UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE
HANDBOOK 2009/2010

FOREWORD TO THE STUDENTS

I wish to extend a warm welcome to all students registered in the Faculty of Science, especially to those of you who are new to the University of Swaziland.

This document, the Faculty of Science Handbook for the 2009/2010 Academic Session, has been prepared by the seven departments to give you a general outline of the Science programmes currently offered at the University of Swaziland.

If there are any areas of concern or points you do not understand in this handbook, feel free to approach any member of the Academic Staff of the Faculty for assistance. The staff is also available to assist you with any problem you may have with your studies. The Heads of Departments and the Tutor=s office are especially useful in this regard. Do not hesitate to approach your lecturers whenever you experience academic problems. They will be pleased to suggest ways in which you may be able to improve your performance.

To succeed as a Science student, you need to work very hard throughout the academic year. Assignments, laboratory sessions and tests, all of which form part of continuous assessment, must be given all the seriousness they deserve. Please note that the Faculty of Science has introduced Semester Examinations.

It is extremely important that all Science students observe all the safety regulations in the laboratories. For example, under no circumstance should any student conduct any unauthorized experiment. A student who does not adhere to the safety guidelines, endangers his or her life and also puts at risk the safety of colleagues. He/she may also damage expensive scientific equipment and other property of the University. Such behaviour will not be tolerated and may lead to expulsion from the University.

For the smooth running of the Faculty, it is also essential that there should be good relations between students and non-academic staff such as Secretaries and Technicians.

Those of you who have been admitted to Year 1 of the Science programme should feel lucky and privileged because places for all Science programmes are at premium. I am sure you are well aware that this year all those admitted to B.Sc. Year 1 and B. Eng. Year I have scored at least 38 points and 40 points, respectively. Use this chance well as the Faculty may not allow students to repeat a year in the very near future because of the great demand for places.

It is the Faculty=s aim that by the time you complete the 4-year B.Sc. or 5-year B.Eng. programmes, we shall have equipped you with the knowledge and skills necessary to meet the numerous challenges of the Science & Technology dominated 21st century.

Science, Technology and Engineering are among the principal drivers of industrial and economic development. The ability of a country to provide for the basic needs of its population is highly dependent on science and technology education. As part of this education, students should learn to solve specific problems and to address the needs of society by utilizing scientific and technological knowledge and skills.

The authority of the Faculty of Science is vested in the Board of the Faculty, the membership of which includes two students, one in Part I and the other in Part II. All students have the right to take part in the free election of their representatives, and you are advised to make your choice as soon as possible, so as to ensure that you have recognized representation at the Board of the Faculty of

Science. A student representative serves on the Board for one year only, but may seek re-election the following year.

Furthermore there is provision for student representation on the Boards of the various Departments of the Faculty. Each Departmental Board is composed of two student representatives, one from Part I and the other from Part II.

It is important for both students and staff to appreciate that all matters within the Faculty of Science must be taken through the appropriate Boards as set down in the statutes. Any subsequent referrals can only be made through the Faculty Board to the other bodies within the official University structure. It is only through such established channels that issues can be properly discussed.

The staff of the Faculty of Science wish you a successful and rewarding academic year.

On behalf of the Faculty of Science,

PROF. M.D. DLAMINI
Dean, Faculty of Science

PROGRAMMES OF THE FACULTY OF SCIENCE:

The Faculty of Science offers programmes leading to the following degrees:

- Bachelor of Science (B.Sc.)
- Bachelor of Engineering (B.Eng.) in Electrical and Electronic Engineering

1. FACULTY OF SCIENCE REGULATIONS

The University Regulations for the Faculty of Science are given below, reproduced from the University calendar 2008/2009. A number of additional clarifications are included:

1.1 SPECIAL REGULATIONS FOR THE B.SC. PROGRAMME

1.1.1 Preamble

Subject to the provisions of the General Regulations, the following Special Regulations of the Bachelor of Science shall apply.

1.2 ENTRANCE REQUIREMENTS

1.2.1 A. O'level Admissions

The minimum requirement for entrance to the Bachelor of Science degree programme shall be:

(a) A minimum of six passes in the G.C.E. obtained which must include a C grade or better in

(i) English Language and Mathematics

(ii) EITHER

Two of the following:

- Biology
- Chemistry
- Geography
- Physics
- Science (Chemistry/Physics)

OR

Additional Combined Science

Combined Science

(iii) Any other subject.

OR

(b) Cambridge Overseas School Certificate in the 1st or 2nd division with a minimum of 5 credits (a C grade or better) which must include the subjects listed in 1.2.1 (a) above.

B. International General Certificate of Secondary Education (IGCSE) Admission

The minimum requirement for entrance to the Bachelor of Science degree programme shall be:

A minimum of six passes in the IGCSE which must include a C grade or better in

(i) English Language and Mathematics

(ii) EITHER

Two of the following:
Biology
Chemistry
Geography
Physics
Physical Science

OR

Co-ordinated Sciences

(iii) Any other subject.

1.2.2 <u>A-Level of Admissions and other Qualifications</u>

Candidates who have taken acceptable A-level examinations and who have at least two grades of C or better at A level, or an equivalent qualification, in the science subjects offered at the University, **MAY** be exempted from the 1st year of the B.Sc. degree provided he/she fits into an acceptable Year 2 programme. Such a student may complete the B.Sc. degree in three years.

1.3 <u>DEGREE STRUCTURE</u>

1.3.1 In both Part I and Part II each subject shall divide its total instruction time (i.e. individual or combined lectures, practicals, tutorials, projects, etc) into courses. Normally, a full course shall have approximately twice the content of a half course. The actual number of hours per week and total duration of courses is determined by each department.

1.3.2 <u>Part I (Years 1 and 2)</u>

(a) Year 1

(i) Each student must take Academic Communication Skills, Computer Science Foundation Course and Mathematics and a minimum of two (or a maximum of three) Science subjects as guided by the possible careers the students may wish to pursue.

Clarification: The possible subject combination are as shown below:

(ii) A minimum of two Science subjects, Academic Communication Skills, Computer Science Foundation Course and Mathematics.

Year 1 Combinations	**Corresponding Year II Subject Combinations**
1. ACS-CSF-M-B-C	CS-M, C-M, B-C
2. ACS-CSF-M-B-GEP	CS-M, GEP-M, CS-GEP

3. ACS-CSF-M-C-GEP	CS-M, C-M, GEP-M, C-GEP, CS-GEP
4. ACS-CSF-M-C-P	CS-M, C-M, CS-P, M-P, C-P, B.ENG.
5. ACS-CSF-M-GEP-P	CS-M, GEP-M, CS-GEP

(iii) A maximum of three Science subjects, Academic Communication Skills, Computer Science Foundation Course and Mathematics.

Year 1 Combinations	Corresponding Year II Subject Combinations
1. ACS-CSF-M-B-C-GEP	C-M, CS-M, B-C, C-GEP, B-GEP, GEP-M, CS-GEP
2. ACS-CSF-M-B-C-P	C-M, CS-M, B-C, B.ENG., C-P, M-P, CS-P.
3. ACS-CFS-M-C-GEP-P	C-M, CS-M, C-GEP, GEP-M, C-P, M-P, B.ENG., GEP-P, CS-P, CS-GEP.

ACS - Academic Communication Skills
CSF - Computer Science Foundation Course
B - Biological Sciences
C - Chemistry
CS - Computer Science
GEP - Geography, Environmental Science & Planning
M - Mathematics
P - Physics

(iv) In order to proceed to Year 2, a student must have an overall average of at least 50% in Year 1 Science and must have passed at least 3 Science subjects in Year 1, and must have sufficient courses and prerequisites to fit into an acceptable Year 2 programme.

Course prerequisites: The minimum Year 1 grades required for the allowed two-
subject programmes in Year 2 are:

Year 2 Subjects	YEAR 1 REQUIRED GRADES					
	Biol. Sc.	Chemistry	GEP	Maths	Physics	CSF

Biol. Sc. - Chem.	D*	D*	-	D*	-	
Biol. Sc.- GEP	D*	D*	D*	D*	-	
Chem. - GEP	-	D*	D*	D*	-	
Chem. - Maths	-	D*	-	D*	-	
Chem. - Phys.	-	D*	-	D*	D*	
Comp. Sc. - GEP	-	-	D*	D*		D
Comp. Sc. - Maths	-	-	-	D*		D
GEP - Maths	-	-	D*	D*	-	
GEP - Phys.		E	D*	D*	D*	
Phys. - Comp. Sc.	-	E		D*	D*	D
Maths - Phys.	-	E	-	D*	D*	

**** For this combination both components of the subject should be passed at 50% or above (D or better).***

(b) Year 2 - B.Sc.

(i) Each student shall take 2 major subjects in Science as guided by the possible subject combinations in 1.3.2.(a).

(ii) The two major subjects shall not consist of more than a total weekly average of thirteen (13) hours of formal instructional time over the year, including support courses, from each of the two major subjects.

(iii) In order to proceed to Part II (Year 3) a student must have an overall average of 50% or better in each major subject and must have achieved at least 50% in all other courses.

1.3.3 <u>Part II (Years 3 and 4)</u>

The Faculty of Science will only offer the combined subjects major programme.

1.4 COMBINED SUBJECTS MAJOR PROGRAMME

(a) Each student shall take two major subjects in Science.

(i) A major subject may include necessary courses from other subjects.

(ii) No major subject shall require more than a total weekly average of thirteen (13) hours of formal instructional time over the year, including support courses, in either Years 3 or 4.

(b) In both Years 3 and 4 normally no subject will include more than two 3-hour practical sessions per week and more formal practical sessions will be allowed only if the total weekly average of thirteen hours of formal instructional time is not exceeded.

(c) All final year students shall be required to do only one research project.

(d) After Year 1, in order to proceed from one year to the next, a student must have obtained at least 50% in each course.

(e) In Year 4, a student shall be deemed to have completed the B.Sc. degree programme if he/she obtained a 50% or better in each course.

1.5 COURSE ASSESSMENT AND FORMAL EXAMINATIONS FOR COMBINED SUBJECTS MAJOR PROGRAMME

1.5.1 (a) Formal examinations shall be conducted at the end of each semester.

1.5.2 (a) In Year I, there will be a paper in Academic Communication Skills (ACS) and one 3-hour paper in Computer Science Foundation Course (CSF100). There will be two 3-hour papers in Biological Sciences (one B111, one in B112); Chemistry (one in C111, one in C112); Geography, Environmental Science and Planning (one in GEP 111, one in GEP 121); Physics (on in P101, one in P102); and Mathematics (one in M111, one in M115).

(b) Subject to departmental regulations, each course shall be examined by one 3-hour paper.

(c) Year 4 Special Practicals will be assessed wholly through continuous assessment.

(d) Year 4 Projects shall be assessed on the basis of course work and a final written project report. The weighting of continuous assessment to final project report shall vary from 2:1 to 1:2 as determined by the special regulations of the department concerned.

1.5.3 Each department shall propose, for the approval of the Faculty, the weighting of continuous assessment and examination and the duration of each examination paper should be consistent with the general regulation.

1.5.4 Any student who fails to complete the required work for a project and obtains a supplementable mark, may with the approval of the Faculty of Science Board, be allowed further time, up to the end of the supplementary examination period, to complete the work. The maximum grade awarded shall be 59%. If the work is not completed by that time, the incomplete grade shall count as a fail grade.

1.6 SUPPLEMENTARY EXAMINATIONS

1.6.1 Year 1

At the end of Year I, supplementary examinations shall be allowed only when a student has obtained an overall mark of at least 50%, in order to:

(i) pass 3 subjects.

(ii) satisfy a prerequisite to proceed to Year 2.

A student who passes the supplementary examinations shall be allowed to major in the subject/courses supplemented.

1.6.2 Years 2, 3 and 4

(a) A student who obtains an E grade in a course(s) shall be allowed to supplement the course(s) in which an E grade was obtained to raise the grade(s) to a D grade provided he/she has obtained an overall mark of at least 50%.

1.6.3 A student who supplements in order to pass a course shall receive no more than a D grade in that Course, and his/her original overall mark before supplementation shall not be recalculated. The subject average, shall not be re-calculated.

1.6.4 For the purpose of degree classification, the Overall Part II (Year 3 and Year 4) mean shall be computed as the average of the two Part II subject means.

1.7 REPEATING FAILED COURSES

1.7.1 After Year 1, a student who

(a) obtains an `F' grade in course(s) shall be required to repeat the failed course(s).

(b) obtains less than 50% in course(s) after supplementary examination shall be required to repeat such a course(s).

1.7.2 A student shall not be allowed to repeat a course(s) more than once.

1.7.3 A Part 1 (Year 1 and Year 2) student may be allowed to take a different course(s) instead of repeating the failed one(s). However, such a student will not be permitted to repeat a year more than once.

1.8 TRANSFERS

1.8.1 A B.Sc. Year I student may be allowed to transfer to B.Eng. Year 2 on the recommendation of the Faculty Board to Senate provided:-

(b) there is room in the programme

(c) he/she has obtained

(i) an overall average of at least a C grade in B.Sc. Year I,

(ii) at least a B grade in both Mathematics and Physics and

(iii) at least a D grade in both Chemistry and Computer Science Foundation Course.

REGULATIONS FOR COMPUTER SCIENCE FOUNDATION COURSE - CSF 100 (½ COURSE)

Assessment:

1. The assessment will be a combination of course work and final examination in the ratio of 3:2.

2. The pass mark will be 50%.

Progression:

1. Except as provided in Special Regulations, all degree students in the Faculty shall be required to take Computer Foundation Course(CSF100) in Year 1.

2. Except as specified in Special Regulations, a student who fails the Computer Foundation Course in his/her first year shall repeat it and be re-examined at the end of the second year.

3. A student shall not be awarded an overall pass in Part I unless he/she has passed the Computer Foundation Course.

4. The grade received in the Computer Foundation Course shall not be taken into account when computing the average mark for the year.

5. A student who has passed the Computer Foundation Course shall not be required to repeat it, even if he/she is required to repeat the year.

2. BIOLOGICAL SCIENCES DEPARTMENT

COMBINED SUBJECTS MAJOR PROGRAMME

2.1 PART I

2.1.1 Year 1

B111 Introductory Botany and B112 Introductory Zoology.

This course aims to introduce students to some of the important groups of plants and animals to illustrate basic concepts in biology using these organisms as examples. Topics covered include: chemicals of life, the cell, variety of life (plant and animal), basic genetics, nutrition, transport, excretion, reproduction and growth and development.
(**Four lectures and one 3-hour practical per week, both semesters).**
*** Candidates must pass both components to major in Biology.**

2.1.2 Year 2

B201 Cryptogamic Botany (half-course)

An introduction to the classification of the Plant Kingdom. Range of form and function in the Cryptogams, consisting of the Thallophyta (bacteria, fungi and algae), Bryophyta and Pteridophyta. Each group will be studied with reference to its classification, structure (of representative species and genera) modes of nutrition, growth, reproduction, life-cycles and dispersal. Phylogenetic relationships among the groups and their evolution. The ecology and adaptation of these groups to their environment. Economic importance of these groups, where-ever applicable. Homology and evolutionary relationship between the reproductive organs of the higher Cryptogams and Cryptogams and those of the Spermatophyta. Local examples will be used as far as possible.
(Four lectures and one 3-hour practical per week, one semester)

<u>B202 Plant Morphology</u> (half-course)
Course contents taken from other courses. Consideration of the basic structure and functions of the following:
The Leaf: Basic morphology and variations thereof.
The Gymnospermic needles.
The flower: Basic structure, the floral formula, the floral diagram, complete and imperfect flowers.
Breeding systems of plants in relation to flower structure.
Inflorescence.
The fruit: Basic structure. Variations to give rise to the various types of fruits.
The seed: Various modifications of the seed coat, the embryo and food repositories.
Morphogenesis and gross morphology of the Gymnosperms and Angiosperms including variations of their root systems.
(Three lectures per week, one 3-hour practical per week, one semester)

<u>B203 Biochemistry and Cell Biology</u> (half-course)
The molecular basis of life, structure of organic molecules: enzyme structure and function; procaryotic and eucaryotic cells; basic cell structure; morphological diversity in plant and animal cells; bacteria; cell organelles; metabolic pathways for energy production and photosynthesis; cell reproduction and protein synthesis and breakdown; membrane transport; influence of environment.
(Three lectures, one 3-hour practical per week, one semester)

<u>B204 Invertebrate Zoology</u> (half-course)
Classification, structure and function, basic adaptive features and evolution, modes of feeding, life cycles and reproduction, economic importance (wherever applicable) of all the major Phyla of Invertebrates including Hemichordates, Urochordates and Cephalochordates.
(Four lectures per week and one 3-hour practical per week, one semester)

2.2 PART II

2.2.1 Year 3

B301 Spermatophyta including anatomy and taxonomy (half-course)
General structure and life-cycle of the Angiosperms and Gymnosperms.
Evolution of the seed habit.
Structure and development of the anther, pollen grains, ovule and embryo-sac.
Pollination types and agents of pollination.
Conditions and mechanisms favouring cross-pollination.
Fertilization and post-fertilization development. Parthenocarpy.

Anatomy of Primary body of Angiosperms; distribution; structure in relation to function of tissues and tissue systems; transport; support; photosynthesis and storage. Origin and development of the secondary body. Meristems, Vascular cambium, Periderm. Gross-structure of wood.
Anatomical modifications and adaptations.

Taxonomy of Higher Plants. Vegetative and reproductive characters used in plant classification. Practical consideration of selected Angiosperm families relevant to Swaziland. Indented and Bracketed Keys.
Binomial nomenclature. C tegories of Classification. Type specimens, Herbarium, Botanical Gardens and Seed Banks. Methods of taxonomic study. Major classification systems.
(Three lectures, one 3-hour practical per week one semester)

B302 Vertebrate Zoology (half-course)
Classification, structure and function, basic adaptive features, evolution and phylogenetic relationships, modes of feeding, life cycles and reproduction, relationships to man and economic importance of the five classes of vertebrates (ie. Amphibians, Fishes, Reptiles, Birds and Mammals).
(Three lectures, one 3-hour practical, per week, one semester)

B303 Genetics (half-course)
An introduction to the principles of heredity. A balanced presentation of classical, polygenic, population and molecular genetics. Topics include Mendelian inheritance, genic interactions, linkage and chromosome mapping, chromosomal mutations, the nature as related to environmental factors, human and microbial genetics. Meiosis and the Chromosome theory of heredity. Probability and Statistical methods in the analysis of genetic data.
Economic applications of genetic knowledge.
Genetics in relation to evolution.

Practical investigations will utilize Drosophila, plants, man and micro-organisms.
(Three lectures and one 3-hour practical per week, one semester)

B304 Ecology (half-course)
Soil studies: Soil texture, soil structure. The soil profile. Chemical properties, soil water; soil erosion.
The ecosystem: Interaction between the soil, climate, vegetation and animals. (Climatic, edaphic and biotic factors).
Limiting factors.
Community structure: The species; Population; the community patterns. Elementary methods in ecological investigations.
(Two lectures per week, one 3-hour practical per week, one semester)

B305 Biostatistics (half-course)
Introduction to the quantitative treatment of biological data; biological variation; basic descriptive statistics; types of distribution; probability; tests of significance; estimation of significance of difference between names; association of two variables; correlation coefficient; regression; covariance; parametric and non parametric tests; variation under different conditions; experimental design and analysis of results. Improving design; randomized block design; Latin square; split plot design; analysis of variance; transformation.
(Two lectures per week, one semester)

2.2.2 Year 4

B401 Animal Physiology (half-course)
Topics will include; biophysics; cellular; nutrition; digestion; excretion; circulation; osmoregulation; respiration; locomotion; thermoregulation; sensory and neurophysiology; endocrinology; reproduction, comparative strategies within the animal kingdom will be examined for each of these topics, with special emphasis on man.
(Three lectures, one 3-hour practical per week, one semester)

B402 Plant Physiology (half-course)
Soil-plant-atmosphere continuum (SPAC), water absorption by plants; water potentials.
Water conduction; stomatal movement and transpiration. Water balance and plant cell-water relations.
Adaptations to water stresses including Xerophytism and Halophytism.
Crassulacean acid metabolism (CAM).
Plant mineral nutrition: Essential elements, availability, absorption, conduction; and metabolism of selected nutrients (major and minor).
Mineral deficiency and toxicity - the calcicole-calcifuge problem.
Plant Growth development - the plant hormones; bioassays and applications.
Physiological adaptations of plants: light, temperature and competition within communities.
(Three lectures, one 3-hour practical per week, one semester)

B403 Evolution (half-course)
Organic Evolution is a one-semester multidiscipline course drawing information into it from several areas of the Biological Sciences with emphasis upon the pattern and processes of evolution. The major areas of study are historic developments, evidence of evolution, natural selection and adaptation, sources of variation, isolating mechanisms and speciation and the evolution of humans. Some time is also spent on the problems of origins and contributions from Africa.
(Three lectures per week, one semester)

B404 Microbiology and Immunology (half-course)
Biochemical nature of bacterial cell envelopes. Inhibitors of cell wall synthesis, antibiotic action. Inhibitors and mechanism of inhibition of bacterial nucleic acids. Ribosome function and protein synthesis. Retroviruses and their significance.
Microflora of the human body. Disease; the process of infection and host reaction. Selected types of bacterial and viral diseases of man an their control.
The physiology and biochemistry of yeasts. Their economic importance in industry and research.
The Immunology section will examine the two systems of immunity involved in the protection of vertebrates and how the immune systems recognizes foreign entities as opposed to self; antibody biosynthesis and function; the development of immune system and the immune response; Immunoassays and Immunodiagnosis; transplantation immunology; Cancer biology and Immunology; Immunopathology with particular emphasis on immunity deficiency related diseases; Applied immunology involving examples of biological research utilizing antibodies as a biochemical tool.
(Three lectures and one 3-hour practical per week, one semester)

B405 Applied Biology (half-course)
A more intensive study of such topics as: Plant and Animal breeding (Applied Genetics): Grassland and Grassland Management (Pastures and Wildlife Areas); Agricultural and Forestry systems: Consideration of some crops relative to their evolution, adaptations and productivity (e.g. Maize, cotton; tobacco, sugarcane, pineapple etc.); Use of forest trees relative to their anatomy and growth habits; Common Agricultural and Forest diseases; Applied Entomology and Parasitology: Medical, Agricultural and Forestry, Infection and disease, control of disease: Tropical diseases; Pollution of Agricultural and Forestry systems (use and misuse of pesticides) of water systems (Dams, Ponds, Rivers) of Urban environment; Food, nutrition and diet; Human population parameters and its problems; aspects of human biology.
(Four lectures per week one semester or two lectures per week both semesters)

B406 Project (half-course)

Students will be required to submit a dissertation on a topic approved by the department. The dissertation must be on some aspect of Biology relevant to Swaziland. The project must be submitted by 12:00 noon on the last day of lectures in the second semester. Any candidate who fails to complete a project by the end of formal classes may be awarded an "Incomplete [I]" grade and may be allowed further time up to the end of the Supplementary Examinations; such work shall be assessed in accordance with the Supplementary Examination regulations (ie. maximum grade 59 D). If the candidate fails to complete the work by that time, the incomplete grade shall count as a fail grade. Each candidate shall present two project seminars, one in October and another in March; the March Seminars shall be assessed by all academic staff members in the department.
(One tutorial/guidance session per week and one 3-hour practical per week both semesters)

<u>B407 Special Practicals (half-course)</u>
Optional course for candidates doing a Research Project in another Department in the Combined Major Programmes (B.Sc./B.Ed.). Therefore, candidates taking this option will NOT do B406 PROJECTS. Four groups of practical sessions in various areas. Each group of Practicals will take on linked observations like a mini-project and go on for six sessions culminating in one report. This will involve half a semester with one academic staff member responsible for the Special Practicals. Therefore FOUR reports would be required per student.
(One tutorial/guidance session per week and one 3-hour practical per week both semesters).

1. All the courses are compulsory.
2. Students in Year 4 will be required to attend weekly project consultations.
3. The final assessment of course work/final examination will be:

    (a) 2:3 in all courses.
    (b) In the final assessment, the various courses will be weighted equally.

<u>COURSES</u>:

Year 1	**Semester I**		
	B111 Introductory Botany	**4L**	**3P**
	Semester 2		
	B112 Introductory Zoology	**4L**	**3P**
Year 2	**Semester I**		
	B201 Cryptogamic Botany	**4L**	**3P**
	B204 Invertebrate Zoology	**4L**	**3P**
	Semester 2		
	B202 Plant Morphology	**3L**	**3P**

	B203 Biochemistry and Cell Biology	**3L**	**3P**
Year 3	**Semester I**		
	B303 Genetics	**3L**	**3P**
	B304 Ecology	**3L**	**3P**
	B305 Biostatistics	**2L**	**0P**
	Semester 2		
	B301 Spermatophyta	**3L**	**3P**
	B302 Vertebrate Zoology	**3L**	**3P**
Year 4	**Semester I**		
	B401 Animal Physiology	**3L**	**3P**
	B402 Plant Physiology	**3L**	**3P**
	B405 Applied Biology	**2L**	**0P**
	B406 Project	**1L**	**3P**
	OR		
	B407 Special Practicals	**1L**	**3P**
	Semester 2		
	B403 Evolution	**3L**	**0P**
	B404 Microbiology and Immunology	**3L**	**3P**
	B405 Applied Biology	**2L**	**0P**
	B406 Project	**1L**	**3P**
	OR		
	B407 Special Practicals	**1L**	**3P**

EXAMINATION:
Years I to IV each half-course: 1 paper. The submitted project dissertation paper in Year IV will be assessed as one examination paper.

3. CHEMISTRY DEPARTMENT

COURSES FOR THE COMBINED SUBJECTS MAJOR PROGRAMME

3.1 PART 1

3.1.1 Year 1

C111 Introductory Chemistry I compulsory course:
Chemical bonds; molecular forces; Basic concepts; thermochemistry; atomic structure.
(3 lectures and one 3 hour practical per week, Semester I)

C112 Introductory Chemistry II compulsory course:
chemical reactions; properties of gases; reaction rates; chemical equilibrium (general theory, acid-base, and solubility); electrochemistry and introduction to organic chemistry.
(3 hour practical per week, Semester II)

3.1.2 Year 2

C200 Chemistry Practicals

Practical course covers experiments in Inorganic Chemistry (C201), Physical Chemistry (C202), Organic Chemistry (C203) and Analytical Chemistry (C204).

(3 hour practical per week, over both semesters I & II)

C201 Introductory Inorganic Chemistry

Forces holding atoms and molecules together. Elementary structures of solids including classification, typical crystal structures, lattice energy and Born-Haber cycle; Descriptive chemistry of the main group elements and their compounds, both regular organometallic, with emphasis on group trends; sources and extracting of the elements.

(4 lectures per week, semester I)

C202 - Introductory Physical Chemistry

* Gaseous State - ideal non-ideal
* Thermodynamics - 1st, 2nd and 3rd laws
* Changes of state - pure compounds - mixtures
* Equilibria - Gibbs functions and Kp
    - Phase equilibria (one, two and three component systems)
    - Colligative properties

(4 lectures per week, semester II)

C203 Introduction to Organic Chemistry

The course is intended as a general introduction to the chemistry of the different classes of organic compounds;General introduction
Alkanes, Alkenes, Alkynes, Stereochemistry; Alkyl halides, Aldehydes, Ethers and epoxides. Alcohols, Aldehydes and Ketones, Benzene and Its derivatives; Carboxylic Acids and their derivatives, Amines Phenols, Spectroscopy

(4 lectures per week, semester I)

C204 Introductory Analytical Chemistry

Errors in chemical analysis; statistical evaluation of analytical data; The chemicals, apparatus and unit operations of analytical chemistry. Gravimetric methods; titrimetric methods; potentiometric methods of analysis. Eliminating interferences.

(4 lectures per week, semester II)

3.2 PART II

3.2.1 Year 3

C300 Chemistry Practicals

Practical course cover experiments in Inorganic Chemistry (C301), Physical Chemistry (C302), Organic Chemistry (C303) and Analytical Chemistry (C304).

(5 hour practical per week, over both semesters I & II)

<u>C301 - Inorganic Chemistry I</u>

Nomenclature, Stereochemistry
Isomerism; Stability of complexes;
Consequences and applications of orbital splitting
Thermodynamic effects, magnetic properties and electronic absorption spectra. Energy level diagrams; Valence Bond Theory
Descriptive chemistry of the d-block transition elements.
The elements of the second and third transition series.
(4 lectures per week, semester II)

<u>C302 - Physical Chemistry</u>

* Quantum theory (Classical mechanics; Translational, vibrational and rotational motion;
Atomic spectra and atomic spectram; Molecular structure & spectra)
* Symmetry and Group Theory - Chemical Applications.
* Electronic spectra
* Resonance techniques (NMR; EPR; Mossbauer spectroscopy)
(4 lectures per week, semester II)

<u>C303 - Organic Chemistry</u>

Stereochemistry; Rearrangement Reactions: Neighbouring group effects
Carbanion reactions:-
α-,ß Unsaturated carbonyl compounds
Molecular orbitals and Orbitals symmetry
Introduction to Organic Spectroscopy
(4 lectures per week, semester I)

<u>C304 Analytical Chemistry</u>

Introduction to Instrumental methods of chemical Analysis; Interaction of electromagnetic radiation with matter; Ultraviolet and Visible Absorption Spectroscopy; Atomic absorption spectrophotometry; Fractional Process; Solvent extraction; chromatography, classification and techniques; Paper chromatography; Thin layer chromatography; Gas chromatography Ion - exchange chromatography
(4 lecturers per week, semester I)

3.2.2 <u>Year 4</u>

<u>C401 - Advanced Inorganic Chemistry</u>

Scandium, Yttrium, Lanthanum and the Lanthanides.
The actinide elements
Organometallic chemistry
Inorganic polymers
Catenation, Heterocatenation, etc
Metal atom clusters.
Non - aqueous solvents
Ammonia

Sulphonic acid, Aprotic solvents, molten salts.
Interhalogen compounds
Bioinorganic chemistry
(4 lectures per week, semester I)

C402 - Advanced Physical Chemistry
Chemical kinetics, Diffraction techniques, electric and magnetic properties of matter, surface chemistry, transport phenomena in fluids equilibrium electrochemistry, statistical thermodynamics.
(4 lectures per week, semester I)

C403 - Advanced Organic Chemistry
Polyaromatic compounds;
Heterocyclic chemistry
Natural products:
(4 lectures per week, semester II)

C404 - Advanced Analytical Chemistry
Conductometric titrations; fundamentals of electrochemistry and electrochemical methods; potentiometry; electrogravimetric and coulometric methods; voltametry; polarography.
(4 lectures per week, semester II)

C400 - Chemistry Project
(One lecture and 4 hours practical per week, both semesters)

C450 - Special Practicals
(Four hours practical per week, both semesters)

COURSE ASSESSMENT

1. Any student who does not take Year 2 Mathematics as second major will be required to take the support course in Mathematics.

2. All students intending to major in Chemistry must take all of the courses.

3. Years 2 and 3 will both have weekly practicals with experiments chosen from the respective courses and half-courses.

4. All the courses are compulsory.

5. The individual course assessment ratios of course work/final examination will be within 2:1 to 1:2 range, and will be specified by the

department at its board meeting at the beginning of the academic year.

6. In determining the overall Chemistry mark for Year 2, each chemistry course will count equally, and the support course if taken, will constitute 10% of the total mark. For Year 3 each Chemistry course will constitute 25% of the total mark. For Year 4, the Chemistry Project will constitute 20%, and each of the other courses 20% of the final mark.

COURSES

Year 1	**Semester I**			
	C111	Introductory Chemistry I	**3L**	**3P**
	Semester 2			
	C112	Introductory Chemistry II	**3L**	**3P**
Year 2	**Semester I**			
	C201	Introductory Inorganic Chemistry	**4L**	**3P**
	C203	Introductory Organic Chemistry	**4L**	**3P**
	M215	Mathematics for Scientists	**4L**	**2T**
	Semester 2			
	C202	Introductory Physical Chemistry	**4L**	**3P**
	C204	Introductory Analytic Chemistry	**4L**	**3P**
Year 3	**Semester I**			
	C303	Organic Chemistry I	**4L**	**5P**
	C304	Analytical Chemistry I	**4L**	**5P**
	Semester 2			
	C301	Inorganic Chemistry I	**4L**	**5P**
	C302	Physical Chemistry I	**4L**	**5P**
Year 4	**Semester I**			
	C401	Advanced Inorganic Chemistry I	**4L**	**0P**
	C402	Advanced Physical Chemistry I	**4L**	**0P**
	C400	Chemistry Project	**1L**	**4P**
		OR		
	C450	Special Practicals	**0L**	**5P**
	Semester 2			
	C403	Advanced Organic Chemistry I	**4L**	**0P**
	C404	Advanced Analytical Chemistry I	**4L**	**0P**
	C400	Chemistry Project	**1L**	**4P**
		OR		
	C450	Special Practicals	**0L**	**5P**

EXAMINATIONS

Each course will be examined by one three - hour paper.
The Chemistry Project (C400) is also an examination to which General and Faculty regulations apply.

ADDITIONAL INFORMATION

In each of Years 2, 3, and 4, a student fails Chemistry unless he/she obtains a grade of D or better in each component, as well as a grade of D or better over all. The subject Chemistry may be supplemented to raise an overall grade of E to D, but only if no grade F was obtained in any component.

4. COMPUTER SCIENCE DEPARTMENT

4.1 PART I

4.1.1 Year 1

All first year science students take CSF 100 - Computer Science Foundation Course.

CSF 100 Computer Science Foundation Course (half course)

In this course students are introduced to computer hardware, software, operating systems, and the common applications: word processing, database, spreadsheets, and computer networks (Internet). The programming language, LOGO is also covered.
(one lecture and one 1-hour practical per week, both semesters).

4.1.2 Year 2

CS211 Theory of Computation (half course)

Finite state automata (FA) and regular expressions are treated at an introductory level. Formal language theory, Finite State Machines (FSM), and Turing Machines are also treated.
(4 lectures per week, first semester).

CS235 Introduction to Logic (half course)

Propositional and predicate logic are treated, with their application to Computer Science. Theory of digital electronics is covered. Gates; boolean algebra; basic digital logic circuits; combinatorial and sequential systems.
(4 lectures per week, first semester)

CS241 Computer Organisation I (half course)

A computer is structured in several levels. The lowest level consists of the hardware. At the top there are several layers that manage the operation of computer. The lowest levels are looked into. Aspects of computer systems organisation; memory components; microprocessor chips; busses; interfacing; microprogramming.
(three lectures and one 1-hr practical per week, second semester).

CS243 Structured Programming I

Structured programming is covered. Constants and variables; input/output; conditional statement; assertions; loops.
(3 lectures and 2 practicals per week, semester 1).

CS244 Structured Programming II

Stepwise refinement; characters; enumerated types; reals; procedures and functions; arrays; records.
(3 lectures and 2 practicals per week, semester II).

CS246 Computer Graphics (half course)
Input hardware: joystick, trackerball, mouse, tablet and light pen. Interactive techniques, the design of the user interface. A comparison of graphical input techniques with other forms. Keyboard, speech. Screen presentation: basic reading considerations, communication considerations.
Types of display hardware. Two-dimensional graphics. Drawing algorithms. Introduction to three-dimensional graphics.
(three lectures and one 1-hr practical per week, second semester).

4.2 PART 2

4.2.1 Year 3

CS341 Computer Organisation II (half course)
This course is a continuation of CS 241. The higher levels are looked into, up to the programming language level. Addressing; instruction types; flow of control; operating system machine level; assembly language level; RISC; advanced computer architectures. Assignments will be given on the conventional machine level.
(three lectures and one 1-hr practical per week, first semester).

CS342 Data Structures (half course)
An introduction is given in the use of abstract data structures like lists, queues, trees, etc. For each data structure a formal description is given after which possible implementation in programming languages like Pascal is discussed.
(three lectures and one 1-hr practical per week, second semester)

CS343 Programming Languages (half course)
The main features and differences of several different programming languages are discussed. For each type of programming language, a specific language is taken as an example. The programming languages discussed are: Prolog, Lisp, Ada, and Smalltalk.
(three lectures and one 1-hr practical per week, second semester).

CS344 C under Xenix (half course)
After a short introduction to Xenix, the programming language C is handled. Emphasis lies on structured programming.
(three lectures and one 1-hr practical per week, first semester).

CS345 Databases and their Design I
The nature of databases is explained. The different levels at which you can look at a database (conceptual, logical, and physical levels).
(three lectures and one practical/tutorial per week, first semester)

CS346 Databases and their Design II

Different approaches like hierarchical, network, and relational approaches are discussed. Also steps to be taken in designing a database are discussed.

(three lectures and one practical/tutorial per week, second semester)

4.2.2 Year 4

CS400 Project (half course)

Students will specify, design and implement a reasonable large program in a programming language.

(one 3-hr practical per week, second semester)

CS437 Networks and Coding Theory I

The basics of data communication and protocols. Error detecting codes and error correcting codes. Encryption and decryption. Also the hardware and features of networks will be discussed.

(three lectures and one practical/tutorial per week, first semester)

CS438 Networks and Coding Theory II

Local Area Networks; internetworking; developments in global computer networks.

(three lectures and one practical/tutorial per week, second semester)

CS442 Operating Systems (half courses)

The management of a multi-user environment is treated. The other topics are memory management and process management.

(three lectures and one 1-hr practical per week, second semester)

CS451 Software Engineering I

The different information structures will be shown as well as techniques on how to computerize a company. Analysis of information flows, organisation structure and their effects on the computer system that has to be built.

(three lectures and one practical/tutorial per week, first semester)

CS452 Software Engineering II

Software projects; software life-cycle models; project organisation; software testing; software quality.

(three lectures and one practical/tutorial per week, second semester)

A Computer Science major must take the following courses:

4.3 COURSES:

Year 1

M 111 Algebra, Trigonometry and Analytic Geometry
M 115 Differentiation and Integration
CSF 100 Computer Science Foundation Course.

Year 2 **Semester 1**

	CS 211Theory of Computation		4L
	CS 243Structured Programming I	3L	1P
	CS 235Introduction to Logic	4L	-
	Semester 2		
	CS 244Structured Programming II	3L	1P
	CS 241Computer Organisation I	3L	1P
	CS 246Computer Graphics	3L	1P
Year 3	**Semester 1**		
	CS 344C under Xenix	3L	1P
	CS 341Computer Organisation II	3L	1P
	CS 345Databases and their Design I	3L	1P
	Semester 2		
	CS 343Programming Languages	3L	1P
	CS 346Databases and their Design II	3L	1P
	CS 342Data Structures	3L	1P

Year 4	**Semester 1**			
	CS437	Networks and Coding Theory I	3L	1P
	CS442	Operating Systems	3L	1P
	CS451	Software Engineering I	3L	1P
	Semester 2			
	CS400	Project	0L	3P
	OR			
	CS401	Special Practicals	0L	3P
	CS438	Networks and Coding Theory II	3L	1P
	CS452	Software Engineering II	3L	1P

4.4 ASSESSMENT

The ratio of continuous assessment to final examination will be 2:3.

5. SCIENCE AND PLANNING (GEP) DEPARTMENT

5.1 PART 1

5.1.1 Year 1

GEP111 Introduction to the Natural Environment (compulsory half course)

Environmental systems and their interactions with the human environment. The fundamental forces and processes operating in the atmosphere, hydrosphere, lithosphere and biosphere. Current environment concerns in the Southern African subregion.

Practicals: Maps: reading and interpretation including Geological Maps. Time and Seasons. Radiation Balance, the Hydrological Cycle. Introduction to Fieldwork.

(Three lectures and one 3-hour practical per week, first semester)

GEP121 Introduction to the Human Environment (Compulsory half Course)

The interrelationship between the environment and Man's economic, social and cultural activities. Spatial Diffusion. Urbanisation and Territorial Conflicts.

Practicals: Graphical representation of geographical data. Exercises on Population Models, Land Use, Urbanisation, Transportation Systems, Diffusion and Territoriality. Introduction to Fieldwork.

(Three Lectures and one 3-hour practical per week, second semester).

5.1.2 Year 2

GEP 213 Elementary Surveying and Cartography

Surveying instruments and techniques. Area, height and slope measurements. Earth coordinate system. Scale. Map compilation. Mapping point, linear, area and volume data. Cartographic design and symbolism. Map projection.

(2 Lectures and one 2-hour practical per week)

GEP223 Statistical Geography

Geographical data. Statistical concepts. Descriptive Statistics. Samples and Sampling methods. Computer applications. Spatial Statistics. Correlation and regression.

(3 Lectures per Week)

GEP227 Applied Physical Geography

The Geological Framework. Plate Tectonics, Minerals and Rocks. Scope and nature of Soil Science. Mineralogical, physical, chemical and biological properties of soils. Geomorphological Processes in slope development. Geomorphological processes of Southern Africa with special reference to Swaziland. Soil forming factors and processes. Soil-water

relations. Soil profile description. Laboratory analyses.

(3 Lectures and one 3 hour practical per week)

GEP 228 Water Resources

Methods and problems of hydrological and weather observations. Atmospheric circulation and its influence on precipitation. Microclimates and Climate classification and climate of Southern Africa. The hydrological cycle and its components. Hydrograph analysis. Methods of Water resources evaluation. Water quality. Water resources in Swaziland.

(3 lectures and one 3-hour practical per week)

5.1.3 Year 3

GEP313 Introduction to Remote Sensing

Concepts of remote sensing. The Electromagnetic spectrum. Imaging Systems and their capabilities. Remote Sensing Platforms. Types and uses of Aerial Photography. Introduction to Photogrammetry.

Principles. Interpretation. Digital image processing. Application in Natural Resources Surveys and Planning.
(2 Lectures and one 2-hour practical/week)

GEP321 Drainage Basin Studies
The Drainage Basin as Geomorphological, Hydrological and Planning unit. Drainage Basin morphology. Runoff, Sediment and Solute dynamics. Drainage Basin Planning, Management and Conservation. Case Studies. Drainage Basins of Swaziland.
(2 Lectures and one 2-hour practical/week)

GEP323 Research Methods in Geography
Types and Methods of research in geographical investigation. Sources of data. Research formulation. Preparation of questionnaires. Sampling techniques. Measurement and Scaling. Data collection. Field Surveys. Geographical Information Systems. Analysis and interpretation. Presentation of research findings.
(2 Lectures and one 2-hour practical/week)

GEP326 Agricultural Systems
Scope and content of Agro-Climatology. Climate-soil-plant relationships. Energetics and Biological Productivity. Climate Management. Climate and Agriculture in Swaziland. The scope and nature of Agricultural Geography. Agricultural land use theory, census and mapping. Theory and models of agricultural activities. Agricultural changes. Agriculture and the environment.

5.1.4 Year 4

GEP400 Applied Geography
Environmental issues. Land management and sustainable development. Environmental economics. Resource use and poverty alleviation. Poverty, inequality and the environment. Geography of disease and health. Sustainable livelihoods. Current development debates and emerging paradigms.
(2-hour practical per week)

OR

GEP401 Project
The collection and analysis of data by the student and write-up of a report, which should include a review of relevant literature and the presentation of information in cartographic form.
(2-hour practical per week)

GEP421 Water Resources Planning
Water supply systems. Factors in water supply planning. Irrigation and drainage. Urban and industrial water supplied. Sewage and waster water treatment. Flood and drought mitigation. Water laws. Cost benefit analysis. Water Resources Planning in Southern Africa and Swaziland.
(2 lectures and one 2-hour practical per week)

<u>GEP433 Applied Soil Science</u>

Methods of soil survey. Principles of Soil Mapping and Soil Classification. International Soil Classification Systems. Soil Survey and Classification in Southern Africa and Swaziland. Causes and mechanics of soil erosion. Nature and impact of soil erosion. Measuring and simulation of erosion. Erosion hazard assessment and prediction. Soil erosion conservation
and management strategies in Southern Africa and Swaziland.

(4 Lectures and one 3-hour practical per week)

<u>GEP434 Resource Management</u> (new course)

Principles and concepts of Land Evaluation. Land characteristics and qualities. Land Capability and Land Suitability Classification system. Principles of land and water resources conservation and management. Remote sensing and GIS in land surveys and data analysis. Traditional and modern Systems of Environmental Management Environmental Impact Assessment. Land management and conservation in Swaziland and Southern Africa.

(4 Lectures and one 3-hour practical per week)

1. In order to take GEP in Year 1, a student must have obtained a C grade or better in Mathematics in the GCE O level or the IGCSE or an equivalent qualification.

2. Student wishing to major in GEP must have 50% or better in GEP111 and in GEP121.

3. Students in the combined major programme must take an equivalent of four half courses in each of Years 2, 3 and 4. All half courses are normally taught in one semester.

4. Students in the final year may choose GEP401 or GEP400.

5. Course Assessment:

   (a) All courses are compulsory and are structured as half courses and are graded equally.

   In order to pass the subject GEP, a student must have 50% or better in all courses. Weighting of course work/final examination marks shall be 2:3.

   (b) Project (GEP401) shall be assessed on the basis of continuous and final examination (Thesis). The ration of continuous assess to the final examination will be 2:3.

   (c) Applied Geography (GEP400) will be assessed wholly through continuous assessment.

COURSES

Year 1	**Semester I**		
	GEP 111	Introduction to the Natural Environment	3L 3P
	Semester 2		
	GEP 121	Introduction to the Human Environment	3L 3P
Year 2	**Semester I**		
	GEP 213	Elementary Surveying and Cartography	2L 3P
	GEP 228	Water Resources	3L 3P
	Semester 2		
	GEP 223	Statistical Geography	2L 3P
	GEP 227	Applied Physical Geography	3L 3P
Year 3	**Semester I**		
	GEP 323	Research Methods in Geography	2L 3P
	GEP 326	Agricultural Systems	4L 3P
	Semester 2		
	GEP 313	Introduction to Remote Sensing	2L 3P
	GEP 321	Drainage Basin Studies	2L 3P
Year 4	**Semester I**		
	GEP 400	Applied Geography	-- 3P
	OR		
	GEP 401	Project	-- 3P
	GEP 421	Water Resources Planning	2L 3P
	GEP 433	Applied Soil Science	4L 3P
	Semester 2		
	GEP 400	Applied Geography	-- 3P
	OR		
	GEP 401	Project	-- 3P
	GEP 434	Resource Management	4L 3P

6. MATHEMATICS DEPARTMENT

6.1.1 Year 1

M111 Algebra, Trigonometry and Analytic Geometry

1. **Fundamentals of Algebra:**
   - The Real Numbers, Exponents, Polynomials, Factoring Rational Expressions, Radicals, Complex Numbers - definition & operations

2. **Polynomial and Rational Functions:**
   - Synthetic Division, Complex Zeros of Polynomial Functions, Rational Zeros of Polynomial Functions, Graphs of Polynomial Functions, Rational Functions

3. **Exponential and Logarithmic Functions:**

- Exponential Functions, Logarithmic Functions, Evaluating Logarithms, Exponential and Logarithmic Equations, Exponential Growth & Decay

4. Trigonometry:

- Trigonometric Functions, Identities, Addition, Sum, Difference, Product, Double and Half Angle Formulas, Trigonometric Equations, Inverse Trigonometric Functions

5. Matrices:

- Matrices and Matrix Solution of Linear Systems, Determinants, Cramer's Rule, Matrix Inverses, Gaussian Elimination

6. Complex Numbers:

- Polar and Exponential Representation, DeMoivre's Theorem, Complex Roots

7. Plane Analytic Geometry:

- Straight Lines, Circles, parabolas, ellipses and hyperbolas

8. **Further Topics in Algebra:**

- Induction, The Binomial Theorem and Binomial Series, Arithmetic and Geometric Sequences.

(Three lectures and one 2-hour tutorial per week, Semester I).

<u>M115 Introduction to Calculus</u>

1. Limits and Their Properties:

- Introduction to Limits, Properties of Limits.
- Techniques for Evaluating Limits, Continuity and One-sided Limits, Infinite Limits.

2. Differentiation:

- The Derivative & the Tangent Line Problem,
- Basic Differentiation Rules and Rates of Change,
- The Product and Quotient Rules and Higher-Order Derivatives,
- The Chain Rule, Implicit Differentiation, Local extrema & curve Sketching of simple polynomials, Related Rates, velocity

3. Integration:

- Antiderivatives and Indefinite Integration,
- Area Riemann Sums and Definite Integrals,
- The Fundamental Theorem of Calculus, Integration by substitution, by parts, use of partial fractions, trigonometric substitutions.
-

4. Logarithmic, Exponential, and Other Transcendental Functions:

- The Natural Logarithmic Function and Differentiation, The Natural Logarithmic Function and Integration
- Inverse Functions, Exponential Functions: Differentiation and Integration, Bases Other than e and Applications
- Inverse Trigonometric Functions: differentiation & integration, and completion of the square;
- Hyperbolic Functions: differentiation & integration. Inverse hyperbolic functions: differentiation & integration involving these.

(Three lectures and one 2-hour tutorial per week, Semester II).

6.1.2 <u>Year 2</u>

M211 Calculus 1

1. **Applications of derivatives:**
    - Extrema on an Interval, Rolle's Theorem & the Mean Value Theorem
    - Increasing/decreasing functions & the 1st Derivative test, Concavity & the 2nd derivative test, Summary of Curve Sketching: discontinuous functions, asymptotes, Limits at Infinity & L'Hospital's rule.
2. **Applications of the Definite Integral**
    - Area of region between two curves, Volume: the disc/shell methods, Arc length & Surfaces of revolution
3. **Infinite Series**:
    - Sequences, Series & convergence,
    - The Integral Test & p-Series, Comparisons of tests, Alternating Series,
    - The Ratio & Root Tests ,
    - Taylor Polynomials & Approximations,
    - Power Series, Taylor & Maclaurin Series.

(3 lectures a week, Semester I)

M212 Calculus II

1. **Polar Coordinates:**
    - Conics & Calculus, Plane Curves & Parametric Equations,
    - Polar Coordinates and Polar Graphs, Area and Arc-length in polar coordinates
2. **Functions of Several Variables**:
    - Introduction to functions of several variables
    - Limits & continuity, Partial derivatives, Differentials, Chain Rule for functions of several variables,
3. **Multiple Integration:**
    - ,Iterated Integrals & Area in the Plane,
    - Double Integrals & Volume,
    - Change of variable: Polar coordinates, Surface area,
    - Triple integrals & applications,Triple integrals in cylindrical & polar coordinates

(3 lectures a week, Semester II)

M220 Liner Algebra

1. **Systems of linear equations:**
    - consistency, solution set, elementary operations,
    - Gaussian elimination; homogeneous systems
2. **Matrix methods**:
    - row operations, echelon form and reduced echelon form
3. **Matrix algebra**
    - inverse of a square matrix – equivalent conditions for existence, finding it by row operations.

- Elementary matrices; expressing an invertible matrix as a product of elementary matrices

4. **Vector spaces:**
    - definition and lots of examples
5. **Subspaces**
    - – lots of examples, including the null space of a matrix.
6. **Linear combinations and spanning sets**;
    - examples including row and column space of a matrix. Looking at systems of equations from this point of view.
7. **Linear dependence and independence**;
    - basis and dimension.
8. **Inner product spaces**
9. **Linear transformations and matrix representation.**
10. **Eigenvalues and eigenvectors.**

(3 lectures a week, Semester I)

<u>M213 Introduction to Ordinary Differential Equations</u>

1. **Introductory Concepts:** Definitions, Origin of Differential Equations, Geometrical Problems, Physical Problems, Political Problems
2. **Variables Separable Equations**: Separation of Variables, Homogeneous Equations, Equations in which M(x,y) and N(x,y) are Linear, but not homogeneous, Miscellaneous Substitutions
3. **Exact and Linear Equations:,** Exact Equations, Integrating Factors, First Order Linear Equations,Bernoulli's Equation
4. **Second Order Equations:**Second Order Equations Reducible to First Order Equations, Characterisation of solutions of the general linear second order differential equation, Linear homogeneous equations with constant coefficients, The equidimensional equation, Method of finding particular Integrals, Method of undetermined coefficients
5. **Higher Order Equations:,**Higher order equations with constant coefficients, Method of undetermined coefficients, Method of variation of parameters, The equidimensional equation, Differential operators
6. **Series Solutions:**Solutions around ordinary points, Solutions around singular points, Regular singular points, Indicial equation.
7. **Method of Laplace Transforms**

   (3 lectures a week, Semester II)

<u>M231 – Foundations of Mathematics</u>

1. **Mathematical Statements and Proofs:**

   - The language of mathematics (Statements, Propositions, Lemmas, Theorems,
     Corollaries, etc)
   - Logical connectives
   - Logical equivalences and implications
   - Proofs (Direct proofs, Proof by contradiction, Proof by contraposition, Proofs of propositions involving quantifiers, Uniqueness proofs, Proof by exhaustion, Proof by elimination, Proofs of Max/Min theorems, Necessity and Sufficiency)

2. Sets and Quantifiers:
- The language of Set Theory
- Quantifiers
- Nested Quantifiers
- Negations of statements containing quantifiers

3. Number Systems:
- Real numbers
- Rationals and Irrationals
- Decimals
- Inequalities

3. The Induction Principle and its Generalizations:
- Principle of mathematical induction
- Generalized induction
- Strong induction

4. Euler's Formula for Convex Polyhedra:
- Euler's formula
- Plane graphs
- An application of Euler's formula

5. Introduction to Analysis:
- Bounded sets
- Least Upper Bounds and Greatest Lower Bounds

6. The Integers:
- The Euclidean Algorithm
- Congruence of Integers

7. Primes and the Prime Factorization Theorem:
- Infinity of the set of all primes
- The Prime Factorization Theorem
- Consequences of the Prime Factorization Theorem

8. More on Sets:
- Operations on Sets
- Cartesian Products
- Finite Sets
-

9. Relations:
- Definitions
- Equivalence Relations
- Equivalence Classes

10. Functions:
- Definitions (bijections, surjections, injections)
- Inverse functions
- Composition of functions
- Counting functions

11. Infinite Sets:
- Countable sets
- Denumerable sets
- Uncountable sets
- A Hierarchy of Infinities
- The Continuum Hypothesis

(3 lectures a week, Semester I)

<u>M255 – Dynamics I</u>

1. **Vectors:**
   - Definitions
   - Dot product
   - Cross product
   - Triple products
2. **Vector Differentiation:**
   - Ordinary derivatives of vectors
   - Partial derivatives of vectors
   - Gradient, divergence and curl
   - Formulas involving the delta operator
   - Velocity and acceleration
   - The unit tangent vector, the unit principal normal and the unit binormal
   - Tangential and normal components of acceleration
3. **Uniform Motion:**
   - Distance-time graphs
   - Uniformly accelerated motion
   - Acceleration due to gravity
   - Motion in a resisting medium
   - Projectile motion
4. **Harmonic Functions and the Harmonic Oscillator:**
   - Harmonic oscillations
   - Phase difference: lead and lag
   - Physical models of a differential equation
   - Free oscillations of a linear oscillator
   - Forced oscillations and transients
   - Resonance
   - Nearly linear systems
5. **Orbital Motion:**
   - Central forces
   - Properties of central forces
   - Equations of motion
   - Determination of orbit from central force
   - Determination of central force from orbit
   - Potential energy in a force field
   - Conservation of energy

(3 lectures a week, Semester I)

<u>M215 Mathematics for Scientists I</u> (half course)

For students majoring in Biology and Chemistry.

Applications of derivatives and integrals: Curves sketching; L' Hospitals Rule; Mean Value Theorem; Multiple integration.

Matrix Algebra : Matrices and determinants; properties; evaluation of determinants. Solving systems of algebraic equations using determinants (Cramer's Rule). Inverse matrices; Vectros: Vector algebra; dot and cros product and their applications. Cylindrical and spherical coordinates.

Functions of several variables: Partial differentiation. Application to maxima and minima of functions of two variables Lagrange Multipliers.
(Four lectures per week, Semester I)

6.1.3 Year 3

M311 Numerical Analysis I

1. Error Analysis
   - Sources of Error
   - Representation of Numbers
   - Floating Point Representation
   - Overflow and Underflow
   - Loss of Significance
2. Roots of Nonlinear Equations
   - The Bisection Method
   - Newton-Raphson Iteration
   - The Secant Method
   - Error Analysis and Convergence
3. Polynomial Interpolation
   - Lagrange Representation
   - Divided Differences
   - Newton Divided Difference Representation
   - Equal Spacing: Newton Forward Difference Representation
   - Errors in Polynomial Interpolations
4. Numerical Integration
   - Newton-Cotes Rules
   - Trapezoidal Rule
   - Simpson's Rule
   - Error Analysis
   - Gauss Quadrature
5. Numerical Linear Algebra (Introduction)
   - Solution of Linear Systems
   - Gaussian Elimination
   - Pivoting and Scaling
   - LU- Factorization
   - Iterative Methods
   - Jacobi and Gauss-Seidel Iterative Methods
   - Error and Perturbation Analysis

   (3 lectures a week, Semester I).

M312 – Vector Analysis

1. **Preliminaries:**
   - Vectors in the Plane and in Space
   - Lines and Planes in Space
   - Parametrizations of Curves in Space
   - Cylinders and Quadratic Surfaces
2. **Tensor Analysis:**
   - Symmetric and Skew Symmetric Tensors
   - The Kronecker Delta and Permutation Symbols
   - Vector Identities

3. Generalized Orthogonal Coordinates:
- An Introduction to Orthogonal Curvilinear Coordinates
- Line Elements and Volume Elements
- Gradient, Divergence, Curl, and the Laplacian Operator
- Cylindrical, Spherical and Paraboloidal Coordinates

4. Line, Surface and Volume Integrals:
- Line Integrals
- Work, Circulation and Flux
- The Work Done by a Force Over a Curve in Space
- Flow Integrals and Circulation
- Flux Across a Plane Curve
- Conservative Fields
- Exact Differential Forms
- Surface Area and Surface Integrals
- Parametrized Surfaces
- Surface Integrals over Parametrized Surfaces
- Oriented Surfaces
- Surface Integral for Flux
- Volume Integrals
- Green's Theorem, the Divergence Theorem and Stoke's Theorem

5. Gamma and Beta Functions:
- The gamma function
- Asymptotic formula for the gamma function
- Miscellaneous results involving the gamma function
- The beta function

6. Legendre Polynomials:
- Legendre's differential equation
- Legendre polynomials
- Generating function for Legendre's polynomials
- Recurrence formulas
- Legendre function of the second kind
- Orthogonality of Legendre polynomials

7. Bessel Functions
- Bessel's differential equation
- Bessel functions of the first kind
- Bessel functions of the second kind
- Generating function for Bessel functions
- Recurrence formulas

(3 lectures a week, Semester II).

<u>M313 Complex Analysis</u>

1. Complex Numbers:
- Sums & Products, Algebraic Properties
- Moduli & Conjugates, Polar Coordinates & Euler's Formula
- Products & Quotients in Exponential Form
- Roots of Complex Numbers

2. **Analytic Functions:**

- Functions of a Complex Variable
- Limits & continuity
- Mappings
- Derivatives & Differentiation Formulas
- Cauchy-Riemann Equations
- Polar Coordinates
- Differentiability & Analytic Functions
- Harmonic Functions

3. **Elementary Functions:**
    - The Exponential Function
    - Trigonometric & Hyperbolic functions
    - The Logarithmic Functions & its branches
    - Complex Exponents
4. **Integrals:**
    - Contours, Contour Integrals
    - Antiderivatives
    - Cauchy-Goursat Theorem
    - Cauchy's Integral Formula
    - Liouville's theorem & maximum moduli functions
5. **Series:**
    - Convergence of Sequences and Series
    - Taylor & Laurent Series
    - Integration & Differentiation of Power Series
6. **Residues & Poles:**
    - Residues & the Residue theorem
    - Isolated Singular Points
    - Residues at Poles
    - Zeros & Poles of order m
7. **Applications of Residues:**
    - Evaluation of Definite Integrals involving sines and cosines
    - Integration along a branch cut
    - Argument Principle & Rouche's Theorem

(3 lectures a week, Semester II).

M323 Abstract Algebra 1

1. **Elementary number theory**
    - Basic properties of **Z**
    - Well-ordering principle (induction)
    - Division algorithm, hcfs and the Euclidean algorithm
    - Primes and the Fundamental theorem of arithmetic

2. **Congruence modulo *m* and congruence arithmetic**
    - Revise equivalence relations and equivalence classes
    - Arithmetic mod *m* ; solving equations (mod *m*)
    - Properties of $\mathbf{Z}_m$ as an algebraic system; it is a field iff *m* is prime
3. **Group theory**.
    - Definition (axioms) and elementary consequences

- Lots of examples – including examples from geometry (symmetry groups of figures in 2D and 3D), permutation groups (to be studied later) and the groups $\mathbf{Z}_m^*$.
- Subgroups. Order of an element, of a group. Cyclic groups, cyclic subgroups.
- Cosets, Lagranges Theorem and its consequences
- Permutation groups, Cayley's theorem.
- Decomposition into disjoint cycles, and into transpositions.
- Even and odd permutations, S_n and A_n
- A survey of groups of small order (up to about order 8)
- Isomorphisms and homomorphisms.
- Normal subgroups, quotient groups and the first isomorphism theorem

(3 lectures a week, Semester II).

<u>M331 Real Analysis</u>

1. **Review of the reals, rationals, integers and basic assumptions about them.**
2. **Sequences**
    - Definitions, examples
    - Algebra of limits
    - Tests for convergence
    - Absolute convergence.
    - Bolzano-Weierstrass.
3. **Series**
    - Definitions, examples; link with sequences
    - Algebra of limits
    - Tests for convergence
    - Absolute convergence
4. **Functions of one variable**
    - Limits of functions (and one-sided limits)
    - Continuity
    - Algebra of continuity
    - IVTheorem
    - Extreme value theorem
    - Monotone functions
5. **Differentiabilty**
    - Definitions and examples
    - Algebra of differentiability
    - Chain rule
    - Rolle's theorem, Mean value theorem, Taylor's theorem
6. **Riemann integration**
    - Definition and examples
    - Integrability of monotone and continuous functions
    - Fundamental theorem of calculus.
7. **Exponential, logarithmic, trigonometric functions**
    - Careful definitions and derivation of their properties

(3 lectures a week, Semester I).

M355 Dynamics II

1. **Lagrangian Mechanics:**
    - Generalised coordinates, transformation equations and degrees of freedom
    - Classification of mechanical systems: Holonomic, non-holonomic, rheonomic and non-rheonomic, conservative and non-conservative systems.
    - Kinetic and Potential energy. Generalised forces and work.
    - The Lagrangian, Lagrange's equations of motion of mechanical systems e.g pendulum and pulley systems.
2. **Hamiltonian Mechanics:**
    - Generalized momentum, the Hamiltonian, Hamilton's equations of motion. Cyclic coordinates.
    - Hamiltonian for conservative systems. Physical significance of the Hamiltonian.
    - Canonical transformations. Poisson Brackets. Poisson formulation of Hamilton's equations.
3. **Calculus of Variations**
    - Functionals. Euler-Lagrange's equation. Extremal functions.
    - Essential and Natural boundary conditions.
    - Alternative forms of Euler-Lagrange's equation. Special cases of Euler-Lagrange's equation.

    (3 lectures per week, Semesters II).

6.1.4 Year 4

M401 Project

Mathematics project.

(3 contact hours a week, Semester II).

M412 Special Functions

The course covers different areas of mathematics depending on the areas of interest of available staff.

(3 contact hours a week, Semester II).

M411 Numerical Analysis II

1. **Approximation of Functions**
    - Function Spaces: Normed Linear Spaces, Inner Product Spaces
    - The spaces $C[a,b]$ and L_2 : Inner products and norms
    - Notion of "Best Approximation"
    - The Weirstrass Approximation Theorem (as motivation)
    - The Continuous Least-Squares Problem: Standard Basis
    - Orthogonal Polynomials: The Gram-Schmidt Process
    - The Continuous Least-Squares Problem: Orthogonal Bases
    - The Discrete Least-Squares Problem

2. **Initial Value Problems for Ordinary Differential Equations (ODE)**
    - Existence and Uniqueness Theorem

- Single-step Methods: Euler's Method, Taylor Series Methods, Runge-Kutta Methods
- Multi-step Methods: Definitions, Consistency, Stability and Convergence; Adam's Methods
- Linearized Stability Theory

3. **Partial Differential Equations (PDE) – Finite Difference Methods**
   - Fundamentals: Grids, Boundary Conditions, Finite Differences
   - Elliptic PDEs: The Heat Equation, Five-Point Formula
   - Time-Dependent PDEs: Introduction
   - Parabolic PDEs: Explicit and Implicit Solutions
   - Hyperbolic PDEs: Method of Lines, CFL Condition

   (3 lectures a week, Semester I).

M415 Partial Differential Equations

1. **Linear Second Order Partial Differential Equations**:
   - Classification
   - Canonical forms
2. **Wave Equation:**
   - Cauchy Problem and d'Alembert's Solution
   - Nonhomogeneous Wave Equation
3. **Solution by Separation of Variables:**
   - Wave equation on a bounded domain
   - The heat conduction problems
   - Laplace's equation
4. **Nonhomogeneous Problems:**
   - Time-independent nonhomogeneities
   - Time-dependent nonhomogeneities
5. **Problems involving circular symmetry:**
   - The Dirichlet problem for a circle
   - Transverse vibration of a circular membrane
   - Dirichlet problem for a sphere
6. **Solutions by Laplace Transform Method:**

7. **Fourier Series Theory:**
   - Fourier series for functions of period two pi, or arbitrary interval, half-range Fourier series, periodic continuation
   - Integration and differentiation of Fourier series
   - The Fourier transform and its inverse, the convolution theorem, application to boundary value problems.
8. **Laplace Transforms:**
   - The Laplace transform, its properties and applications
   - The convolution theorem and its applications.

   (3 lectures a week, Semester I).

M423 Abstract Algebra II

1. **Introduction**
   - Familiar number systems (**Z**,**Q**,**R**,**C**) and how they can be distinguished by simple properties,
2. **Properties of Z**

- Division algorithm,
- Primes and irreducibles,
- hcfs and Euclidean algorithm,
- prime = irreducible,
- Fundamental Theorem of Arithmetic

3. **Polynomials**
   - Polynomials over **R, Q, Z, C**;
   - Degree, irreducibles, primes, units.
   - Division algorithm, hcfs and Euclidean algorithm,
   - prime = irreducible, unique factorisation.
   - Primitive polynomials, Gauss' lemma, Eisenstein's test.
4. **Rings**
   - Axioms and lots of examples;
   - Properties deducible from the axioms;
   - Special kinds of rings: commutative, with identity, integral domain, field; finite ID is a field

5. **Divisibility in rings**
   - Units, irreducibles, primes, hcfs;
   - study of the rings $\mathbf{Z}_n$ and $\mathbf{Z}[d^{1/2}]$ for square free d, especially d=-1;
   - Euclidean domains
6. **Subrings and ideals**
   - Principal ideals and PIDs,
   - Factor (quotient) rings
7. **Isomorphisms and homomorphisms**
   - Image, kernel,
   - first isomorphism theorem
8. **Fields**
   - Prime subfield, characteristic,
   - Field of fractions of an integral domain,
9. **Field extensions**
   - Construction of field extension to solve any polynomial;
   - Explicit examples for $F= \mathbf{Z}_n$ with n=2,3,5 and polynomials of small degree.

   (3 lectures a week, Semester I).

<u>M431 Metric Spaces</u>

1. Motivation – iterations and convergence, how to understand this?
2. Metric spaces – definition and lots of examples – especially $\mathbf{R}^n$ for n=2,3 and C[a,b] with uniform and L_p –metrics (mainly p=1,2). On $\mathbf{R}^2$ lots of different metrics (Euclidean, max, Chicago, New York, London). (Later – introduce sequence spaces.)
3. Convergence in metric spaces – with lots of examples. Use the terminology "eventually" consistently and rigorously.
4. Completeness of a metric space – lots of examples.
5. Contraction mappings and the contraction mapping principle (for complete metric spaces). Examples – sequences in **R** and elementary differential equations.
6. Closed and open sets; limit points, boundary, interior and closure
7. Compact metric spaces

8. Continuous functions between metric spaces
9. Further applications of the contraction mapping principle.
10. (Time permitting): special kinds of metric spaces (spaces with extra structure): normed spaces and inner product spaces

    (3 lectures a week, Semester I).

M455 Fluid Dynamics

1. **Inviscid, incompressible flow.**
    - Kinematics of fluids in motion: local and particle rate of change of a fluid velocity, acceleration of a fluid. Eulerian and Lagrangian description of fluid motion. Equations of pathlines, streaklines and streamlines.
    - Ideal fluids: Basic conservation laws, equation of continuity.Velocity potential. Derivation of Euler's and Bernoulli's equation of motion.
    - Two dimensional flows: stream functions, irrotational flows, circulation and vorticity. Uniform flow over a cylinder and sphere. Complex velocity potential. Elementary flows: uniform streams, line sources and sinks, doublets, line vortices, vortex streets. Milne-Thomson circle theorem.
2. **Viscous Flow**
    - Navier-Stokes equations. Exact solutions of equation of motion for flow over simple geometries; flow between parallel plates, Poiseulle flow, Couette flow, flow between concentric, rotating cylinders.
    - Laminar boundary layers. Reduction to similarity form.

    (3 lectures a week, Semester I).

EXAMINATION:

1. Students who wish to major in Mathematics in Year 2 must have obtained at least 50% in both M 111 and M 115.

2. Year 2 students who are required by other departments to take Mathematics for Scientists I (M 215) as a support course must have obtained at least 50% in Introductory Mathematics (M 110).
3. The ratio of continuous Assessment to the Final Examination will be 2:3.

COURSES

Year 1	**Semester I**		
	M111 Algebra, Trigonometry and Analytic Geometry	**3L**	**2T**
	Semester 2		
	M115 Differentiation and Integration	**3L**	**2T**
Year 2	**Semester I**		
	M211 Calculus I	**3L**	**2T**
	M220 Linear Algebra	**3L**	**2T**
	M231 Foundations of Mathematics	**3L**	**2T**
	Support Course		
	M215 Mathematics for Scientists	**4L**	**2T**
	Semester 2		
	M212 Calculus II	**3L**	**2T**
	M213 Differential Equations	**3L**	**2T**
	M255 Dynamics I	**3L**	**2T**

Year 3	**Semester I**		
	M311 Numerical Analysis I	**3L**	**2T**
	M331 Real Analysis	**3L**	**2T**
	M355 Dynamics II	**3L**	**2T**
	Semester 2		
	M312 Vector Analysis	**3L**	**2T**
	M313 Complex Analysis	**3L**	**2T**
	M323 Abstract Algebra I	**3L**	**2T**
Year 4	**Semester I**		
	M401 Project	**0L**	**4T**
	OR		
	M412 Special Functions	**2L**	**2T**
	M415 Partial Differential Equations	**3L**	**2T**
	M423 Abstract Algebra II	**3L**	**2T**
	M431 Metric spaces	**3L**	**2T**
	Semester 2		
	M401 Project	**0L**	**4T**
	OR		
	M412 Special Functions	**2L**	**2T**
	M411 Numerical Analysis II	**3L**	**2T**
	M455 Fluid Dynamics	**3L**	**2T**

7. PHYSICS DEPARTMENT

7.1 PART I

7.1.1 Year I

All students intending to major in Physics must pass P101 and P102.

P101 Introductory Physics I

Newtonian mechanics; Mechanics of fluids; Kinetic theory of gases; Thermodynamics;

(3 lectures and one 3-hour practical per week, both semesters)

P102 Introductory Physics II

Wave motion; Electricity and magnetism; optics; Introduction to atomic and nuclear physics.

(3 lectures and one 3-hour practical per week, in the second semester)

7.1.2 Year II

P200 General Practicals

Practical course includes topics from lectures.

(3 hour per week, both semesters).

P211 Mechanics

Vectors and calculus based treatment of problems in kinematics and dynamics of a particle. Newton's law in vector form. Friction. Conservative forces. Collisions. Rigid body dynamics. Gravitation. Mechanical properties of matter. Viscosity of gases and liquids, surface tension, elasticity and plasticity. Introduction to oscillations: damped and forced oscillations, resonance, coupled oscillators. Waves: solution of wave equations, waves in media.
(3 lectures per week, first semester)

P221 Electricity and Magnetism
Electrostatics. Steady currents. Magnetic fields. Electromagnetic induction: self and mutual inductance. Transient and A. C. theory. Elementary electronics.
(4 lectures per week, first semester)

P231 Modern Physics and Wave Optics
Atomic view of matter. Atomic models. Planck's radiation law. Photoelectric effect, waves and particles. Compton effect. Radioactivity. Transmutation of elements. Binding energy. Nuclear reactions. Fission and fusion. Physical optics: Interference, diffraction and polarization. Electro-and magneto-optics. Quantum optics and lasers.
(3 lectures per week, second semester)

P242 Thermodynamics
Heat and temperature: Thermal conductivity, and radiation. Thermal properties of matter. Heat and work: internal energy and the first law. Entropy and the second law. Molecular properties or matter.
(3 lectures per week, second semester)

P262 Computational Methods I
First and second order ordinary differential equations. Systems of differential equations. Use of computer software (eg, Maple) to help in solving problems involving the above topics.
(3 lectures and one tutorial per week, second semester).

P272 Mathematical Methods for Physicists
Applications of derivatives and integrals. Curvilinear coordinate systems. Ordinary and partial differential equations and their applications. Matrices and eigenvalue problems. Vector operators.
(3 hours per week, first semester)

7.2 PART II (Combined Subjects Major Programme)

7.2.1 Year III

P301 General Practicals
A half-course covering experiments in electromagnetic waves, ultrasonics, thermal and thermodynamic properties of gases and solids, optics.
(3 hours per week, first semester)

P311 Electronics I
Introduction to semiconductors. The p-n junction diode. The bipolar junction transistor. The field-effect transistor. Amplifiers at low frequencies.
(3 lectures and 3 laboratory hours per week, first semester)

P312 Electronics II
Feedback amplifiers. Operational amplifiers characteristics. Waveform generators and wave shaping. Impedance matching techniques and the Smith chart. Filters.
(3 lectures and 3 laboratory hours per week, second semester)

P320 Classical Mechanics
Calculus of variations. Lagrangian and Hamiltonian dynamics. Central-force motion. Noninertial frame. Dynamics of rigid body. Coupled oscillations.
(4 lectures per week, second semester)

P331 Electromagnetic Theory
Vector analysis: gradient, divergence, curl. Maxwell's equations. Electrostatics and magnetostatics: Laplace's and Poisson's equations, scalar and vector potentials. Electromagnetic radiation from simple systems.
(3 lectures per week, second semester)

P342 Quantum Mechanics
Limits of classical physics. Wave packets and uncertainty principle. Introduction to special relativity. The Schröedinger wave equation. Eigenfunctions and eigenvalues. One-dimensional potentials. Operator methods. N-particle systems. Schröedinger equations in three dimensions. Angular momentum. The radial equation. The hydrogen atom. Pertubation theory.
(4 lectures per week, first semester)

7.2.2 Year IV

P400 Special Practicals
A full course covering experiments in solid state physics, nuclear physics, fluid mechanics.
(3 hours per week, both semesters)

P450 Special Project
A full course equivalent project of theoretical or experimental nature based on individual student/staff agreement and approved by the department. Projects in solid state physics, nuclear physics, electronics, computational physics.
(3 hours per week, both semesters)

P411 Digital Electronics

Number systems and codes. Logic gates and Boolean algebra. Logic functions. Flip-flops and related devices. Counters and registers. Memories. System interfacing and introduction to microprocessor based systems.

(3 lectures and 3 laboratory hours per week, first semester)

P412 Solid State Physics

Crystal structure and crystal binding. Lattice vibrations and thermal properties of insulators. The free electron theory. Band theory and semi-conductors.

(3 lectures per week, second semester)

P442 Nuclear Physics

Nuclear properties. The deuteron. Nucleon-nucleon scattering. Nuclear models. Stopping and detecting nuclear radiation. Radioactivity. Gamma transitions. Alpha decay. Beta decay. Nuclear reactions. Nuclear accelerators. Basic Particle Physics.

(3 lectures per week, second semester)

P461 Statistical Physics & Thermodynamics

Temperature, thermodynamic variables. Principles of statistical mechanics: probability, entropy. Boltzmann statistics. Gibbs and Boltzmann factors. Partition function. Fermions and Bosons: Distribution functions. Black body radiation. Free electron gas.

(3 lectures per week, first semester)

P482 Computational Methods II

Introduction to C^{++}. Inheritance and interfaces. Input and output. Numerical methods for differential equations. Motion in one dimension. Oscillations and animation. Chaotic motion. Two body problems. Trajectories and orbits. Numerical and Monte Carlo methods. Numerical and Monte Carlo methods in one multidimensional integrals. Monte Carlo error analysis. Random walks with examples.

(3 lectures and one tutorial per week, first semester)

7.3 ASSESSMENT

The weighting of continuous assessment and formal examinations shall be equal to 60% and 40% for courses with a laboratory, and 50% each for courses without a practical component. The special Project (P450) is considered as a separate examination and a single mark will be awarded, consisting of 40% for continuous assessment and 60% for the final examination (Thesis). The Special practicals (P400) will be assessed wholly by continuous assessment.

7.4 EXAMINATIONS

Combined Subjects Major Programme

Faculty of Science Regulations apply.

SUMMARY OF COURSES

Year 1 Semester I

P101	Introductory Physics I	**3L**	**3P**

Semester 2

P102	Introductory Physics II	**3L**	**3P**

Year 2 Semester I

P211	Mechanics	**3L**	**0P**
P221	Electricity & Magnetism	**4L**	**0P**
P272	Mathematical Methods for Physicists	**3L**	**0P**
P200	General Practicals	**0L**	**3P**

Semester 2

P231	Modern Physics and Wave Optics	**3L**	**0P**
P242	Thermodynamics	**3L**	**0P**
P262	Computational Methods I	**3L**	**1T**
P200	General Practicals	**0L**	**3P**

Year 3 Semester I

P311	Electronics I	**3L**	**3P**
P342	Quantum Mechanics	**4L**	**0P**
P301	General Practicals	**0L**	**3P**

Semester 2

P312	Electronics II	**3L**	**3P**
P320	Classical Mechanics	**4L**	**0P**
P331	Electromagnetic Theory	**3L**	**0P**

Year 4 Semester I

P411	Digital Electronics	**3L**	**3P**
P461	Statistical Physics and Thermodynamics	**3L**	**0P**
P482	Computational Methods II	**3L**	**1T**
P400	Special Practicals	**0L**	**3P**
OR			
P450	Special Project	**0L**	**3P**

Semester 2

P412	Solid State Physics	**3L**	**0P**
P442	Nuclear Physics	**3L**	**0P**
P400	Special Practicals	**0L**	**3P**
OR			
P450	Special Project	**0L**	**3P**

8. ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

8.1 PREAMBLE

Subject to the provisions of the General Regulations, the following Special Regulations of the Bachelor of Engineering in Electrical and Electronic Engineering shall apply.

8.2 ENTRANCE REQUIREMENTS

8.2.1 A. "O" Level Admissions

The minimum requirement for entrance to the Bachelor of Engineering degree programme shall be :

(a) A minimum of six passes in the G.C.E. obtained in not more than two sittings, which must include a C grade or better in:

(i) English Language and Mathematics

(ii) **EITHER:**
Physics and Chemistry
OR
Physics and Biology
OR
Physics and Geography
OR
Science (Chemistry/Physics) and Biology
OR
Science (Chemistry/Physics) and Geography
OR
Combination Science and Additional Combined Science.

(iii) Any other subject

OR

(b) Cambridge Overseas School Certificate with a minimum of 5 credits (a C grade or better) which must include the subjects listed in 8.2.1(a) above,

(c) In addition, a cutoff point established by the Admissions Committee will be used.

B. International General Certificate of Secondary Education (I.G.C.S.E) Admissions

The minimum requirement for entrance to the Bachelor of Engineering degree programme shall be a minimum of six passes in the I.G.C.S.E. obtained in not more than two sittings, which must include a C grade or better in:

(ii) English Language and Mathematics

(iii) **EITHER**
Physical Science and Biology
OR

Physical Science and Chemistry
OR
Physical Science and Geography
OR
Physical Science and Physics
OR
Physics and Chemistry
OR
Physics and Biology
OR
Physics and Geography
OR
Coordinated Sciences

(iv) Any other subject

8.2.2 A-level Admissions and other Qualifications

Candidates who have taken acceptable A Level examinations and who have at least two grades of C or better at A level, or an equivalent qualification, in the relevant science subjects offered at the university, MAY be exempted from 1st year of B Eng.

8.3 DEGREE PROGRAMME

8.3.1 In both Part I and Part II the programme shall divide its total instruction time (i.e. individual or combined lectures, practicals, tutorials, projects, etc.) into courses. The actual number of hours per week and total duration of a course is determined by each department.

8.3.2 Part I (Year 1 and Year 2)

(i) Each student must take Academic Communication Skills, Chemistry, Computer Science Foundation Course , Mathematics, Physics and any other Science subject in the B Sc Year 1 programme.

(ii) In order to proceed to Year 2, a student must have an overall average of at least 50% in Year I Science and must have obtained at least 50% in Computer Science Foundation Course, and in each course in Chemistry, Mathematics and Physics.

8.3.3 Part II (Year 3, Year 4 and Year 5)

Courses prescribed for Year 3, Year 4, and the common courses in Year 5 are mandatory. In addition each student must take 4 elective courses in Year 5. The electives in Year 5 will be offered, subject to the availability of staff and relevant facilities.

8.4 PROGRESSION IN THE PROGRAMME

8.4.1 After Year 1, in order to proceed from year to year in the B.Eng programme, a student must obtain 50 % or better in each individual course.

8.5 COURSE ASSESSMENT AND FORMAL EXAMINATIONS

8.5.1 Formal examinations shall be conducted at the end of each semester.

8.5.2 (a) In Year I each course shall be examined by a 3-hour paper unless stated otherwise in the relevant regulations for the course.

(b) In Years 2, 3, 4, and 5 each course will be examined by one 3-hour paper, unless otherwise stated.

8.5.3 (a) The weighting of continuous assessment and formal examination shall be equal to 60% and 40% for courses with a laboratory, and 50% each for courses without a practical component.

(b) In all courses which have a related laboratory, the student shall be deemed to have failed the continuous assessment if he/she has not submitted at least 60% of the laboratory reports for marking.

8.5.4 The grades for EE311 Professional Communication shall not be taken into account when computing the average mark for the year.

8.5.5 Courses assessed wholly by course work are not supplementable.

8.5.6 A Project is considered as a separate examination and a single mark will be awarded, consisting of 40% for the continuous assessment and 60% for the Thesis. In calculating the average mark for the fifth year, EE590 Design Project shall be counted as double the weighting of the other courses.

8.5.7 All students shall be required to complete the 8-week supervised Industrial Attachment course, normally undertaken between semester 8 and 9. This course must be passed before the award of the B.Eng. Degree.

8.5.8 The grade for EE500 Industrial Attachment shall be "pass" or "fail" and shall not be taken into account when computing the average mark for the year.

8.5.9 A student who has passed Industrial Attachment shall not be required to repeat it even if he/she is required to repeat the year.

8.6 SUPPLEMENTARY EXAMINATIONS

8.6.1 Refer to General Regulations for Bachelors' degree.

8.6.2 At the end of Year 1, supplementary examinations shall be allowed only when a student has obtained an overall mark of at least 50% in order to:
(i) pass three subjects
(ii) satisfy a prerequisite to proceed to Year 2.

A student who passes the supplementary examinations shall be allowed to major in the subject/courses supplemented.

8.6.3 After Year I, a student who obtains an E grade in a course(s) shall be allowed to supplement the course(s) in which an E grade was obtained to raise the grade(s) to a D grade, provided he/she has obtained an overall mark of at least 50%.

8.6.4 A student who supplements a course(s) in a subject may receive no more than a D grade in that course(s).

8.7 REPEATING FAILED COURSES

8.7.1 After Year 1, a student who:
(a) obtains an F grade in a course(s) shall be required to repeat the failed course(s).

(b) obtains less than 50% in a course(s) after supplementary examinations shall be required to repeat such a course(s).

8.7.2 A student shall not be allowed to repeat a course more than once.

8.8 DEGREE AWARD AND CLASSIFICATION

8.8.1 To be awarded a B.Eng. degree, a student must have passed all common courses and four elective courses in the final year.

8.8.2 For purposes of degree classification, the overall Part II (Year 3, Year 4, Year 5) mean will be computed using the following weighting: Year 3, 20%; Year 4, 30%; Year 5, 50%.

8.9 TRANSFERS

A B.Eng 1 student may be allowed to transfer to B.Sc. 2 on the recommendation of the Faculty Board to Senate provided:
(i) there is room in the programme.
(ii) He/she has passed at least 3 Science subjects in B.Eng 1, and
(iii) fits into an acceptable B.Sc. 2 programme.

8.10 COURSE DESCRIPTIONS

B111 INTRODUCTORY BOTANY and B112 INTRODUCTORY ZOLOGY.
This course aims to introduce students to some of the important groups of plants and animals to illustrate basic concepts in biology using these organisms as examples. Topics covered include: chemicals of life, the cell,

variety of life (plant and animal), basic genetics, nutrition, transport, excretion, reproduction and growth and development.
(4 lectures and one 3-hour practical per week, both semesters).

C111 INTRODUCTORY CHEMISTRY I
Basic concepts; chemical reactions; properties of gases; thermo-chemistry; atomic structure.
(3 lectures and one 3-hour practical per week, Semester I)

C112 INTRODUCTORY CHEMISTRY II
Chemical bonds; molecular forces; reaction rates; chemical equilibrium (general theory, acid-base, and solubility); electrochemistry and introduction to organic chemistry.
(3 lectures and one 3-hour practical per week, Semester II)

CSF 100 COMPUTER SCIENCE FOUNDATION COURSE
In this course students are introduced to computer hardware, software, operating systems, and the common applications: word processing, database, spreadsheets, and computer networks (Internet). The programming language, LOGO is also covered.
(One lecture and one 1-hour practical per week, both Semesters)

GEP111 INTRODUCTION TO THE NATURAL ENVIRONMENT
Environmental systems and their interactions with the human environment. The fundamental forces and processes operating in the atmosphere, hydrosphere, lithosphere and biosphere. Current environmental concerns in the Southern African subregion.
Practicals: Maps: reading and interpretation including Geological Maps. Time and Seasons. Radiation Balance, the Hydrological Cycle. Introduction to Fieldwork.
(Three lectures and one 3-hour practical per week, first semester)

GEP121 INTRODUCTION TO THE HUMAN ENVIRONMENT
The interrelationships to the Human Environment and Man's economic, social and cultural activities. Spatial Diffusion. Urbanisation and Territorial Conflicts.
Practicals: Graphical representation of geographical data. Exercises on Population Models, Land Use, Urbanisation, Transportation Systems, Diffusion and Territoriality. Introduction to Fieldwork.
(Three lectures and one 3-hour practical per week, first semester)

M111 ALGEBRA, TRIGONOMETRY AND ANALYTICAL GEOMETRY
Fundamentals of Algebra. Polynomial and Rational Functions. Exponential and Logarithmic Functions. Trigonometry. Matrices. Complex Numbers. Plane Analytic Geometry. Further Topics in Algebra.
(3 lectures and one 2-hour tutorial per week, Semester I)

M115 DIFFERENTIATION AND INTEGRATION

Limits and Their Properties. Differentiation. Integration. Logarithmic, Exponential, and Other Transcendental Function
(3 lectures and one 2-hour tutorial per week, Semester II)

P101 INTRODUCTORY PHYSICS I
Newtonian mechanics; Mechanics of fluids; Kinetic theory of gases; Thermodynamics;
(3 lectures and one 3-hr practical per week, Semester I)

P102 INTRODUCTORY PHYSICS II
Wave motion; Electricity and magnetism; optics; Introduction to atomic and nuclear physics.
(3 lectures and one 3-hr practical per week, Semester II)

EE200 WORKSHOP PRACTICE
Practical work involving: Workshop safety and use of hand tools; Workshop processes, drilling, cutting, filing, grinding, machining, fitting, welding, braising, sheet metal bending, riveting, and casting. Introduction to field surveying, masonry and woodwork
Electrical workshop, domestic wiring, standards and regulations, cable jointing. The course is examined by coursework only.
(One 3-hour practical per week, Semester II).

EE201 ENGINEERING MECHANICS AND MATERIALS SCIENCE
Concepts of mechanics of materials, loading, static and dynamic forces, stress and strain in tension and shear, bending moments, torsion.
Mechanics of machines, linear and rotational dynamics, balancing of rotating systems. Friction, application to belt drives screw threads and clutches. Lubrication and wear. Vibration and noise.
Engineering mechanisms, kinematics of plane mechanisms, gears, pinion and rack, gear trains.
Elements of Materials science, crystalline structure of materials, binary equilibrium, alloying and alloying systems. Fundamental properties of materials. Characteristics of ferrous, non ferrous alloys and plastics. Metal joining processes (welding, soldering, adhesives, riveting and brazing), forming (rolling, extrusion, plastic injection molding), metal finishing (grinding, lapping and polishing), heat treatment (hardening, annealing, tempering).
(3 lectures and one 1.5-hour practical per week, Semester I).

EE202 THERMOFLUIDS
Fluid mechanics, fluid statics, fluids in motion, flow through pipes
Engineering thermodynamics, energy, heat and work, laws of thermodynamics, heat transfer, the Carnot cycle, entropy, industrial heating and cooling.
(3 lectures and one 1.5-hour practical, Semester II).

EE203 ENGINEERING GRAPHICAL COMMUNICATION
Engineering graphical communication; importance of drawings, free hand sketching and lettering, title box. Computer-Aided drafting, 2D and 3D-

isometric drawings, 3D perspective drawings. Simple geometric drawings, dimensioning; scale; Interpretation of three-view drawing layout; auxiliary views; hidden detail, sections and cross-hatching. Interpenetration of assembly drawings. Block diagrams and flow diagrams as communication tools
(One 3-hour practical per week, Semester II)

EE221 BASIC ELECTRONICS
Electronic measurements: principles and practice. P-n junctions. Basic characteristics and applications of diodes, BJTs, FETs, and MOSFETs in electronic circuits.
The ideal opamp: properties, voltage follower, inverting and non-inverting amplifier, summing and difference amplifier. Combinational logic circuits. Boolean algebra and minimization Logic gates.
(4 lectures and one 3-hour practical per week, Semester I).

EE251 BASIC ELECTRICAL ENGINEERING
Circuit Analysis. Basic network theorems, Nodal and mesh analysis, Star-Delta transformations. A.C. circuits; Series and parallel resonance, Q-factor Three-phase circuits Computer aided circuit analysis. Magnetic circuits; Magnetic field strength. B-H curves; Losses in magnetic circuits. Mutual inductance and transformers. induced e.m.f., m.m.f., models for inductive coupling, star-delta connections, auto-transformers. Equivalent circuits of single phase transformer.
Introduction to electrical machines, DC machine: series- separately-excited and shunt connected.
(4 lectures and one 3-hour practical per week, Semester I).

EE271 PROGRAMMING TECHNIQUES I
Structure of a general purpose computer. Operating systems. File organizations. Problem solving and algorithm development. Programming environment and program structure. Data types,

expressions and statements. Functions and procedures.
(3 lectures and one 3-hour practical per week, Semester I).

EE272 PROGRAMMING TECHNIQUES II
Object Oriented Programming: approach User-defined data types. Static and dynamic data structures. File processing. Application development. Basis of an object oriented programming language: classes, objects and their lifetimes, inheritance. Polymorphism. Class libraries. User interface programming.
(3 lectures and one 3-hour practical per week, Semester II).

M211 CALCULUS I
Applications of derivatives. Applications of the Definite Integral. Infinite Series.
(3 lectures per week, Semester I)

M212 CALCULUS II

Polar Coordinates. Functions of Several Variables. Multiple Integration.
(3 lectures per week, Semester II)

M213 INTRODUCTION TO ORDINARY DIFFERENTIAL EQUATIONS
Introductory Concepts: Definitions, Origin of Differential.
Variables Separable Equations. Exact and Linear Equations. Second Order Equations. Higher Order Equations. Series Solutions. Method of Laplace Transforms.
(3 lectures per week, Semester II)

M220 LINEAR ALGEBRA
Systems of linear equations. Matrix methods. Matrix algebra. Vector spaces. Subspaces. Linear combinations and spanning sets. Linear dependence and independence. Inner product spaces. Linear transformations and matrix representation. Eigenvalues and eigenvectors.
(3 lectures per week, Semester I)

EE301 PROBABILITY AND STATISTICS
Outcomes, Events and sample space. Probability function, conditional probability, Independent and mutually exclusive events. One dimensional Random Variables: Discrete and Continuous Random variables, Mean, Variance and their distributions illustrated by Binomial, Poisson, Normal, Uniform, Gamma, Chi-square, T- and F-distributions. Probability and moment generating functions
(3 lectures per week, Semester I).

EE311 PROFESSIONAL COMMUNICATION
Inter-personal communication skills; team working and interdisciplinary working Technical report writing and oral communication skills. Presentation techniques.
The course is examined by coursework only.
(One 1-hour practical per week, Semester I).

EE321 ANALOGUE DESIGN I
Single transistor amplifiers: inverters, voltage followers, tuned amplifier, biasing, frequency response, input and output resistances.
Non-ideal opamps, linear and non-linear opamp circuits, opamp compensation. Design examples.
(3 lectures and one 1.5-hour practical per week, Semester I).

EE322 DIGITAL SYSTEMS I
Analysis and design of combinational circuits. Code conversion, arithmetic circuits.
Analysis and design of sequential circuits, flip flops, counters and shift registers. Asynchronous and synchronous design using MSI and LSI devices. Logic families and their characteristics,
Memories: Random access memories and read-only memories, memory system design.
(3 lectures and one 1.5-hour practical per week, Semester I).

EE323 ANALOGUE DESIGN II
Feedback and its effects in amplifiers. RC and LC oscillators, waveform generators. Power amplifier circuits, power opamps, class B, AB, C and D amplifiers. MOSFET amplifiers. Design examples
(3 lectures and one 1.5-hour practical per week, Semester I)

EE324 DIGITAL SYSTEMS II
Synchronous state machines. Asynchronous sequential design. ASM charts, Design of timing circuits.
CAD tools. Programmable logic devices, PLAs, CPLDs and ASICs. Use of VHDL
(3 lectures and one 1.5-hour practical per week, Semester II)

EE331 SIGNALS AND SYSTEMS I
Introduction to signals. Classification of signals, continuous and discrete time signals, energy and power of signals, singularity functions, impulse and step functions. Orthogonal basis functions, properties of such functions including Parseval's theorem. Approximation error in finite number of basis functions, Fourier series. Walsh functions.
Mathematical models of physical systems, differential equation representation.
Properties of LTI systems. Time domain techniques: transient, forced, natural response of first order and second order systems, steady-state response, impulse response, Laplace Transform techniques: Laplace transform, properties of simple systems, inverse Laplace transform, partial fractions and residues. The convolution, initial and final value theorems., solution of LTI differential equations.
(3 lectures and one 1.5-hour practical per week, Semester I)

EE332 SIGNALS AND SYSTEMS II
Sinusoidal steady state response, Bode diagram, simple low pass and high pass filters.
Characteristic equation. Transient and steady state response. Damped, critically damped, under-damped and un-damped systems. Relationship between impulse and step response.
Spectra of signals, equivalence of multiplication in the time and frequency domains to convolution in the frequency and time domains respectively. Amplitude modulation.
The sampling theorem and representation of a continuous time signal by its samples, impulse sampling, sample and hold sampling, filtering, filter design, reconstruction from the samples, interpolation function. Aliasing and the spectrum of a sampled signal.
Discrete time systems and the difference equation. The z-transform definition and its relationship to the Laplace transform. Solution to difference equations using z-transform.
(3 lectures and one 1.5-hour practical per week, Semester II)

EE341 ELECTROMAGNETIC FIELDS I

Electrostatics: Dielectrics and static fields, Electrical structure of matter, conductors and dielectrics, dielectric constant, boundary conditions for E and D at dielectric interfaces. Dielectrics and capacitance. Energy storage in a capacitor. Electric polarization; electric field inside and outside dielectrics; electric susceptibility; electric displacement.
Magnetostatics: solution of magnetic fields; Biot-Savart Law; force between current-carrying conductors; magnetic induction; Ampere's law; the toroid; the solenoid.
Magnetic Fields: Moving charges and magnetic fields, magnetic flux density B, motion of charged particles in a uniform magnetic field, Lorentz force. Savart-Biot law and its applications to simple circuits, Ampere's law and current loops, Faraday's laws of electromagnetic induction, self and mutual inductance, energy stored in a magnetic field.

Conduction in metals, current density, microscopic form of Ohm's law, resistivity, Kirchhoff's laws.
(3 lectures and one 1-hr practicals per week, Semester I).

EE351 FUNDAMENTALS OF POWER ENGINEERING
Sources of electrical energy: Introduction to generation, transmission and distribution of electrical power. Three-phase circuits, power in three-phase circuits. Star- and delta connected balanced and unbalanced loads. Power factor and power factor improvement. Ideal three-phase transformer. Electricity tariffs Rotating and linear motion machines; principles of operation, force and torque. Introduction to the induction motor.
(3 lectures and one 1.5-hour practical per week, Semester II).

EE391 INTRODUCTORY DESIGN LABORATORY
The design process. Developing specifications. Passive devices: types, characteristics and design selection criteria. Active devices: characteristics and design selection criteria. Component packaging. Heat management. EMI management. Reliability. Simple designs to meet specifications.
The course is examined by coursework only.
(One 3-hour practical per week, Semester II).

M311 NUMERICAL ANALYSIS I
Error Analysis. Roots of Nonlinear Equations. Polynomial Interpolation. Numerical Integration. Numerical Linear Algebra (Introduction).
(3 lectures per week, Semester I)

M312 – VECTOR ANALYSIS
Preliminaries. Tensor Analysis. Generalized Orthogonal Coordinates. Line, Surface and Volume Integrals. Gamma and Beta Functions. Legendre Polynomials. Bessel Functions.
(3 lectures per week, Semester II)

M313 COMPLEX ANALYSIS
Complex Numbers. Analytic Functions. Elementary Functions. Integrals. Series. Residues & Poles. Applications of Residues.

(3 lectures per week, Semester II)

EE411 PROFESSIONAL PRACTICE

Social, ethical, environmental and legal contexts in which the engineer practices. Societal concerns, issues such as privacy, product safety, environmental pollution and ethical conduct. Professional ethics, professional societies and legal registration, intellectual property, contract law, and risk management. Case studies.

(3 lectures per week, Semester II).

EE421 ANALOGUE DESIGN III

Multi-transistor configurations and circuits, cascode, darlington, pushpull, differential pair, current mirror, buffers, current limiting, active loads, analog integrated circuits

Power supply circuits. Phase locked loops, operation and applications. Design examples.

(3 lectures and one 1-hour practical per week, Semester I)

EE422 POWER ELECTRONICS

Power devices: Characteristics, ratings and protection of power devices such as: Diodes, SCRs (triacs, diacs and thyristors), GTOs, BJTs, MOSFETs, IGBTs. Applications of power devices: AC-DC converters, DC-DC converters, SMPS, DC-AC inverters, forced commutation, series, parallel, impulse commutated. AC-AC converters

(3 lectures and one 1-hour practical per week, Semester I).

EE423 MICROCONTROLLERS AND MICROCUMPUTER SYSTEMS

Microprocessor and microcontrollers, Architecture, bus structures, parallel and serial I/O interfaces, timers, interrupts, support devices.

Assembly and C language programming. Data acquisition, Bus Interfacing, peripheral interfacing.

(3 lectures and one 1-hour practical per week, Semester II)

EE429 SOLID STATE ELECTRONICS

Fundamentals of semiconductor materials and devices, introduction to quantum mechanics. Quantum theory in conductors, insulators and semi-conductors

Pn junction theory., applications to BJT, FET, MOSFET and opto-electronic devices and integrated circuits.

Electron emission. ionization, glow and breakdown of gases

Light emission: lasers

Magnetic materials and their properties, hysterisis loss; ferrites.

(3 lectures per week, Semester I).

EE431 CONTROL ENGINEERING I

Control Concepts, mathematical models of control elements. Dynamic response in the time domain, rise time overshoot and settling time. Principles of feedback control, analysis of feedback systems, stability frequency response, Bode diagrams, Nyquist plots, relative stability, gain margin, phase margin, closed loop frequency response, polar plots, Stability criteria, Root

locus and frequency response design techniques. Feed back system design, frequency domain models, PID controllers, lead-lag compensation. Introduction to state-space representation of dynamic systems
(3 lectures and one 1-hour practical per week, Semester I).

EE441 ELECTROMAGNETIC FIELDS II
Time-varying Electromagnetic Fields: conduction and displacement currents, Maxwell's equations, application of Maxwell's equations, Electromagnetic waves: time harmonics fields, unbounded uniform plane waves, wave equations, wave functions, behaviour in conducting and dielectric media, power flow, Poynting vector, skin effect. Reflection and refraction of waves, Snell's laws critical angle, brewster angle, diffraction. Waves in bounded space, boundary conditions, standing and travelling waves, polarisation, TE, TM, TEM waves.
Transmission lines, transmission line parameters. Phase and group velocities, dispersion.
(3 lectures and one 1-hr practicals per week, Semester I).

EE442 COMMUNICATION SYSTEM PRINCIPLES
Basic structure of a communication system. Fourier series and discrete spectrum. Fourier integral and continuous spectra. Filtering.
Noise in communication systems: noise bandwidth, noise temperature, cascaded systems. Baseband transmission: channel properties, detection of digital signals in Gaussian noise, need for a carrier. Analogue modulation and demodulation techniques: AM, FM, PM, bandwidth considerations, SSB. SNR considerations. FDM
Signal sampling: PAM, TDM, PWM, PPM. Signal quantization and coding, need for digital signals, binary codes, PCM, Code detection, companding. Digital modulation ASK, FSK, PSK, TDM-PCM, DM, Multichannel trasmission, TDM and FDM.
(3 lectures and one 1.5-hour practical per week, Semester I).

EE443 INTRODUCTION TO DIGITAL SIGNAL PROCESSING
Discrete-time signals and systems, the z-transform and its inverse, transform analysis of LTI systems, frequency response.
Fourier transforms: DTFT, DFT and FFT
Window functions, digital spectral analysis.
Infinite and finite response filter design, realization structures.
Sampling and interpolation, quantization effects.
Digital signal processors: architectural, hardware and software features.
Selected topics on algorithms. Design and application of DSP.
(3 lectures and one 1-hour practical per week, semester II).

EE451 ELECTRICAL MACHINES
Magnetic circuits, determination of magnetic field strength, energy in magnetic circuits, loss in magnetic circuits, B-H curve. Transformers, induced e.m.f., m.m.f., models for inductive coupling, star-delta connections, auto-transformers. Principles of operation of rotating and linear motion machines,

force and torque. D.C. machines, construction, e.m.f. and torque equations, excitation methods. D.C. motors, speed control, efficiency.
Induction motors, rotating field, synchronous speed, equivalent circuit, losses, torque and slip. Three phase induction machines, characteristics, starting methods, speed control.
Synchronous machines, characteristics and features, stepper motors and brushless motors.
Machine related topics: insulation, heating, cooling, ventilation, noise and vibration.
(3 lectures and one 1.5-hour practical per week, Semester I).

EE452 POWER SYSTEMS
Fundamental concepts: Symmetrical components, impedances and power, n-Phase case
Power system representation, Per-unit quantities, One-line diagram
Single-phase circuits Analysis methods. Active and reactive power. Power measurement
Transformers: principles, equivalent circuits
Balanced three phase a.c. systems, steady state operations, power in a.c. circuits, kVA, kW, and kVAr, measurement of three phase power, phase sequences, power system components, representation of power systems, models, line constants, long lines, single line equivalent circuits.
Load curves and maximum demand. Economic considerations, tariff policies, power factor correction.
Electrical services in buildings, domestic, commercial and factory installations
Introduction to power system faults and protection, switchgear.
Power system instrumentation, voltage and current transformers.
(3 lectures and one 1.5-hour practicals per week, Semester I)

EE491 ELECTRICAL AND ELECTRONIC DESIGN LABORATORY I
Design principles, Design versus implementation, specification, description, and depiction. Evaluation of designs, good versus bad design. Electrical and electronic design exercises to meet specifications. Electrical Design exercises.
The course is examined by coursework only.
(One 3-hour practical per week, Semester I).

EE492 ELECTRICAL AND ELECTRONIC DESIGN LABOARTORY II
Group work and/or individual design of selected problems in electrical or electronic engineering. Build and test the solutions in the lab. Detailed design reports to be written and oral/poster presentations may be required.
The course is examined by coursework only.
(One 3-hour practical per week, Semester II).

M415 PARTIAL DIFFERENTIAL EQUATIONS
Linear Second Order Partial Differential Equations. Wave Equation. Solution by Separation of Variables. Wave equation on a bounded domain. The heat conduction problems. Laplace's equation. Nonhomogeneous

Problems. Problems involving circular symmetry. Solutions by Laplace Transform Method. Fourier Series Theory. Laplace Transforms.
(3 lectures per week, Semester I)

EE500 INDUSTRIAL ATTACHMENT

Students will be attached to an approved industrial, service or training establishment for on-the-job practical training for a period of 10 weeks. Each student shall keep a log book in which he/she shall record his/her daily activities in the work place over the attachment period. Students shall be visited during the same period to advice and assess them on practical knowledge acquired and on such other things as work attitude, discipline at work and record keeping. At the end of the attachment, each student shall submit a technical report to the department for evaluation.
The course is evaluated as a "pass" or "fail" only.
(8 weeks between Year 4 and 5)

EE511 ENTREPRENEURSHIP

What is an entrepreneur? Evaluation of opportunities. Market research. Types and legal forms of businesses. Business plans. Financial and other resources for starting business . Trademarks, copyrights and patents. Management of an enterprise, financial statements, human resources, customer relations, distribution and promotions. Exit strategies.
(3 lectures per week, Semester I).

EE512 ENGINEERING MANAGEMENT

Principles of Management Practice: Management functions; management of people and resources. Organisational behaviours and motivation. Accounting methods and cost control. Book keeping. Financial statements. Cost benefit analysis. Discounted cash flow. Ratio analysis. Capital investment appraisal. Elements of project analysis, design, appraisal, implementation and evaluation procedure and contracts. Contract documents. Implementation, operation, maintenance. Industrial Relations and trade unions. Health and safety aspects. **(3 lectures per week, Semester II).**

EE521 INSTRUMENTATION SYSTEMS

Transducers and sensors: types, special techniques for signal amplification, conditioning, calibration and linearization, active filtering.
Characteristics: resolution, errors, reliability, accuracy, power supply sensitivity, frequency response. Signal conditioning, V-I, and V-F conversion circuits and vice-versa. Isolation and cabling.
A/D converters, sample and hold, sampling and aliasing, conversion methods, conversion time, resolution, span, dynamic range. D/A characteristics: transfer function, resolution, absolute error, linearity error.
Data acquisition control, polling, interrupts, memory
Data transmission: current loop, differential transmission, wireless, telemetry. EMI, grounding, noise reduction. DSP techniques in instrumentation. Instrumentation busses: 1-wire, CAN, I^2C, GPIB, LAN, IEEE, USB. Handshaking
PC-based instrumentation, virtual instrumentation, use of LabVIEW to build virtual instruments

(4 lectures and one 1.5-hour practical per week, any semester).

EE522 EMBEDDED SYSTEMS

Use of assemblers and disassemblers. Assembly language programming, macros, subroutines, stacks, interrupts. Applications in measurement and control.

Embedded C programming, Interfacing C and Assembly, Loaders and object files, Profiling and code optimization

Microprocessor interfacing and peripheral devices, parallel and serial busses, DMA, Input-output devices, timers,

Real-time embedded hardware and software design using microprocessors

(4 lectures and one 1.5-hour practical per week, any semester).

EE523 MICROELECTRONIC CIRCUITS

Static and transistor models. Opamp topologies, deviations from reality, bipolar and CMOS opamps, design considerations, frequency response, feedback, single-stage and multistage feedback, instability and compensation. Voltage regulators. Switched capacitor filters.

Translinear and current mode circuits, wide-band amplifiers, analogue multipliers

Noise: noise sources, noise calculations.

MOS, CMOS logic design

(4 lectures and one 1.5-hour practical per week, any semester).

Theory of circuit interruption. The fault clearing processes: problem of switching, arcing and arc-interruption principles. Recovery and re-striking voltages. Categories of switchgear. Types and characteristics of circuit breakers. Testing and rating of switchgear. Classification, construction and characteristics of relays including: over-voltage, under-voltage, over-current, directional, differential, distance relays both electromagnetic hand solid state. Protection of distribution and industrial systems. **(4 lectures and one 1.5-hour practical per week, any semester).**

EE531 INDUSTRIAL CONTROL AND MEASUREMENT

Process elements: Characteristics, response characteristics.

Transducers, survey of types and specifications measurement of parameters such as position, force, motion, level, pressure, flow, temperature.

Analog and digital controllers. Power interfaces.

Programmable logic controllers. Supervisory control and data acquisition (SCADA) system control.

Signal transmission and industrial networks, industrial Ethernet.

(4 lectures and one 1.5-hour practical per week, any semester).

EE532 CONTROL ENGINEERING II

State-space control concepts and techniques

Estimator design. Compensator design

Introduction to digital control, difference equations, z-transforms, stability of sampled data systems, hardware characteristcs, sample rate reduction

Non-linear control, describing functions; stability analysis, stability criteria. Introduction to optimal control and adaptive control
Control of multivariable feedback systems
(4 lectures and one 1.5-hour practical per week, any semester).

EE533 INTELLIGENT SYSTEMS
Adaptive filter design
Fuzzy logic, applications in control, fuzzy filter design
Neural networks, architectures and algorithms, filter design.
Implementation, FPGA designs, VHDL
(4 lectures and one 1.5-hour practical per week, any semester).

EE541 ANTENNA ENGINEERING AND WAVE PROPAGATION
Basic antenna parameters: **gain, effective aperture, radiation resistance, beamwidth, sidelobes, impedance, polarization, bandwidth.**; Hertzian and half wave dipole; **linear and loop antennas.** Radiation pattern of a single antenna and arrays;. **Radiation from discontinuities, slots and horns. Introduction to antenna synthesis. Antenna measurements**.
The radio spectrum; free space, terrestrial and ionospheric propagation models and observations. Multipath propagation conditions. Siting, antenna and receiver noise temperatures.
(4 lectures and one 1.5-hour practical per week, any semester).

EE542 MICROWAVE AND OPTICAL SYSTEMS
Propagation of guided waves; Microwave components, Metallic and dielectric guiding structures. hybrid modes, , micro strip lines , wave guiding mechanisms in copper signal lines, transmission lines and microwave systems, transmission and reflection of guided waves. scattering parameters. Applications of microwaves in communication and industry. Effects of biological exposure to microwave radiation, safety precautions.
Optical fibres:, principles of optical propagation in fibers, optical fiber measurements, sources, modulators, detectors and other components
(4 lectures and one 1.5-hour practical per week, any semester).

EE543 DIGITAL COMMUNICATION SYSTEMS
Data transmission: bandwidth effects, intersymbol interference, optimum source encoding, channel capacity and information rate.
Reliable Communication In the Presence of Noise.
Shannon's Fundamental Theorem of Information Theory. The continuous channel. Orthogonal signals. Block coding for binary systems. Hamming codes, Hamming weight and Hamming distance. Error correction. Cyclic codes. Convolution codes. The Viterbi Algorithm. Feedback channels.

Decision theory: the optimum and matched filters. ISI and minimizing ISI. Raised Cosine filters. Eye diagrams. Probability of error calculations. M-ary baseband. Partial response signaling. Adaptive receivers and channel equalization.
(4 lectures and one 1.5-hour practical per week, any Semester).

EE544 TELECOMMUNICATIONS AND WIRELESS SYSTEMS
Satellite communications: Geo-synchronous orbit, geo-stationary orbit, space link, access methods, satellite services, satellite transponders, antenna systems and gain, Capacity constraints.
Optical communications:, principles of optical propagation in fibers, single and multi mode, dispersion and attenuation, limitation of distance and bit rate, bit-rate distance product, figure of merit.
Public Switched Telephone network: telephone traffic, switching, local and trunk switching, ISDN
Wireless communications: cellular radio systems and personal communications, multipath wireless channels, fading, intersymbol interference. Spread spectrum transmissions, frequency hoping. Wireless networking, WIFI, GSM, CDMA. Frequency planning.
(4 lectures and one 1.5-hour practical per week, any semester).

EE551 SWITCH GEAR AND PROTECTION
Theory of circuit interruption. The fault clearing processes: problem of switching, arcing and arc-interruption principles. Recovery and re-striking voltages. Categories of switchgear. Types and characteristics of circuit breakers. Testing and rating of switchgear. Classification, construction and characteristics of relays including: over-voltage, under-voltage, over-current, directional, differential, distance relays both electromagnetic hand solid state. Protection of distribution and industrial systems.
(4 lectures and one 1.5-hour practical per week, any semester).

EE552 POWER SYSTEM ANALYSIS AND OPERATION
Fault Analysis, balanced and unbalanced faults, analysis methods, symmetrical components.
Transmission lines: Equivalent circuits, Power loading, line compensation, Steady state analysis, Transient analysis, DC transmission, Construction, insulation, reliability.
Power flow and control, load flow studies, fault calculations, system voltage control, load prediction
Power system protection and dynamic performance
(4 lectures and one 1.5-hour practical per week, any semester).

EE553 ELECTRIC DRIVES
Electric and electronic drives for AC and DC machines, analytical models, variable speed operation, speed control methods. Use of digital signal controllers.
(4 lectures and one 1.5-hour practical per week, any semester).

EE571 COMPUTER ENGINEERING

Evolution of the computer. Advanced microprocessor-based system design. Bus interfacing. Interrupts. DMA. Parallel processing. Pipelining. Cache and virtual memory. Microprogramming. Real-time and multi-user operating systems. Use of the UNIX operating system and C-language as tools for real-time applications.

(**(4 lectures and one 1.5-hour practical per week, any semester).**

EE572 COMPUTER NETWORKS

Networks, reason for use, basic terminology, bandwidth, circuit switching, message switching, packet switching, virtual circuits.

Local area networks, LAN, WAN and VPN technology. OSI model.

Network topologies, protocols and standards. Physical layer, Ethernet. Application layer protocols, TCP, IP. Overview of current LAN system components such as bridges, hubs, switches, routers, transmission media. Internet communication, data communications interfaces, data link control, servers and security considerations. Wide area networks, frame relay, ATM, X.25. Distributed applications, ISDN.

(4 lectures and one 1.5-hour practical per week, any semester).

EE590 DESIGN PROJECT

Each student is given a major design project to conduct which may involve literature search, analysis, design and construction, software development, laboratory and/or field investigation. Assessment will be based on oral presentation, laboratory presentation and a written report. This course lasts two semesters. **(8 hours practical per week, both Semesters).**

8.11 SUMMARY OF COURSES

All courses are half courses unless stated otherwise.

YEAR 1

Semester I

ACS Academic Communication Skills	4L	-
C111 Introductory Chemistry I	3L	3.0P
CSF100 Computer Science Foundation Course	1L	1.0P
M111 Algebra, Trigonometry & Analytical Geometry	3L	2.0T
P101 Introductory Physics I	3L	3.0P
Course in elective science subject	3L	3.0P

Semester 2

ACS Academic Communication Skills	4L	-
CSF100 Computer Science Foundation Course	1L	1.0P
P102 Introductory Physics II	3L	3.0P
C112 Introductory Chemistry II	3L	3.0P
M115 Differentiation & Integration	3L	2.0T
Course in elective science subject	3L	3.0P

YEAR 2

Semester I

EE201 Engineering Mechanics and Materials Science	3L	1.5P

EE203 Engineering Graphical Communication	-	3.0P
EE251 Basic Electrical Engineering	4L	3.0P
EE271 Programming Techniques	3L	3.0P
M211 Calculus I	3L	-
M220 Linear Algebra	3L	-
Semester 2		
EE200 Workshop Practice	-	3.0P
EE202 Thermofluids	3L	1.5P
EE221 Basic Electronics	4L	3.0P
EE272 Programming Techniques II	3L	3.0P
M212 Calculus II	3L	-
M213 Introduction to Ordinary Differential Equations	3L	-

YEAR 3

Semester I

EE301 Probability and Statistics	3L	-
EE311 Professional Communication	-	1.0P
EE321 Analogue Design I	3L	1.5P
EE322 Digital Systems I	3L	1.5P
EE331 Signals & Systems I	3L	1.5P
EE341 Electromagnetic Fields I	3L	1.0P
M415 Partial Differential Equations	3L	-
Semester 2		
EE323 Analogue Design II	3L	1.5P
EE324 Digital Systems II	3L	1.5P
EE332 Signals & Systems II	3L	1.5P
EE351 Fundamentals of Power Engineering	3L	1.5P
EE391 Introductory Design Laboratory	-	3.0P
M312 Vector Analysis	3L	-
M313 Complex Analysis	3L	-

YEAR 4

Semester I

EE421 Analogue Design III	3L	1.0P
EE431 Control Engineering I	3L	1.0P
EE441 Electromagnetic Fields II	3L	1.0P
EE442 Communication System Principles	3L	1.5P
EE451 Electrical Machines	3L	1.5P
EE491 Electrical and Electronic Design Laboratory I	-	3.0P
M311 Numerical Analysis I	3L	-
Semester 2		
EE411 Professional Practice	3L	-
EE422 Power Electronics	3L	1.0P
EE423 Microcontrollers and Microcomputer Systems	3L	1.0P
EE429 Solid State Electronics	3L	-
EE443 Introduction to Digital Signal Processing	3L	1.0P
EE452 Power Systems	3L	1.5P
EE492 Electrical and Electronic Design Laboratory II	-	3.0P

YEAR 5

EE500 Industrial Attachment	**8 WEEKS**

COMMON COURSES:

Semester I		
EE511 Entrepreneurship	3L	-
EE590 Design Project	-	8.0P
Elective I from list below	4L	1.5P
Elective II from list below	4L	1.5P
Semester 2		
EE512 Engineering Management	3L	-
EE590 Design Project	-	8.0P
Elective III from list below	4L	1.5P
Elective IV from list below	4L	1.5P

ELECTIVE COURSES, Choose 4 as offered by department from:

EE521 Instrumentation Systems	4L	1.5P
EE522 Embedded Systems	4L	1.5P
EE523 Microelectronic Circuits	4L	1.5P
EE531 Industrial Control and Measurement	4L	1.5P
EE532 Control Engineering II	4L	1.5P
EE533 Intelligent Systems	4L	1.5P
EE541 Antennas & Wave Propagation	4L	1.5P
EE542 Microwave and Optical Systems	4L	1.5P
EE543 Digital Communication Systems	4L	1.5P
EE544 Telecommunications & Wireless Systems	4L	1.5P
EE551 Switchgear and Protection	4L	1.5P
EE552 Power Systems Analysis and Operation	4L	1.5P
EE553 Electric Drives	4L	1.5P
EE571 Computer Engineering	4L	1.5P
EE572 Computer Networks	4L	1.5P

9. POSTGRADUATE STUDIES PROGRAMME

MASTER OF SCIENCE IN ENVIRONMENTAL RESOURCE MANAGEMENT [M.Sc. (Environmental Resource Management)]

9.1 OBJECTIVES

The M.Sc. (Environmental Resource Management) programme aims to:

- develop human resources, both within Swaziland and regionally, in the field of environmental resource management.
- provide a framework for sustainable environmental management through scientific research and experimentation.

- broaden awareness of the issues on environmental resources
- help candidates use the acquired knowledge to contribute to conservation, sustainable utilization and appropriate management of environmental resources.

9.2 ACADEMIC REGULATIONS

552.00 SPECIAL REGULATIONS FOR THE M.SC (ENVIRONMENTAL RESOURCE MANAGEMENT)

552.01 PREAMBLE:

Subject to the provisions of the General Regulations for Post-Graduate Degrees (Master's) programmes (050.00), the following special regulations of the M.Sc (Environmental Resource Management) shall apply.

552.10 ENTRANCE REQUIREMENTS

552.11 The minimum entry requirement for the M.Sc (Environmental Resource Management) shall be **either** a B.Sc. degree **or** a B.A. degree (with Majors in any of the following: Biology, Chemistry, Geography, Environmental Science & Planning, Environmental Health or any other relevant area) or a B.Sc. degree (Agriculture) from UNISWA or any other recognised institution, with at least a Second Class (Second Division) of either a single subject major degree programme or a combined subject major degree programme.

552.20 PROGRAMME STRUCTURE

552.21 The M.Sc (Environmental Resource Management) programme shall be by course work and thesis, extending over at least four semesters for full-time students. In the first semester of the first year a compulsory core curriculum will be offered. Students will be required to choose an area of specialization in the second semester. In the second year an independent research project, in the area of specialization will be conducted, leading to the preparation and submission of a thesis (ERM699).

552.22 Both the core curriculum and the area of specialization shall consist of four (4) half courses each.

552.23 Each area of specialization will be housed in the relevant academic department.

552.24 Each half course shall consist of three (3) lecture hours per week for one semester. Practical aspects from all the half courses shall be accommodated in two weekly three hour practicals running throughout the academic year.

552.25 For part-time students, the programme may extend between three and four years. In the first two years, part-time students must register for at least two half courses per semester. The thesis (ERM699), and any work leading up to it, must be completed within four semesters.

552.30 ASSESSMENT

552.31 With the exception of the thesis (ERM699), all half courses shall be assessed by a combination of continuous assessment, and examination after completion of all course work.

552.32 The ratio of continuous assessment to examination shall be 1:1. Continuous assessment in each half course shall consist of a combination of assignments, tests, reports, seminar presentations and any other appropriate assessment.

552.33 Students are required to submit work for continuous assessment by the due date. Failure to do so will normally result in the award of a zero for such work.

552.34 Each half course shall normally be examined at the end of the academic year by one final examination paper of three hours duration. Some examinations may be written at the end of Semester 1.

552.35 Part-time students shall normally write examinations at the end of the first and second year of the programme.

552.36 For the thesis, an oral examination shall be conducted by a committee as laid out in the Academic General Regulations 050.80 and 050.81.

552.37 The thesis will be considered to constitute a subject which may either be passed or failed and shall be examined as recommended in 050.82. A Pass, Refer or Fail will be used in grading the thesis.

552.40 SUPPLEMENTARY EXAMINATIONS

552.41 There shall be no supplementary examinations, except as provided for by the thesis.

552.50 NOMENCLATURE

552.51 The M.Sc. as presented in this proposal shall be referred to as M.Sc. (Environmental Resource Management).

552.60 COURSE STRUCTURE

All students are required to take the core curriculum courses. Students must then choose one of the areas of specialization offered below. Half courses for the M.Sc are as follows:

CORE CURRICULUM (Compulsory half courses)

ERM 601 Environmental Management and Resource Economics (½)

ERM 602 GIS and Spatial Analysis (Environmental Research Methods) (½)
ERM 603 Environmental Pollution (½)
ERM 604 Environmental Law (½)

AREA OF SPECIALIZATION "A"
Biodiversity Conservation and Management (Department of Biological Sciences).
Students are required to take a total of four half courses. Half course ERM 610 Biological Research Techniques is compulsory for this area of specialization (indicated by *). Students may take a maximum of one half course from any one of the other areas of specialization.

ERM 610* Biological Research Techniques (½)
ERM 611 Biological Resources Management (½)
ERM 612 African Ecology and Conservation (½)
ERM 613 Microbes as a Resource (½)

AREA OF SPECIALIZATION "B"
Land and Water Resources Management (Department of Geography, Environmental Science and Planning).
Students are required to take all four half courses listed below.

ERM 620 Development, Urban Systems and the Environment (½)
ERM 621 Climate Change and Environment (½)
ERM 622 Land and Water Resources Planning & Management (½)
ERM 624 Environmental Geomorphology (½)

AREA OF SPECIALIZATION "C"
Livestock and Environment (Department of Animal Production and Health).
Students are required to take all four half courses listed below.
ERM 630 Animal Production Systems (½)
ERM 631 Animal Welfare and Legislation (½)
ERM 632 Rangeland Management (½)
ERM 633 Environmental Impacts of Livestock Production (½)

AREA OF SPECIALIZATION "D"
Environmental Chemistry and Management (Department of Chemistry).
Students are required to take all four half courses listed below.
ERM 640 Environmental Chemistry (½)
ERM 641 Chemical Pollution Studies (½)
ERM 642 Environmental Analytical Research Techniques (½)
ERM 643 Evaluation of Analytical Data (½)

AREA OF SPECIALIZATION "E"

Environmental Crop Production (Department of Crop Production).

Students are required to take all four half courses listed below.

ERM 650	Stress Physiology	(½)
ERM 651	Advanced Soil Management	(½)
ERM 652	Integrated Pest Management	(½)
ERM 653	Cropping Systems in the Semi-Arid Tropics	(½)

AREA OF SPECIALIZATION "F"

Integrated Land Use and Management (Department of Land Use and Mechanisation). Students are required to take all four half courses listed below.

ERM 660	Water Resources Management	(½)
ERM 661	Land Resources Planning	(½)
ERM 662	Resource & Environmental Economics	(½)
ERM 663	Integrated Study Assignment	(½)

OUTLINE OF COURSES

CORE CURRICULUM

ERM 601 - ENVIRONMENTAL MANAGEMENT AND RESOURCE ECONOMICS

Lectures (3 hours)
Practicals (2 hours)
Principles of environmental management. Causes, types and effects of environmental degradation. Economic valuation of environmental resources, methods of environmental impact assessment, risk assessment, environmental policies and legislation, strategies. Application of Geographical Information Systems (GIS) in environmental impact assessments. Basic principles of remote sensing. Application of economic principles to natural resource issues. Valuation of natural resources. Economic value of biodiversity.

ERM 602 - GIS AND SPATIAL ANALYSIS (ENVIRONMENTAL RESEARCH METHODS)

Lectures (3 hours)
Practicals (2 hours)
Basic principles and physical bases of remote sensing. Sensors, sensor platforms and sensor packages. Digital data handling. Concepts in GIS. Data models, data structures, database design, data capture, spatial analysis. GIS applications in environmental planning and management.

ERM 603 - ENVIRONMENTAL POLLUTION

Lectures (3 hours)
Practicals (2 hours)

Types and sources of pollution. Principles of pollution monitoring. Principles of waste management. Use of organisms as indicators of pollution. Strategies to combat the effects of pollution in Swaziland. Major pollutants in Swaziland. Levels of pollution in Swaziland. Environmental biotechnology. Case studies.

ERM 604 - ENVIRONMENTAL LAW

Lectures (3 hours)
Practicals (2 hours)
Laws pertaining to the environment in Swaziland. International conventions and treaties related to the environment. Strategies for effective law enforcement. Environmental institutions. Public participation and outreach programmes. Community involvement in conservation-oriented projects. Environmental awareness.

AREA OF SPECIALIZATION "A": BIODIVERSITY CONSERVATION AND MANAGEMENT

ERM 610 - RESEARCH TECHNIQUES

Lectures (3 hours)
Practicals (2 hours)
Field techniques. Sampling and census techniques. Design of field experiments. Spatial analysis. Assessing and recording environmental variables. Acquisition, processing and analysis of data and use of documental resource materials. Applied statistics as a tool in environmental resource management. Advanced statistical procedures.

Laboratory techniques. Safety in microbiology - an advanced treatise. Aspects of growth in microorganisms. Practicalities of growth. Sterile techniques. Inoculation, isolation and identification. Quantification. Harvesting and processing of microorganisms. Serological techniques. Molecular microbiological techniques. Histological techniques. Sources, types and acquisition of material. Preparation including: fixation, embedding, sectioning, mounting and staining of material. Tissue maps.
Report writing and presentation, oral presentation.

ERM 611 - BIOLOGICAL RESOURCES MANAGEMENT

Lectures (3 hours)
Practicals (2 hours)
Ecological and resource conservation theory and practice with emphasis on conservation ecology, conservation and sustainable development, biological resource management and restoration ecology. Biological extinction and re-introduction programmes. Handling of alien invasive species. Use of biological control methods for the control of pest species. Management and maintenance of populations. Carrying capacity and harvesting quotas and strategies. Management of ecosystems and ecological services. Conservation of threatened and rare species.

ERM 612 - AFRICAN ECOLOGY AND CONSERVATION

Lectures (3 hours)
Practicals (2 hours)

The African environment. Population ecology, community and landscape ecology in an African context. Definition and characterization of biodiversity. Biodiversity of Africa in general and Swaziland in particular. Distribution of flora and fauna in Swaziland. Conservation of biodiversity in southern Africa. Species of conservation concern in Swaziland. Fragile and sensitive ecosystems.
Important ecosystems of Swaziland. Case studies.

ERM 613 - MICROBES AS A RESOURCE

Lectures (3 hours)
Practicals (2 hours)
Microbial population dynamics in various ecosystems. Nutrient cycles. Distribution and dispersal. Microbialinteractions. Beneficial microorganisms. Environmental remediation. Degradation of pollutants. Modeling the effects of physical environment on microbialpopulations, a management strategy. Soil physical properties - microbial interactions. Decomposition of organic matter. Mycorrhizae and other symbiotic associations. Algal blooms. Algae as indicators of water quality, fertility and pollution. Lichens as pollution indicators.

Environmental toxicology, toxin producing microorganisms. Actions of microorganisms involved in detoxification of hazardous waste. Strain improvement. Identification of toxic components. Effects of microenvironment on toxin production. Mode of action of microbial toxins on other microorganisms. Mycotoxins. Environmental contaminants. Types and sources of pollution. Effects on biological diversity and climate change. Types and classification of pesticides. Environmental impacts on ecosystems. Case studies.

AREA OF SPECIALIZATION "B": LAND AND WATER RESOURCES MANAGEMENT

ERM 620 - DEVELOPMENT, URBAN SYSTEMS AND THE ENVIRONMENT

Lectures (3 hours)
Practicals (2 hours)
Ecosystems and environments. Environmental change and ecological dislocations. Ecology and economics of the environment. Concepts of sustainable development. Issues in regional development. Economic development policy and planning. Models and theories of development. Socio-economic development and population. Urban ecosystem, urban biome and its differentiation. Urban process. Cross-cutting issues in urban neighbourhoods. Environmental policy and urban management. Legal framework for environmental management in urban areas.

ERM 621 - CLIMATE CHANGE AND ENVIRONMENT

Lectures (3 hours)
Practicals (2 hours)
A study of the earth system components influencing global, regional and local climates and climate change. Energy and mass exchange, climates of different surfaces (non-vegetated, vegetated), non-uniform terrain.

Intentional and inadvertent climate modifications by human activities. Climate variability and current issues in climatology: climate change, greenhouse effect, ozone depletion, models on climate change.

ERM 622 - LAND AND WATER RESOURCES PLANNING AND MANAGEMENT

Lectures (3 hours)
Practicals (2 hours)
Principles of land resource development and project planning; land as ecosystem; land use as an economic activity; land use and decision-making; processes of decision-making. The objectives of land users. Factors in decision-making; types of ownership and occupancy; perceptions of the environment; information available, age and cultural factors. Land policy, government control of land use. Structures and trends in land use. Land economics and models of land use. Land use and conservation. Land use planning. Introduction to water resources management. Need for planning, stages of planning, needs assessment, data needs in water resources management. Economics of water resources analysis. Determination of the catchment water yield as a function of storage using mass balance approach, water use coefficients, conjunctive use of surface and ground water. Water demand and quality management. Water law and policy.

ERM 623 - ENVIRONMENTAL GEOMORPHOLOGY

Lectures (3 hours)
Practicals (2 hours)
Geomorphological processes, interactions and their influence on the environment. Mineralogy and petrography of rock types, influences of rock types on weathering rates and soil formation. Analysis of hillslope and erosion processes and their influences on other parts of the environment.

AREA OF SPECIALIZATION "C": LIVESTOCK AND ENVIRONMENT

ERM 630 - ANIMAL PRODUCTION SYSTEMS

Lectures (3 hours)
Practicals (2 hours)
Climatic conditions (high temperatures, humidity, El-nino), vegetation (subtropical seasonal variation in herbage quality and quantity), animal genetic potential, diseases and parasites, water resources (scarce). Production systems: extensive (pastoral, nomadic, transhumane, sedentary, agropastoral commercial ranching), intensive (feedlotting, cages, battery system, deep litter, semi-intensive). Potential negative impact and mitigation measures.

ERM 631 - ANIMAL WELFARE AND LEGISLATION

Lectures (3 hours)
Practicals (2 hours)
Housing: shelter, kraaling, exercise, stock persons, medication, experimental use, feeding, slaughtering, social and cultural issues (lobola, prestige for keeping animals). Livestock products in fragile environment, external factors. Legislation: prevention of cruelty to animals (welfare), livestock movement to

control diseases and animal population, siting of project buildings, environmental impact assessment, land tenure.

ERM 632 - RANGELAND MANAGEMENT

Lectures (3 hours)
Practicals (2 hours)
Range management for multiple use: rangeland hydrology, grazing impact on rangelands, timber production and grazing, recreational use of rangelands. Range plant physiology: basic concepts, carbohydrate reserves, water relations, grazing optimisation theories. Range ecology: rangeland ecosystem components and functions, succession and climax, drought, competition, bush encroachment, fire. Range inventory and monitoring: determination of vegetational attributes, determining utilisation, determining trends, range condition. Range livestock production: economics of range livestock production. Considerations concerning stocking rates.

ERM 633 - ENVIRONMENTAL IMPACT OF LIVESTOCK PRODUCTION

Lectures (3 hours)
Practicals (2 hours)
Types of pollution: soil, water, air, animal products. Sources of pollution: manure/slurry, acaricides (chemical), carcasses, abattoir, agro-industrial waste (abattoir and dairy). Effects of pollution: greenhouse, diseases. Pollution control: bioprocessing, biosorption, remediation, bioconvention. Monitoring range conditions (range trends): number and types of animals, seasonal distribution and movement of animals, condition of animals, soil and water points. Changes in social organisation and wildlife, monitoring chemical residues and livestock products.

AREA OF SPECIALIZATION "D": ENVIRONMENTAL CHEMISTRY AND MANAGEMENT

ERM 640 - ENVIRONMENTAL CHEMISTRY

Lectures (3 hours)
Practicals (5 hours)
Stratospheric chemistry and the ozone layer: principles of photochemistry and catalytic process of ozone destruction; the ozone hole and consequences. Ground level (tropospheric) air chemistry: hydrocarbons, atmospheric sulphur dioxide, acid rain, ecological effects of outdoor and indoor air pollutants. Greenhouse effects and global warming; major and minor greenhouse gases. Global cycles: N_2, CO, CO_2 and sulphur cycles.

Toxic organic chemicals: pesticides, organochloric insecticides (e.g. DDT), herbicides, PCBs, principles of toxicology, transport of atmospheric pollutants; toxic heavy metals, toxicity of metals, bioaccumulation, life-cycles of mercury, lead, cadmium, arsenic and heavy metals; safety aspects.
The chemistry of natural waters: redox chemistry in natural waters: oxygen demand, acid-base chemistry in natural waters, alkalinity, hardness index. Emphasis will be placed on our sources, transport and fate, mitigation and toxicology of pollutants.

Environmental soil chemistry: chemistry of inorganic and organic soil components, soil acidity and salinity, ion exchange and redox phenomena; technology of remediating contaminated soils; sorption and desorption of inorganic and organic pollutants.

ERM 641 - CHEMICAL POLLUTION STUDIES

Lectures (3 hours)
Practicals (5 hours)
Pollution assessment parameters: biological oxygen demand, chemical oxygen demand; effects of pollution on the environment and the principles of pollution control; dissemination of air pollutant, heavy metals and toxic substances; Green House Gas Inventory and protocols.

Waste Management: waste control and disposal of toxic and hazardous waste; radioactive, heavy metals, chemical waste, dust and gases, toxic solvents; the relevant statutes and implications, risk assessment and case studies. Sewerage purification, sludge treatment and disposal, operation and design of treatment plants. Waste disposal methods; environmental aspects of surface and colloidal chemistry and organic chemistry.

Environmental geochemistry and hydrology: retention mechanisms, impact, modelling and transport processes of pollutants (e.g. pesticides).

ERM 642 - ENVIRONMENTAL ANALYTICAL RESEARCH TECHNIQUES

Lectures (3 hours)
Practicals (2 hours)
Separation methods: gas chromatography (GC), high performance liquid chromatography (HPLC), electrophoresis, supercritical fluid chromatography (SFC). Liquid-liquid extraction, ion-exchange chromatography, exclusion chromatography, ion chromatography.

ERM 643 - EVALUATION OF ANALYTICAL DATA

Lectures (3 hours)
Practicals (5 hours)
Statistical methods, experimental design and sampling methods. Computers in analytical instrumentation - principles of digital instrumentation, interfacing devices. Principles of data acquisition, chemometrics, statistical evaluation of analytical data.

AREA OF SPECIALIZATION "E": ENVIRONMENTAL CROP PRODUCTION

ERM 650 - STRESS PHYSIOLOGY

Lectures (3 hours)
Practicals (2 hours)
Ecosystem energy flow and nutrient fluxes-cycles. Stress physiology: biotic and abiotic stresses. Plant environment and cultural manipulation for higher yields. Towards the abolition of limiting factors. Recent advances in environmental crop physiology and cultural manipulations for stress management.

ERM 651 - ADVANCED SOIL MANAGEMENT

Lectures (3 hours)
Practicals (0 hours)
Management of problem soils, saline, sodic and acid sulphate. Soil water management, land cultivation and management, principles and practices of land drainage, rehabilitation of disturbed land (oil contaminated, herbicide contaminated, mine dumps), soil management for tree crops, management of shallow soils. Recent advances in soil fertility management.

ERM 652 - INTEGRATED PEST MANAGEMENT

Lectures (2 hours)
Practicals (2 hours)
Review of the status and prospects of integrated pest management [IPM]. Rationale, principles and concepts of IPM. The control techniques of IPM. Formulation, administration and implementation of IPM programmes in crop production, crop protection, horticulture, forestry and weed science. Major constraints and limitations of IPM.

ERM 653 - CROPPING SYSTEMS IN THE SEMI-ARID TROPICS

Lectures (2 hours)
Practicals (2 hours)
Basis for cropping systems in the semi-arid tropics. Types of cropping systems. Cropping systems for the small-scale farmer and the private sector. Indices of productivity. Crop diversification. Novel cropping systems for the estate sector. Agroforestry: concepts, agroforestry systems and components, agrosilviculture, agrosilvipasture, silvoaquaculture, alley farming, Socio-economic aspects of cropping systems. Research methods in cropping systems and agroforestry. Sustainability in cropping systems.

AREA OF SPECIALIZATION "F": INTEGRATED LAND USE AND MANAGEMENT

ERM660 - WATER RESOURCES MANAGEMENT

Lectures (3 hours)
Practicals (2 hours)
Introduction to water resources management. Need for planning, stages of planning, needs assessment, data needs in water resources management. Economics of water resources analysis. Determination of the catchment water yield as a function of storage using mass balance approach, water use coefficients, conjunctive use of surface and ground water. Water demand and quality management. Water law and policy.

ERM 661 - LAND RESOURCES PLANNING

Lectures (3 hours)
Practicals (2 hours)
Principles of land resource development and project planning; land as ecosystem; land use as an economic activity; land use and decision-making;

processes of decision-making. The objectives of land users. Factors in decision-making; types of ownership and occupancy; perceptions of the environment; information available, age and cultural factors. Land policy, government control oland use. Structures and trends in land use. Land economics and models of land use. Land use and conservation.

ERM 662 - RESOURCES & ENVIRONMENTAL ECONOMICS

Lectures (3 hours)
Practicals (2 hours)
Application of economic principles to natural resource issues. Valuation of natural resources. Economic value of biodiversity. Optimal use of resources, conservation and preservation. Sustainable development. Nature of resource policy processes, environmental policy development, environmental accounting, and international environmental policy.

ERM 663 - INTEGRATED STUDY ASSIGNMENT

Lectures (2 hours)
Practicals (5 days field trip)
Introduction to inter-relationships between human, social, cultural and economic systems and the environment. Interpretation of landscape, people and biota and the implications for present day issues. Multidisciplinary approach to research in land and water and socio-economic issues. Report writing and presentation of results.