a neural network and applying it to solve a real-world problem; and
- (3) a genetic algorithm and applying it to solve a real-world problem.

Computer security and ethics 330 (COS 330)

Module credits 18.00

NQF Level 07

Prerequisites COS 110, admission to relevant programme

Contact time 1 practical per week, 2 lectures per week

Language of tuition Module is presented in English

Department Computer Science

Period of presentation Semester 2

Module content

This module develops an appreciation of the fundamentals and design principles for information assurance and security. Students will develop a clear understanding of the basic information security services and mechanisms, enabling them to design and evaluate the integration of solutions into the user application environment. Emphasis will be placed on services such as authorisation and confidentiality. Students will acquire knowledge and skills of Security Models such as the Bell-LaPadula, Harrison-Ruzzo Ullman and Chinese Wall Model. Students will develop a detailed understanding of the confidentiality service by focusing on cryptology and the practical implementation thereof. The student will be introduced to professional and philosophical ethics. At the end of the module students will be able to engage in a debate regarding the impact (local and global) of computers on individuals, organisations and society. The professionalism of IT staff will be discussed against national and international codes of practices such as those of the CSSA, ACM and IEEE.

Programming languages 333 (COS 333)

Module credits	18.00
NQF Level	07
Prerequisites	COS 110, admission to relevant programme
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 1

Module content

Programming languages are the backbone for software development. Each language has its own different syntax and semantics, but there are many common concepts that can be studied and then illustrated through the languages. The module concentrates on issues of object orientation, including delegation, iteration and polymorphism. It surveys how languages provide the basic building blocks for data and control, as well as exception handling and concurrency. At the end of the module, students will be able to appreciate the rich history behind programming languages, leading to independent principles that evolve over time. They will be skilled at using a variety of programming languages, including new paradigms such as functional, logical and scripting, and will know how to learn a new language with ease. From this experience, they will be able to apply evaluation criteria for choosing an appropriate programming language in a given scenario.

Computer graphics 344 (COS 344)

Module credits	18.00
NQF Level	07
Prerequisites	COS 110 and WTW 124 or WTW 146, admission to relevant programme
Contact time	1 practical per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Computer Science
Period of presentation	Semester 1

Module content

The aim of this module is to acquire a sound knowledge of the basic theory of interactive computer graphics and basic computer graphics programming techniques. The theory will cover graphics systems and models, graphics programming, input and interaction, geometric objects and transformations, viewing in 3D, shading, rendering techniques, and introduce advanced concepts, such as object-oriented computer graphics and discrete techniques. The module includes a practical component that enables students to apply and test their knowledge in computer graphics. The OpenGL graphics library and the C programming language will be used for this purpose.

Economic geology 367 (GLY 367)

Module credits	36.00
NQF Level	07
Prerequisites	No prerequisites
Contact time	4 lectures per week, 2 practicals per week
Language of tuition	Module is presented in English
Department	Geology
Period of presentation	Semester 2

Module content

This module details the genesis and exploitation of major ore deposits, with an emphasis on South African examples. The processes through which ore deposits are formed and modified will be discussed, highlighting the relevance of sedimentary, metamorphic and igneous processes in the genesis of world-class ore bodies. The module will also address the methods of mining commonly used, and the international commodity market, including a brief introduction to ore reserve estimation and the evaluation of potential ore deposits. The section of the module involving mineral exploration and mining will emphasize the need of pursuing a sustainable mineral resources development mindset, by addressing and sharing ideas on the impact that mining has on environmental, social and economic issues including community welfare, impact of mining on land use, and rehabilitation post mining.

Structural geology and hydrogeology 370 (GLY 370)

Module credits	36.00
NQF Level	07
Prerequisites	GLY 263
Contact time	2 practicals per week, 4 lectures per week
Language of tuition	Module is presented in English
Department	Geology
Period of presentation	Semester 1

Module content

This is an integrated theoretical and practical module dealing with the principles and analysis of deformed rocks, as well as the movement of fluids like water and air through these rocks and other media such as soils and karst. Faults, folds and shear zones form and behave differently in terms of seismology and hydraulic behaviour in the vadose (unsaturated) and phreatic (saturated) zones. Underground water feeds rivers and biota for survival. It is, however, also susceptible to contamination and pollution causing changes in its quality due to many natural and anthropogenic activities. In countries like South Africa, where fractured aquifers dominate, structural geology is the first step in understanding this significant source of water.

Observational astronomy 300 (PHY 300)

Module credits	36.00
NQF Level	07
Prerequisites	PHY 210, PHY 255 and PHY 263
Contact time	2 practicals per week, 4 lectures per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 1

Module content

Structure of the universe, navigation of the sky, spherical geometry, optical, radio and high energy physics and sources, instruments, practical observational skills, data recording, analysis, interpretation (signal and image processing, noise, calibration, error analysis). Project: A selected project in either optical or radio astronomy, resulting in a formal report and a presentation.

Particle and astroparticle physics 310 (PHY 310)

Module credits	18.00
NQF Level	07
Prerequisites	PHY 255 and PHY 263 and PHY 356
Contact time	1 discussion class per week, 1 practical per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 2

Module content

Relativistic kinematics, fundamentals of elementary particle physics, the four forces of nature and the Standard Model, beyond the Standard Model, early universe cosmology (inflation, baryogenesis), the Cosmic Microwave Background, high-energy astronomy (cosmic rays, gamma rays and neutrinos), gravitational waves, dark matter (evidence, candidates, detection), dark energy and the Standard Cosmological Model.

Physics project 353 (PHY 353)

Module credits	12.00
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NQF Level	07
Prerequisites	Availability of a suitable project and supervisor has to be confirmed with the head of department.
Contact time	3 practicals per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 1

Module content

*Cannot be used as substitute for other Physics 300 modules to obtain admission to the BSc(Hons) in Physics. A student is required to complete a project under guidance of the lecturer. The nature of the project is determined jointly by the student, lecturer and the head of department.

Physics project 363 (PHY 363)

Module credits	12.00
NQF Level	07
Prerequisites	Availability of a suitable project and supervisor has to be confirmed with the head of department.
Contact time	3 practicals per week
Language of tuition	Module is presented in English
Department	Physics
Period of presentation	Semester 2

Module content

*Cannot be used as substitute for other Physics 300 modules to obtain admission to the BSc(Hons) in Physics. A student is required to complete a project under guidance of the lecturer. The nature of the project is determined jointly by the student, lecturer and the head of department.

The science of data analytics 353 (STK 353)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Natural and Agricultural Sciences
Prerequisites	WST 212
Contact time	1 practical per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Statistics
Period of presentation	Semester 2

Module content

Introduction to coding: data types, basic arithmetic, logical comparisons, functions, loops, conditional statements, packages. Data exploration and visualisation. Visualisation best practices. Data wrangling: data cleaning, missing values, duplicate data, outliers. Data transformation. Principal component analysis. Statistical coding. Algorithmic thinking. Sampling: basic techniques in probability, non-probability, and resampling methods, Monte Carlo, probability integral transformation, bootstrap method, acceptance/rejection algorithm. Machine learning: train/test split, performance metrics, classification and clustering, performance metrics, cross-validation. Supervised and unsupervised learning: linear regression, decision tree, random forest, naïve Bayes, K-nearest neighbour, hierarchical clustering. Interpretation and communication of results. Text mining and analytics: topic modelling and word embeddings. Statistical concepts are demonstrated and interpreted through practical coding and simulation within a data science framework.

Mid-latitude and polar meteorology 315 (WKD 315)

Module credits	18.00
NQF Level	07
Prerequisites	WKD 261 and WKD 265
Contact time	2 lectures per week, 1 tutorial every 2nd week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

Mean state, major patterns of atmospheric variability in the mid-latitudes and polar regions. Air masses. Synoptic scale cold, warm, occluded and quasistationary fronts, frontogenesis. Mid-latitude depressions, Norwegian cyclone model, conveyor belts. Basic cyclone model, Shapiro-Keyser model hybrid models, cyclogenesis. Polar weather systems; katabatic winds, barrier winds, cold-air damming, polar lows. Jet stream and jet streaks. Extreme weather and impacts. Conceptual models.

Tropical meteorology 316 (WKD 316)

Module credits	18.00
NQF Level	07
Prerequisites	WKD 261 and WKD 265
Contact time	1 tutorial every 2nd week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 1

Module content

Mean state, major patterns of atmospheric variability in the tropics. Tropical weather systems and their temporal variability, inter tropical convergence zone, tropical waves, trade inversions, trade winds, tropical and sub-tropical jet streams, cloud clusters, tropical depressions, Africânes, sub-tropical ridges, upper-level anticyclones. Tropical cyclones and warnings. Analysis techniques. Tropical waves, Kelvin waves, equatorial Rossby waves and Madden Julian Oscillation. Physical and dynamical process in monsoon circulation. Hazardous weather. Conceptual models and case studies.

Dynamic meteorology 370 (WKD 370)

Module credits	36.00
NQF Level	07
Prerequisites	WKD 261 and WKD 263
Contact time	4 lectures per week
Language of tuition	Module is presented in English
Department	Geography Geoinformatics and Meteorology
Period of presentation	Semester 2

Module content

Scale analyses and simplification of the basic equations. The geostrophic, thermal and gradient wind. The vorticity equation and divergence. Potential vorticity. Vertical motion and surface pressure tendency. Vorticity in barotropic fluids. Tendency and Omega equations. Model of a baroclinic system.

Multivariate analysis 311 (WST 311)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Economic and Management Sciences Faculty of Natural and Agricultural Sciences
Prerequisites	WST 211, WST 221, WTW 211 GS and WTW 218 GS
Contact time	1 practical per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Statistics
Period of presentation	Semester 1

Module content

Multivariate statistical distributions: Moments of a distribution, moment generating functions, independence. Multivariate normal distribution: Conditional distributions, partial and multiple correlations. Distribution of quadratic forms in normal variables. Multivariate normal samples: Estimation of the mean vector and covariance matrix, estimation of correlation coefficients, distribution of the sample mean, sample covariance matrix. Principal component analysis. The linear model: Models of full rank, least squares estimators, test of hypotheses. The generalised linear model: Exponential family mean and variance, link functions, and deviance. Poisson and Logistic regression. Cross-validation for model checking and hyperparameter selection. Model regularisation. Reproducible research. Metrics for model performance. Practical applications: Practical statistical modelling and analysis using statistical computer packages and interpretation of the output.

Stochastic processes 312 (WST 312)

Module credits 18.00

NQF Level 07

Service modules Faculty of Economic and Management Sciences
Faculty of Natural and Agricultural Sciences

Prerequisites WST 211, WST 221, WTW 211 GS and WTW 218 GS

Contact time 1 practical per week, 2 lectures per week

Language of tuition Module is presented in English

Department Statistics

Period of presentation Semester 1

Module content

Definition of a stochastic process. Stationarity. Covariance stationary. Markov property. Random walk. Brownian motion. Markov chains. Chapman-Kolmogorov equations. Recurrent and transient states. First passage time. Occupation times. Markov jump processes. Poisson process. Birth and death processes. Structures of processes. Structure of the time-homogeneous Markov jump process. Applications in insurance. Practical statistical modelling, analysis and simulation using statistical computer packages and the interpretation of the output.

Time-series analysis 321 (WST 321)

Module credits 18.00

NQF Level 07

Service modules Faculty of Economic and Management Sciences
Faculty of Natural and Agricultural Sciences

Prerequisites WST 211, WST 221 or STK 210, STK 210

Contact time 2 lectures per week, 1 practical per week

Language of tuition Module is presented in English

Department Statistics

Period of presentation Semester 2

Module content

Note: Only one of the modules WST 321 or STK 320 may be included in any study programme.

Stationary and non-stationary univariate time-series. Properties of autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) processes. Identification, estimation and diagnostic testing of a time-series model. Forecasting. Multivariate time-series. Practical statistical modelling and analysis using statistical computer packages, including that of social responsibility phenomena.

Analysis 310 (WTW 310)

Module credits 18.00

NQF Level 07

Service modules
Faculty of Education
Faculty of Economic and Management Sciences
Faculty of Humanities

Prerequisites WTW 220

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 1

Module content

Topology of finite dimensional spaces: Open and closed sets, compactness, connectedness and completeness. Theorems of Bolzano-Weierstrass and Heine-Borel. Properties of continuous functions and applications. Integration theory for functions of one real variable. Sequences of functions.

Complex analysis 320 (WTW 320)

Module credits 18.00

NQF Level 07

Service modules Faculty of Education

Prerequisites WTW 218 and WTW 220

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

Series of functions, power series and Taylor series. Complex functions, Cauchy- Riemann equations, Cauchy's theorem and integral formulas. Laurent series, residue theorem and calculation of real integrals using residues.

Algebra 381 (WTW 381)

Module credits 18.00

NQF Level	07
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Economic and Management Sciences Faculty of Humanities
Prerequisites	WTW 114 and WTW 211
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 1

Module content

Group theory: Definition, examples, elementary properties, subgroups, permutation groups, isomorphism, order, cyclic groups, homomorphisms, factor groups. Ring theory: Definition, examples, elementary properties, ideals, homomorphisms, factor rings, polynomial rings, factorisation of polynomials. Field extensions, applications to straight-edge and compass constructions.

Dynamical systems 382 (WTW 382)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Economic and Management Sciences
Prerequisites	WTW 218 and WTW 286/264
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 1

Module content

Matrix exponential function: homogeneous and non-homogeneous linear systems of differential equations. Qualitative analysis of systems: phase portraits, stability, linearisation, energy method and Liapunov's method. Introduction to chaotic systems. Application to real life problems.

Numerical analysis 383 (WTW 383)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Economic and Management Sciences Faculty of Humanities



Prerequisites	WTW 114, WTW 123 WTW 124 and WTW 211
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 2

Module content

Direct methods for the numerical solution of systems of linear equations, pivoting strategies. Iterative methods for solving systems of linear equations and eigenvalue problems. Iterative methods for solving systems of nonlinear equations. Introduction to optimization. Algorithms for the considered numerical methods are derived and implemented in computer programmes. Complexity of computation is investigated. Error estimates and convergence results are proved.

Partial differential equations 386 (WTW 386)

Module credits	18.00
NQF Level	07
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education
Prerequisites	WTW 248 and WTW 286/264
Contact time	2 lectures per week, 1 tutorial per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 1

Module content

Conservation laws and modelling. Fourier analysis. Heat equation, wave equation and Laplace's equation. Solution methods including Fourier series. Energy and other qualitative methods.

Continuum mechanics 387 (WTW 387)

Module credits	18.00
NQF Level	07
Prerequisites	WTW 248 and WTW 286/264
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Module is presented in English
Department	Mathematics and Applied Mathematics
Period of presentation	Semester 2

Module content

Kinematics of a continuum: Configurations, spatial and material description of motion. Conservation laws. Analysis of stress, strain and rate of deformation. Linear constitutive equations. Applications: Vibration of beams, equilibrium problems in elasticity and special cases of fluid motion.

Geometry 389 (WTW 389)

Module credits 18.00

NQF Level 07

Service modules Faculty of Engineering, Built Environment and Information Technology
Faculty of Education
Faculty of Humanities

Prerequisites WTW 211

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Department Mathematics and Applied Mathematics

Period of presentation Semester 2

Module content

Axiomatic development of neutral, Euclidean and hyperbolic geometry. Using models of geometries to show that the parallel postulate is independent of the other postulates of Euclid.

General Academic Regulations and Student Rules

The [General Academic Regulations \(G Regulations\)](#) and [General Student Rules](#) apply to all faculties and registered students of the University, as well as all prospective students who have accepted an offer of a place at the University of Pretoria. On registering for a programme, the student bears the responsibility of ensuring that they familiarise themselves with the General Academic Regulations applicable to their registration, as well as the relevant faculty-specific and programme-specific regulations and information as stipulated in the relevant yearbook. Ignorance concerning these regulations will not be accepted as an excuse for any transgression, or basis for an exception to any of the aforementioned regulations. The G Regulations are updated annually and may be amended after the publication of this information.

Regulations, degree requirements and information

The faculty regulations, information on and requirements for the degrees published here are subject to change and may be amended after the publication of this information.

University of Pretoria Programme Qualification Mix (PQM) verification project

The higher education sector has undergone an extensive alignment to the Higher Education Qualification Sub-Framework (HEQSF) across all institutions in South Africa. In order to comply with the HEQSF, all institutions are legally required to participate in a national initiative led by regulatory bodies such as the Department of Higher Education and Training (DHET), the Council on Higher Education (CHE), and the South African Qualifications

Authority (SAQA). The University of Pretoria is presently engaged in an ongoing effort to align its qualifications and programmes with the HEQSF criteria. Current and prospective students should take note that changes to UP qualification and programme names, may occur as a result of the HEQSF initiative. Students are advised to contact their faculties if they have any questions.