



University of Pretoria Yearbook 2017

BSc Physics (02133203)

Duration of study 3 years

Total credits 428

Admission requirements

- The following persons will be considered for admission: a candidate who is in possession of a certificate that is deemed by the University to be equivalent to the required Grade 12 certificate with university endorsement; a candidate who is a graduate from another tertiary institution or has been granted the status of a graduate of such an institution; and a candidate who is a graduate of another faculty at the University of Pretoria.
- Life Orientation is excluded in the calculation of the Admission Point Score (APS).
- Grade 11 results are used for the provisional admission of prospective students. Final admission is based on the Grade 12 results.

Minimum requirements												
Achievement level												
Afrikaans or English				Mathematics				Physical Science				APS
NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	
5	3	C	C	5	3	C	C	5	3	C	C	32

- Candidates who do not comply with the minimum admission requirements for BSc (Physics), may be considered for admission to the BSc - Extended programme for the Physical Sciences. The BSc - Extended programme takes place over a period of four years instead of the normal three years.

BSc - Extended programme for the Physical Sciences:

Minimum requirements													
Achievement level													
	Afrikaans or English				Mathematics				Physical Science				APS
	NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	
BSc - Extended programme for the Physical Sciences	4	3	D	D	4	3	D	D	4	3	D	D	26

Other programme-specific information



A student must pass all the minimum prescribed and elective module credits as set out at the end of each year within a programme as well as the total required credits to comply with the particular degree programme. Please refer to the curricula of the respective programmes. At least 144 credits must be obtained at 300-/400-level, or otherwise as indicated by curriculum. The minimum module credits needed to comply with degree requirements is set out at the end of each study programme. Subject to the programmes as indicated a maximum of 150 credits will be recognised at 100-level. A student may, in consultation with the Head of Department and subject to the permission by the Dean, select or replace prescribed module credits not indicated in BSc three-year study programmes to the equivalent of a maximum of 36 module credits.

It is important that the total number of prescribed module credits is completed during the course of the study programme. The Dean may, on the recommendation of the Head of Department, approve deviations in this regard. Subject to the programmes as indicated in the respective curricula, a student may not register for more than 75 module credits per semester at first-year level subject to permission by the Dean. A student may be permitted to register for up to 80 module credits in a the first semester during the first year provided that he or she obtained a final mark of no less than 70% for grade 12 Mathematics and achieved an APS of 34 or more in the NSC.

Students who are already in possession of a bachelor's degree, will not receive credit for modules of which the content overlap with modules from the degree that was already conferred. Credits will not be considered for more than half the credits passed previously for an uncompleted degree. No credits at the final-year or 300- and 400-level will be granted.

The Dean may, on the recommendation of the programme manager, approve deviations with regard to the composition of the study programme.

Please note: Where elective modules are not specified, these may be chosen from any modules appearing in the list of modules.

It remains the student's responsibility to ascertain, prior to registration, whether they comply with the prerequisites of the modules they want to register for.

The prerequisites are listed in the Alphabetical list of modules.

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 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 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 Senior Appeals Committee.
- Any decision taken by the Senior Appeals Committee is final.

Pass with distinction

A student obtains his or her degree with distinction if all prescribed modules at 300-level (or higher) are passed in one academic year with a weighted average of at least 75%, and obtain at least a subminimum of 65% in each of the relevant modules.



Curriculum: Year 1

Minimum credits: 140

Minimum credits:

Fundamental = 12

Core = 64

Electives = 64

Additional information:

Students who do not qualify for AIM 102 must register for AIM 111 and AIM 121.

CMY 117,127 and WTW 162 are recommended. Electives can be chosen from eg Mathematics, Meteorology, Geology, Geography, IT, Mathematical Statistics, Computer Science, Biochemistry, Zoology etc.

Fundamental modules

Academic information management 111 (AIM 111)

Module content:

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

Module credits 4.00

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

Prerequisites No prerequisites.

Contact time MAMELODI, 2 lectures per week

Language of tuition Separate classes for Afrikaans and English

Academic organisation Information Science

Period of presentation Semester 1

Academic information management 121 (AIM 121)

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.

Module credits 4.00



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 Faculty of Veterinary Science
Prerequisites	No prerequisites.
Contact time	2 lectures per week, MAMELODI
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Informatics
Period of presentation	Semester 2

Language and study skills 110 (LST 110)

Module content:

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

Module credits	6.00
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
Academic organisation	Unit for Academic Literacy
Period of presentation	Semester 1

Academic orientation 102 (UPO 102)

Module credits	0.00
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Natural + Agric Sciences Dean
Period of presentation	Year

Academic information management 102 (AIM 102)

Module content:

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



technology. 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.

Module credits 6.00

Service modules

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
Faculty of Veterinary Science

Contact time 2 lectures per week

Language of tuition Separate classes for Afrikaans and English

Academic organisation Information Science

Period of presentation Semester 2

Core modules

Calculus 114 (WTW 114)

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.

Module credits 16.00

Service modules

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

Prerequisites Refer to Regulation 1.2. Mathematics 60% Grade 12.

Contact time 1 tutorial per week, 4 lectures per week

Language of tuition Separate classes for Afrikaans and English

Academic organisation Mathematics and Applied Maths

Period of presentation Semester 1



First course in physics 114 (PHY 114)

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.

Module credits 16.00

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

Prerequisites Refer to Regulation 1.2: A candidate must have passed Mathematics and Physical Science with at least 60% in the Grade 12 examination

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

Language of tuition Separate classes for Afrikaans and English

Academic organisation Physics

Period of presentation Semester 1

First course in physics 124 (PHY 124)

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.

Module credits 16.00

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

Prerequisites WTW 114 GS and PHY 114 GS

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

Language of tuition Separate classes for Afrikaans and English

Academic organisation Physics

Period of presentation Semester 2

Mathematics 124 (WTW 124)

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, polar curves and quadratic curves.

Module credits	16.00
Prerequisites	WTW 114
Contact time	4 lectures per week, 1 tutorial per week
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 2

Elective modules

General chemistry 117 (CMY 117)

Module content:

General introduction to inorganic, analytical and physical chemistry. Atomic structure and periodicity. Molecular structure and chemical bonding using the VSEOR 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.

Module credits	16.00
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Health Sciences Faculty of Veterinary Science
Prerequisites	Final Grade 12 marks of at least 60% for Mathematics and 60% for Physical Sciences.
Contact time	1 practical per week, 4 lectures per week
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Chemistry
Period of presentation	Semester 1

General chemistry 127 (CMY 127)

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.

Module credits	16.00
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	Separate classes for Afrikaans and English
Academic organisation	Chemistry
Period of presentation	Semester 2

Exploring the universe 154 (SCI 154)

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.

Module credits	16.00
Prerequisites	Prohibited combination SCI 164
Contact time	4 lectures per week
Language of tuition	Module is presented in English
Academic organisation	Physics
Period of presentation	Semester 1

Discrete structures 115 (WTW 115)

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.

Module credits	8.00
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Economic and Management Sciences
Prerequisites	Refer to Regulation 1.2: A candidate must have passed Mathematics with at least 50% in the Grade 12 examination
Contact time	2 lectures per week, 1 tutorial per week
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 1

Numerical analysis 123 (WTW 123)

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.

Module credits	8.00
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	WTW 114 GS
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 2

Mathematical modelling 152 (WTW 152)

Module content:

Introduction to the modelling of dynamical processes using difference equations. Curve fitting. Introduction to linear programming. Matlab programming. Applications to real-life situations in, among others, finance, economics and ecology.

Module credits	8.00
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	Refer to Regulation 1.2
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Module is presented in English



Academic organisation	Mathematics and Applied Maths
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Period of presentation	Semester 1
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Dynamical processes 162 (WTW 162)

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.

Module credits	8.00
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Prerequisites	WTW 114 GS
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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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Academic organisation	Mathematics and Applied Maths
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Period of presentation	Semester 2
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Curriculum: Year 2

Minimum credits: 144

Minimum credits:

Core = 96

Elective = 48

Additional information:

Electives can be chosen from eg Mathematics, Meteorology, Geology, Geography, IT and Mathematical Statistics, etc. Students interested in further studies in astronomy are advised to consider the module PHY 210 Astronomy for physicists as an elective.

Core modules

General physics 263 (PHY 263)

Module content:

Classical mechanics (28 lectures)

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 (14 lectures)

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

Physics of Materials (14 lectures)

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 (14 sessions)

Module credits 24.00

Service modules Faculty of Education

Prerequisites PHY 255 GS and WTW 218 GS and WTW 220# and WTW 248#

Contact time 1 practical per week, 4 lectures per week, 2 discussion classes per week

Language of tuition Module is presented in English

Academic organisation Physics

Period of presentation Semester 2

Linear algebra 211 (WTW 211)

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.



Module credits	12.00
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Economic and Management Sciences
Prerequisites	WTW 124
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 1

Calculus 218 (WTW 218)

Module content:

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

Module credits	12.00
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	Separate classes for Afrikaans and English
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 1

Analysis 220 (WTW 220)

Module content:

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.

Module credits	12.00
Service modules	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	Separate classes for Afrikaans and English



Academic organisation Mathematics and Applied Maths

Period of presentation Semester 2

Waves, thermodynamics and modern physics 255 (PHY 255)

Module content:

Vibrating systems and waves (14 lectures)

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 (30 lectures)

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 (12 lectures)

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 (7 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 (7 practical sessions)

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

Module credits 24.00

Service modules Faculty of Education

Prerequisites [PHY114 and PHY124] or [PHY171] or [PHY143 and PHY153 and PHY163] and [WTW211#] and [WTW218#]

Contact time 4 lectures per week, 1 practical per week, 2 discussion classes per week

Language of tuition Module is presented in English

Academic organisation Physics

Period of presentation Semester 1

Vector analysis 248 (WTW 248)

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.



Module credits	12.00
Service modules	Faculty of Education
Prerequisites	WTW 218
Contact time	1 discussion class per week, 2 lectures per week
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 2

Elective modules

Physical chemistry 282 (CMY 282)

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.

Module credits	12.00
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	4 lectures per week, 1 tutorial per week, 2 practicals per week
Language of tuition	Module is presented in English
Academic organisation	Chemistry
Period of presentation	Quarter 2

Analytical chemistry 283 (CMY 283)

Module content:

Theory: Statistical evaluation of data, gravimetric analysis, aqueous solution chemistry, chemical equilibrium, precipitation-, neutralisation- and complex formation titrations, redox titrations, potentiometric methods, introduction to electrochemistry.

Module credits	12.00
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	2 practicals per week, 4 lectures per week, 1 tutorial per week
Language of tuition	Module is presented in English
Academic organisation	Chemistry
Period of presentation	Quarter 3



Organic chemistry 284 (CMY 284)

Module content:

Theory: 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.

Module credits	12.00
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	4 lectures per week, 2 practicals per week, 1 tutorial per week
Language of tuition	Module is presented in English
Academic organisation	Chemistry
Period of presentation	Quarter 1

Inorganic chemistry 285 (CMY 285)

Module content:

Theory: 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, chemistry of the main group elements, electrochemical properties of transition metals in aqueous solution, industrial applications of transition metals. Fundamentals of spectroscopy and introduction to IR spectroscopy.

Module credits	12.00
Service modules	Faculty of Education
Prerequisites	CMY 117 and CMY 127
Contact time	2 practicals per week, 1 tutorial per week, 4 lectures per week
Language of tuition	Module is presented in English
Academic organisation	Chemistry
Period of presentation	Quarter 4

Process geomorphology 252 (GGY 252)

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 fluvial processes. Practical laboratory exercises are based on the themes covered in the module theory component.

Module credits	12.00
Service modules	Faculty of Education Faculty of Humanities
Prerequisites	GGY 166 or GLY 155



Contact time	4 lectures per week, 2 practicals per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 2

Geomorphology of the built environment 265 (GGY 265)

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.

Module credits	12.00
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	No prerequisites.
Contact time	4 lectures per week
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 3

Geographic data analysis 220 (GIS 220)

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.

Module credits	14.00
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	GMC 100 AND (STK 110 OR BME120)
Contact time	1 practical per week, 2 lectures per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Semester 2



Physical meteorology 261 (WKD 261)

Module content:

Conservative forces and conservation laws. Basic thermodynamic laws for dry and humid air. The equation of state. Adiabatic processes and temperature lapse rates. The Clausius-Clapeyron equation. Calculation of the wet adiabat.

Module credits	12.00
Prerequisites	WTW 114
Contact time	4 lectures per week, 1 tutorial per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 1

Linear algebra 221 (WTW 221)

Module content:

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

Module credits	12.00
Service modules	Faculty of Education Faculty of Economic and Management Sciences
Prerequisites	WTW 211
Contact time	1 tutorial per week, 2 lectures per week
Language of tuition	Separate classes for Afrikaans and English
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 2

Differential equations 256 (WTW 256)

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.

Module credits	8.00
Service modules	Faculty of Engineering, Built Environment and Information Technology
Prerequisites	WTW 158 and WTW 164
Contact time	1 discussion class per week, 2 lectures per week
Language of tuition	Separate classes for Afrikaans and English



Academic organisation Mathematics and Applied Maths

Period of presentation Semester 1

Discrete structures 285 (WTW 285)

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.

Module credits 12.00

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

Prerequisites WTW 115

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Academic organisation Mathematics and Applied Maths

Period of presentation Semester 2

Differential equations 286 (WTW 286)

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.

Module credits 12.00

Service modules Faculty of Economic and Management Sciences

Prerequisites WTW 114, WTW 124 and WTW 162

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Module is presented in English

Academic organisation Mathematics and Applied Maths

Period of presentation Semester 1

City structure, environment and society 266 (GGY 266)

Module content:

An urbanising world. Urban structure and land use. Urban processes. The urban environment. Social structure and change in cities. Living in the city. Economy, society and politics in the city. Third-world cities and South African cities. Urban futures.



Module credits	24.00
Service modules	Faculty of Education Faculty of Humanities
Prerequisites	No prerequisites.
Contact time	1 practical per week, 3 lectures per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Semester 2

Introduction to dynamic meteorology 263 (WKD 263)

Module content:

Vector algebra, curl of a vector, total and partial derivatives, second law of motion. 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.

Module credits	12.00
Prerequisites	WTW 126 and WTW 128 (students should simultaneously be enrolled for WTW 218).
Contact time	1 tutorial per week, 4 lectures per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 2



Curriculum: Final year

Minimum credits: 144

Minimum credits:

Core = 72

Elective = 72

Additional information:

PHY 353 and/or PHY 363 can be chosen as elective modules. Students interested in further studies in astronomy or high energy physics are advised to consider PHY 300 Observational astronomy and PHY 310 Particle and astroparticle physics as electives.

Core modules

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

Module content:

Statistical mechanics (28 lectures)

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 (28 lectures)

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.

Module credits 36.00

Service modules Faculty of Education

Prerequisites PHY 356 and WTW 211 and WTW 218 and WTW 220 GS and WTW 248 GS

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

Language of tuition Module is presented in English

Academic organisation Physics

Period of presentation Semester 2

Electronics, electromagnetism and quantum mechanics 356 (PHY 356)

Module content:

Electronics (14 lectures)



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

Electromagnetism (21 lectures)

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

Magnetostatics: Lorenz 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 (28 lectures)

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.

Module credits	36.00
Service modules	Faculty of Education
Prerequisites	PHY 255 GS and PHY 263 GS and WTW 211 GS and WTW 218 GS and WTW 220 GS and WTW 248 GS
Contact time	2 discussion classes per week, 4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Academic organisation	Physics
Period of presentation	Semester 1

Elective modules

Physical chemistry 382 (CMY 382)

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.

Module credits	18.00
Service modules	Faculty of Education
Prerequisites	CMY 282, CMY 283, CMY 284 and CMY 285
Contact time	2 practicals per week, 4 lectures per week, 1 discussion class per week



Language of tuition Module is presented in English

Academic organisation Chemistry

Period of presentation Quarter 4

Analytical chemistry 383 (CMY 383)

Module content:

Theory: Separation methods: Extraction, multiple extraction, chromatographic systems. Spectroscopy: Construction of instruments, atomic absorption and atomic emission spectrometry, surface analysis techniques. Mass spectrometry. Instrumental electrochemistry.

Module credits 18.00

Service modules Faculty of Education

Prerequisites CMY 282, CMY 283, CMY 284 and CMY 285

Contact time 1 discussion class per week, 2 practicals per week, 4 lectures per week

Language of tuition Module is presented in English

Academic organisation Chemistry

Period of presentation Quarter 1

Organic chemistry 384 (CMY 384)

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).

Module credits 18.00

Service modules Faculty of Education

Prerequisites CMY 282, CMY 283, CMY 284 and CMY 285

Contact time 2 practicals per week, 1 discussion class per week, 4 lectures per week

Language of tuition Module is presented in English

Academic organisation Chemistry

Period of presentation Quarter 3

Inorganic chemistry 385 (CMY 385)

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, reactivity and reaction mechanisms, reaction types, acid-base concepts, non-aqueous solvents, special



topics.

Module credits	18.00
Service modules	Faculty of Education
Prerequisites	CMY 282, CMY 283, CMY 284 and CMY 285
Contact time	2 practicals per week, 4 lectures per week, 1 discussion class per week
Language of tuition	Module is presented in English
Academic organisation	Chemistry
Period of presentation	Quarter 2

Physics project 353 (PHY 353)

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.

Module credits	12.00
Prerequisites	TDH
Contact time	3 practicals per week
Language of tuition	Module is presented in English
Academic organisation	Physics
Period of presentation	Semester 1

Physics project 363 (PHY 363)

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.

Module credits	12.00
Prerequisites	TDH
Contact time	3 practicals per week
Language of tuition	Module is presented in English
Academic organisation	Physics
Period of presentation	Semester 2



Atmospheric vorticity and divergence 352 (WKD 352)

Module content:

Scale analyses and simplification of the basic equations. The geostrophic, thermal and gradient wind. The vorticity equation and divergence.

Module credits	18.00
Prerequisites	WKD 263 GS and WTW 248 GS
Contact time	1 tutorial per week, 4 lectures per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 3

Quasi-geostrophic analysis 361 (WKD 361)

Module content:

Tendency and Omega equations. Model of a baroclinic system. Introduction to numerical models. Application in meteorological display and analysis software.

Module credits	18.00
Prerequisites	WKD 352 GS and WKD 254
Contact time	4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 4

Analysis 310 (WTW 310)

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.

Module credits	18.00
Service modules	Faculty of Education Faculty of Economic and Management Sciences Faculty of Humanities
Prerequisites	WTW 220
Contact time	2 lectures per week, 1 tutorial per week
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Mathematics and Applied Maths



Period of presentation Semester 1

Complex analysis 320 (WTW 320)

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.

Module credits 18.00

Service modules Faculty of Education

Prerequisites WTW 218 and WTW 220

Contact time 2 lectures per week, 1 tutorial per week

Language of tuition Afrikaans and English is used in one class

Academic organisation Mathematics and Applied Maths

Period of presentation Semester 2

Dynamical systems 382 (WTW 382)

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.

Module credits 18.00

Service modules Faculty of Education
Faculty of Economic and Management Sciences

Prerequisites WTW 218 and WTW 286 or WTW 264

Contact time 1 tutorial per week, 2 lectures per week

Language of tuition Afrikaans and English is used in one class

Academic organisation Mathematics and Applied Maths

Period of presentation Semester 1

Numerical analysis 383 (WTW 383)

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.



Module credits	18.00
Service modules	Faculty of Engineering, Built Environment and Information Technology Faculty of Economic and Management Sciences Faculty of Humanities
Prerequisites	WTW 114, WTW 124 and WTW 211
Contact time	2 lectures per week, 1 practical per week
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 2

Partial differential equations 386 (WTW 386)

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.

Module credits	18.00
Service modules	Faculty of Education
Prerequisites	WTW 248 and WTW 286 or WTW 264
Contact time	2 lectures per week, 1 tutorial per week
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 1

Continuum mechanics 387 (WTW 387)

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.

Module credits	18.00
Service modules	Faculty of Education
Prerequisites	WTW 248 and WTW 286 or WTW 264
Contact time	2 lectures per week, 1 tutorial per week
Language of tuition	Afrikaans and English is used in one class
Academic organisation	Mathematics and Applied Maths
Period of presentation	Semester 2



Geometry 389 (WTW 389)

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.

Module credits 18.00

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

Prerequisites WTW 211

Contact time 2 lectures per week, 1 tutorial per week

Language of tuition Afrikaans and English is used in one class

Academic organisation Mathematics and Applied Maths

Period of presentation Semester 2

Sustainable development 356 (GGY 356)

Module content:

The module conceptually integrates environmental, economic, and social components of sustainable development. Other topics covered include changing perceptions on development and environment, development paradigms, challenges of sustainable development, actors and actions in sustainable development, rural and urban livelihoods, and a Third World assessment of sustainable development in the developing world.

Module credits 18.00

Service modules Faculty of Education
Faculty of Humanities

Prerequisites No prerequisites.

Contact time 3 lectures per week, 1 practical per week

Language of tuition Module is presented in English

Academic organisation Geography, Geoinf + Meteor

Period of presentation Quarter 1

Development frameworks 366 (GGY 366)

Module content:

Classic development frameworks. Spatial development history and legacy in South Africa. Overview of contemporary environmental legislation in South Africa. Rural development strategy. Rural and agricultural reconstruction. Land reform. Urban development and strategy. Urban spatial reconstruction. National spatial development frameworks.

Module credits 18.00



Service modules	Faculty of Education Faculty of Humanities
Prerequisites	No prerequisites.
Contact time	3 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 3

Human environmental interactions 301 (ENV 301)

Module content:

The module focuses on contemporary environmental issues in southern Africa. Recent and future impacts of human pressures on natural resources, the state of the environment in South Africa, management of critical resources, population trends, biodiversity loss, pollution, water scarcity, desertification, climate change, waste accumulation and management, environmental management tools, environmental education and environmental management legislation.

Module credits	18.00
Service modules	Faculty of Education Faculty of Humanities
Prerequisites	No prerequisites.
Contact time	4 lectures per week, 1 practical per week
Language of tuition	Module is presented in English
Academic organisation	Geography, Geoinf + Meteor
Period of presentation	Quarter 2

Fundamentals of weather forecasting 366 (WKD 366)

Module content:

Meteorological observations data codes. Weather applications software and computing environments of meteorological analysis and weather forecasting techniques. Applications of remote sensing in weather forecasting. Aerological diagrams. Applications of numerical weather prediction, and types of weather forecasts. Integration of information to describe the current state of the atmosphere and to predict a future state of the atmosphere.

Module credits	36.00
Prerequisites	WKD 155, WKD 261, WKD 254 (students should simultaneously be enrolled for WKD 361)
Contact time	1 practical per week, 4 lectures per week
Language of tuition	Module is presented in English



Academic organisation Geography, Geoinf + Meteor

Period of presentation Semester 2

Observational astronomy 300 (PHY 300)

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.

Module credits 36.00

Prerequisites PHY 255 and PHY 263

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

Language of tuition Module is presented in English

Academic organisation Physics

Period of presentation Semester 1

Particle and astroparticle physics 310 (PHY 310)

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.

Module credits 18.00

Prerequisites PHY 255 and PHY 263 and PHY 356

Contact time 2 lectures per week, 1 practical per week, 1 discussion class per week

Language of tuition Module is presented in English

Academic organisation Physics

Period of presentation Semester 2

The information published here is subject to change and may be amended after the publication of this information. The [General Regulations \(G Regulations\)](#) apply to all faculties of the University of Pretoria. It is expected of each student to familiarise himself or herself well with these regulations as well as with the information contained in the [General Rules](#) section. Ignorance concerning these regulations and rules will not be accepted as an excuse for any transgression.