UWI
MONA CAMPUS
JAMAICA, WEST INDIES

MONA SCHOOL OF
ENGINEERING
FACULTY OF SCIENCE & TECHNOLOGY

UNDERGRADUATE INFORMATION HANDBOOK

Regulations & Syllabuses

2017-2018

CONTENTS

MISSION STATEMENT

The mission of the Mona School of Engineering is to be the provider of a world class quality education in Engineering and Research and Development programmes in support of Caribbean business, industry and infrastructure; with its graduates, staff and facilities being at the forefront in propelling growth, development and innovation in the region.

DRESS CODE AND CONDUCT

Students must at all times conduct and present themselves in a manner in keeping with the nature of the Engineering Profession, and as directed by the Department in which the student is registered. In particular, due to Occupational Health and Safety issues in the laboratories, PRESCRIBED LABORATORY ATTIRE WOULD BE ENFORCED AT ALL TIMES. Any student who is not appropriately attired SHALL NOT BE ALLOWED ENTRY in any Laboratory or Workshop.

Student ID cards MUST be clearly displayed at all times when on UWI premises. Student ID cards are also required to facilitate all transactions in the Faculty/ University.

Food and drink SHALL NOT be brought into classrooms or laboratories.

STAFF LISTING

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Aiken, Paul
BSc, MPhil (Physics) UWI; MSc, PhD (Electrical Engineering), Columbia University, New York; Senior Member IEEE; Professional Engineer
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COORDINATORS

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Senior Member IEEE
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UNDERGRADUATE COORDINATOR

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OUTREACH COORDINATOR

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Professional Engineer (PE)
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PROJECTS AND LABORATORY COORDINATOR

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ADMINISTRATIVE STAFF

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Gray, Shanique
Administrative Assistant II
Ext: 2254

Williams, Tena
Customer Service Representative
Ext: 2254

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Thompson, Gowan
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Anderson, Stephan
Information Technologist III
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Douglas, Dennis
Laboratory Technologist
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Full time staff of MSE

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SENIOR LECTURERS

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Staff shared with other Departments in FST.

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(Telecommunication)
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(Power Plant Instrumentation)

Young, Garfield
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Geomatics Education
(Geomatics for Civil and Environmental Engineers)

MESSAGE FROM THE DIRECTOR

On behalf of all the staff of the Mona School of Engineering (MSE) in the Faculty of Science and Technology of the University of the West Indies (Mona), let me welcome all new and returning students for the 2017/2018 Academic Year.

In response to the demands of our biomedical and health sectors, we have added the BSc. in Biomedical Engineering to our list of engineering programmes. In an effort to increase access to our engineering programmes, we have also added a 1-year preliminary engineering programme which consists of the necessary components of mathematics, sciences, computer and laboratory techniques and communications skills for the beginner engineer. The first cohort of Jamaican students entering this programme have been awarded a US$5,000 bursary (50%) toward their tuition. This programme is a direct response to a call from the Government of Jamaica (GoJ) and various industries for an increase in the number of engineering graduates. The growing technical sectors of the country has estimated a demand of 1000 engineers graduates per year.

The GoJ and the Student Loan Bureau (SLB) have responded to our request for increased access to loans by engineering students. The interest rates on engineering loans have been reduced from 9.5% to 6%, and the loan threshold has been raised to J$750,000, up from $500,000. Other forms of funding opportunities to engineering students are being explored .

We continue to strengthen our partnerships with local and international industries. Our civil and electronics engineering teams have been working with the National Road Operating and Constructing Company Limited (NROCC) to resolve environmental issues that potentially resulted from roadway construction, including the design and deployment of equipment to remotely sense environmental conditions. We intend to launch our first shared engineering project design with Binghamton University where four of our final year electronics and computer systems engineering students will work with four of their final year electronics and computer engineering students on two Capstone Projects.

(Continued on page 8)

We encourage your participation in the activities of the student engineering clubs (JIE and IEEE), and also your support to our team preparing for the annual international robotics competition by IEEE South East USA. We have continued to excel in this competition and last year our very own Mr Jason Brown (final year computer systems engineering student) won the coveted Best Paper award from a pool of 1000 applicants.

The MSE continues to work hard towards creating a world class teaching and research facility, with strong synergies with our industrial and commercial partners. We have successfully attracted four new academic staff including a professor of electronics and electrical engineering (formerly of University of Florida). ABET International accreditation will be doing a site visit on October 8-12 for assessment of our BSc Electronics Engineering. This is our first attempt at international accreditation and we will use the learning experience from this exercise to facilitate accreditation of all our engineering programmes.

We wish you a very successful 2017/2018 academic year.

Paul Aiken, PhD, PE, Senior Member IEEE
Director, MSE and Deputy Dean, Faculty of Science and Technology

SECTION 1: GENERAL INFORMATION

1.1 PROGRAMMES OF STUDY

The Mona School of Engineering (MSE) in the Faculty of Science and Technology (FST) at the UWI Mona Campus currently offers both four (4) year (with the first year being Preliminary Engineering) and three 3-year programmes of study leading to a BSc. in the following engineering programmes: **Biomedical Engineering**, **Civil Engineering**, **Computer Systems Engineering**, **Electrical Power Engineering** and **Electronics Engineering**. Each BSc. programme is divided into Levels 1, 2 and 3 and is conducted over three (3) academic years; each year consisting two (2) semesters.

The **Preliminary Engineering programme** is a 1-year programme that serves as a qualifying year for students seeking to access any one of the 3-year BSc engineering programmes. The existing BSc. Engineering programmes have a minimum entry requirement of passes in CAPE mathematics and physics (or equivalent). Students who do not meet this requirement will now have the opportunity for admissions to the preliminary year. This preliminary year allow students from any country to access our engineering programmes. It creates a pathway for students from non-traditional educational backgrounds, such as City and Guilds .

1.2 ACADEMIC QUALITY ASSURANCE

Quality assurance systems are aligned with that of the UWI Faculty of Engineering at St Augustine, Trinidad where they are well defined and linked to programme outcomes and individual course learning outcomes. The Faculty of Engineering, St. Augustine oversees the adherence to the guidelines set by the accrediting agencies.

Each BSc Engineering programme at Mona will apply for ABET international accreditation as soon as they are eligible to do so after graduating the first cohort.

1.3 COURSE MATERIALS

Upon payment of tuition fees (either in full or part payments) , the student shall receive an E-tablet with the prescribed texts for each course within their registered programme.

SECTION 2: UNDERGRADUATE REGULATIONS

2.1 QUALIFICATIONS FOR ADMISSION TO BSc. ENGINEERING PROGRAMMES

1) Minimum requirements for entry to the preliminary engineering programme are:
   a. Passes in at least 5 CXC CSECs, or 5 GCE O'Levels, or 5 International Baccalaureate® (IB) all including Mathematics, English, Physics (or equivalent) and any other two subjects; or
   b. Certificate or Diploma in City & Guilds engineering examinations; or
   c. Relevant high schools and SAT passes from international institutions, or
   d. Relevant passes in 'Gaokao' (China's National College Entrance Examination) examination, or
   e. Passes in relevant college entry exams from other countries, or
   f. Passes in high school Mathematics and Physics (or other sciences) and completed HEART NTA diploma in relevant technical discipline, or has been working in relevant technical field for at least 4 years.
2) Admissions for the traditional 3-year BSc engineering programmes (starts at Level 1) requires passes in at least five (5) CSECs (or equivalent) including English A, Mathematics, and Physics, along with:
   a. Passes in units 1 and 2 of CAPE Mathematics and Physics; or
   b. Passes in GCE A'Levels Mathematics and Physics; or
   c. Passes in MATH0100, MATH0110, PHYS0411, PHYS0412, PHYS0421 and PHYS0422 from the Preliminary year of the Faculty of Science and Technology of The UWI; or
   d. Diploma in a relevant engineering programme from an approved institution; or
   e. Diploma in a relevant engineering discipline in the City & Guilds examination, inclusive of a pass in the advanced Mathematics and science courses (Unit 351); or
   f. Associate degrees with Mathematics and Physics or relevant engineering programmes from approved community colleges; or
   g. Passes in Higher International Baccalaureate (IB) in Mathematics and Physics; or

h. Successful completion of the Preliminary Engineering Year with minimum GPA of 2.0, including passes in all pre-engineering Mathematics and Physics courses.

Applicants with a Diploma in Electrical or Electronics engineering (or equivalent) and a minimum GPA of 2.5, may be eligible to matriculate into Level 2, but may be required to do prescribed Level 1 course(s).

2.2 GPA REQUIREMENTS

The Grade Point Average (or quality points) for BSc Engineering programmes is calculated from ALL COURSES from Level 1 to Level 3 that constitutes the candidate's degree. The actual GPA will determine the class of degree received. The GPA accrued from the preliminary engineering year WILL NOT be calculated in the final GPA of the BSc programmes.

Upon completion of the required courses for the degree, candidates must possess a GPA of 2 or greater in order to satisfy the graduation requirements.

In the determination of GPA, the defined grades with the corresponding quality points shall be:

GRADE	QUALITY POINTS
A+	4.30
A	4.00
A-	3.70
B+	3.30
B	3.00
B-	2.70
C+	2.30
C	2.00
F1	1.70
F2	1.30
F3	0.00

The scheme to be used for conversion of numerical marks to letter grades shall be as follows:

GRADE GPA	MARKS %
A+	90-100
A	80-89
A-	75-79
B+	70-74
B	65-69
B-	60-64
C+	55-59
C	50-54
F1	45-49
F2	40-44
F3	0-39

Weighted GPA

The Weighted GPA for the BSc Engineering programmes is the sum of 80% of the average determined by applying weights of 10%, 30% and 60% for levels 1, 2 and 3 courses respectively (except for the 6 credit final year project(s)), and 20% of the compulsory 6 credit final year project.

Other Regulations

A student having a GPA for a given semester of less than 2.00 shall be deemed to be performing unsatisfactorily, and shall be placed on warning. A student on warning whose GPA for the succeeding semester is less than or equal to 1.99, will be required to withdraw. However, a student may be reinstated if his/her GPA improves beyond 1.99 in Semester 2 by credits obtained in summer re-sit examinations.

Students must be guided by all other rules and regulations of the School as outlined in the Mona School of Engineering Regulations at (https://www.mona.uwi.edu/engineering).

2.3 CLASSIFICATION OF DEGREE

BSc degrees in the School of Engineering are awarded in the following classes, based on the final Grade Point Average (GPA) and the overall performance of the graduating students throughout the programme:

DEGREE CLASS	CUMULATIVE GPA
First	≥ 3.60
Upper Second	3.00 – 3.59
Lower Second	2.50 – 2.99
Pass	2.00 – 2.49

SECTION 3: UNDERGRADUATE PROGRAMME DESCRIPTIONS

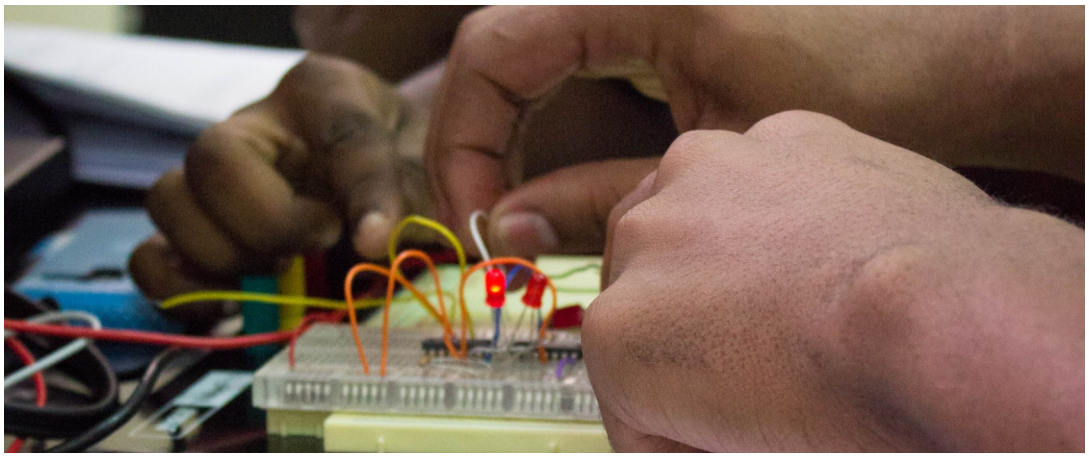
Definition Course Codes:

BMNG	Biomedical Engineering
COMP	Computer Science
CVNG	Civil Engineering
ECNG	Electrical and Computer Engineering
ELET	Electronics
ELNG	Electronics Engineering
ENGR0xxx	Preliminary Engineering Courses
ENGR1xxx	Faculty of Engineering
FOUN	Foundation Courses
GEOM	Geomatics and Geoinformatics
INFO	Information Technology
MGMT	Management Studies
MATH	Mathematics
PHYS	Physics

Note: The letter 'E' or 'C' preceding the credit allocation indicates Examination by Written Papers or by Course Work, respectively.

3.0 PRELIMINARY ENGINEERING (1 year qualifying programme)

Coordinator: Dr Paul Aiken



The overall aims of this preliminary engineering programme are to:

- provide a programme structure that allows students to qualify for transition into any of the BSc engineering programmes within The UWI;
- provide the requisite foundation in mathematics, sciences, laboratory techniques and communication skills that are required for a beginner engineering student; and
- facilitate increased enrolment in engineering to meet the future needs of our industries.

Students are required to register for 30 credits of courses across two semesters. These courses will facilitate the development of competences in mathematics, sciences, laboratory skills, technical writing, along with exposure to softer skills via electives from social sciences and humanities. The credits for these courses **will not** be added to any of the BSc Engineering programmes in The UWI and will only serve to qualify students for access to the BSc engineering programmes .

PROGRAMME STRUCTURE AND CONTENT

Note: E = Examination, C = Coursework, and the numeral after E or C = Number of Credits

ONE YEAR (all courses are compulsory)

Semester 1: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ENGR0110	Pre-Engineering Physics I	E3
ENGR0120	Pre-Engineering Mathematics I	E4
ENGR0130	Chemistry for Engineers	E3
ENGR0230	Biology for Engineers	E3
ELECTIVE 1	Humanities/Social Sciences course	E3

Semester 2: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ENGR0210	Pre-Engineering Physics II	E3
ENGR0220	Pre-Engineering Mathematics II	E4
ENGR0150	Basics of Technical Communications	C2
ENGR0240	Computer Applications for Beginning Engineers	C2
ELECTIVE 1	Humanities/Social Sciences course	E3

Note: Students with CAPE passes (or equivalent) in mathematics or sciences may be eligible for respective exemptions.

3.1 BSc IN BIOMEDICAL ENGINEERING

Coordinator: Dr Paul Aiken

Students are required to complete a minimum of 97 credits for the award of the BSc in Biomedical Engineering.

PROGRAMME STRUCTURE AND CONTENT

Note: E = Examination, C = Coursework, and the numeral after E or C = Number of Credits

LEVEL 1 (all courses are compulsory)

Semester 1: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG1009	Introduction to Programming	C3
ELET1400	Introduction to Electronics	E3
ELNG1101	Physics for Engineers	E3
ENGR1000	Introduction to Engineering	E3
ENGR1180	Engineering Mathematics I	E3

Semester 2: 16 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
BMNG1210	Introduction to Biomedical Engineering	E3
COMP1161	Object Oriented Programming	E3
ECNG1000	Electrical Circuits	E3
ECNG1006	Laboratory and Project Design I	C3
ECNG1012	Engineering Science and Technology	C4

LEVEL 2 (all courses are compulsory)

Semester 1: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG2004	Laboratory and Project Design II	C3
ELET2450	Embedded Systems	E3
ELET2460	Signals and Systems	E3
MATH2230	Engineering Mathematics II	E3
PHYS2386	Electromagnetism and Optics	E3

Semester 2: 14 Credits

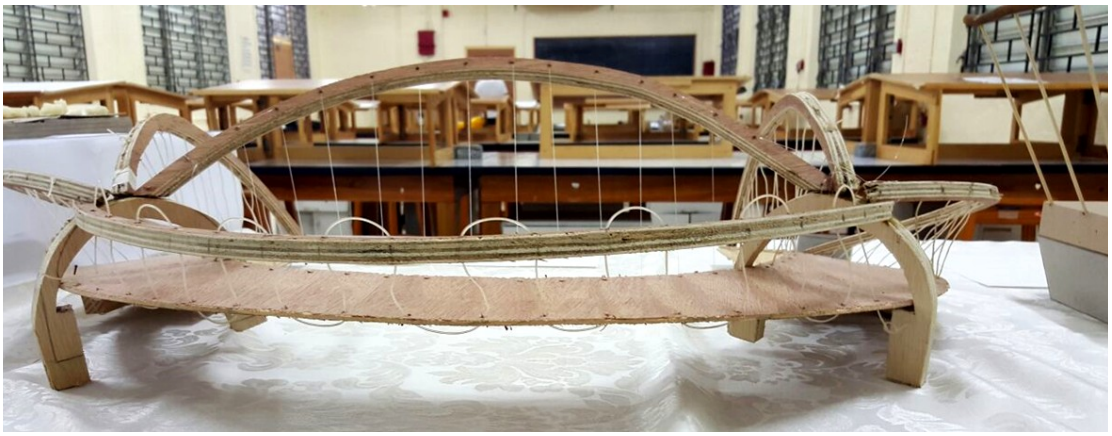
COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
BMNG2210	Biomedical Instrumentation I	E3
ECNG2005	Laboratory and Project Design III	C3
ECNG2009	Control Systems	E3
ELET2410	Analysis and Design of Analog Circuits	E3
MATH2240	Probability and Statistics	E2

LEVEL 3 (Core 22 Credits)

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CORE COURSES		
BMNG3110	Biomedical Instrumentation II	E3
ECNG3020	Capstone Project	C6
ECNG3021	Introduction to Engineering Management and Accounting System	E4
ELET3460	Digital Signal and Image Processing	E3
PHYS3391	Biomedical Optics and Biomechanics	E3
PHYS3397	Medical Radiation Physics and Imaging	E3
ELECTIVES (select any two) — 6 Credits		
MDSC3104	Health Services Management	E3
MGMT3136	Venture Capital and Entrepreneurship	C3
BMNG3230	Clinical Engineering	E3
BMNG3240	Rehabilitation Engineering and Design	E3
ELECTIVE 1	Social Science (Level 2 or 3)	E3
ELECTIVE 2	Humanities (Level 2 or 3)	E3

3.2 BSc IN CIVIL ENGINEERING

Coordinator: Dr. Nicolas McMorris



Students are required to complete a minimum of 105 credits for the award of the BSc in Civil Engineering.

PROGRAMME STRUCTURE AND CONTENT

Note: E = Examination, C = Coursework, and the numeral after E or C = Number of Credits

LEVEL 1 (all courses are compulsory)

Semester 1: 18 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG1005	Science of Materials	E3
CVNG1009	Engineering Graphics	C3
ECNG1009	Introduction to Programming	C3
ELNG1101	Physics for Engineers	E3
ENGR1000	Introduction to Engineering	E3
ENGR1180	Engineering Mathematics I	E3

Semester 2: 20 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG1000	Mechanics of Solids	E3
CVNG1001	Mechanics of Fluids I	E3
CVNG1002	Civil Engineering Design I	C3
CVNG1007	Introduction to Geotechnical Engineering	C2
CVNG1008	Building Services Engineering	E4
CVNG1011	Geology	E3
CVNG1012	Civil Engineering Law	E2

LEVEL 2 (all courses are compulsory)

Year-Long Courses (Semesters 1 and 2): 7 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG2003	Civil Engineering Design II	C3
CVNG2006	Structural Design I	C4

Semester 1: 13 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG2001	Structural Mechanics	E3
CVNG2005	Mechanics of Fluids II	E3
CVNG2008	Soil Mechanics I	E2
GEOM2015	Geomatics for Civil & Environmental Engineers	E2
MATH2230	Engineering Mathematics II	E3

Semester 2: 12 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG2009	Soil Mechanics II	E2
CVNG2010	Civil Engineering Management	E3
CVNG2011	Engineering Hydrology	E3
MATH2240	Probability and Statistics	E2
GEOM2017	Geoinformatics for Civil & Environmental Engineers	E2

LEVEL 3

Year-Long (Semesters 1 & 2): 12 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG3014	Civil Engineering Design Project	C6
CVNG3015	Special Investigative Project	C6

Semester 1: 14 Credits

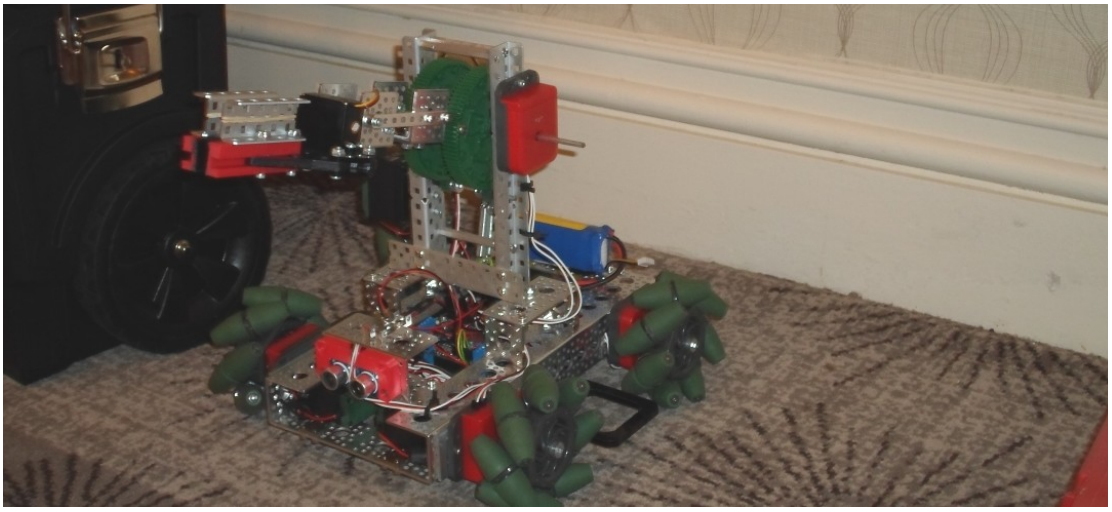
COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG3002	Structural Analysis	E3
CVNG3003	Structural Design II	C2
CVNG3005	Foundation Engineering	E3
CVNG3007	Environmental Engineering I	E3
CVNG3009	Highway Engineering	E3

Semester 2: 6 Credits (Select any two courses)

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG3008	Environmental Engineering II	E3
CVNG3010	Transportation Engineering	E3
CVNG3011	Pavement Design & Management	E3
CVNG3013	Coastal Engineering	E3

3.3 BSc in COMPUTER SYSTEMS ENGINEERING

Coordinators: Dr Ezra Mugisa and Mr Lindon Falconer



All Computer Systems Engineering students are required to complete a minimum of 105 credits for the award of the BSc in Computer Systems Engineering. The Foundation courses are not shown.

PROGRAMME STRUCTURE AND CONTENT

Note: E = Examination, C = Coursework, and the numeral after E or C = Number of Credits

LEVEL 1

Semester 1: 18 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
COMP1126	Introduction to Computing I	E3
COMP1127	Introduction to Computing II	E3
ELET1400	Introduction to Electronics	E3
ELNG1101	Physics for Engineers	E3
ENGR1000	Introduction to Engineering	E3
ENGR1180	Engineering Mathematics I	E3

Semester 2: 16 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
COMP1161	Object-Oriented Programming	E3
COMP1220	Computing and Society	E3
ECNG1000	Electrical Circuits	E3
ECNG1006	Laboratory and Projects 1	C3
ECNG1012	Engineering Science and Technology	C4

LEVEL 2

Semester 1: 18 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
COMP2101	Discrete Mathematics for Computer Science	E3
COMP2140	Software Engineering	E3
COMP2190	Net-Centric Computing	E3
ELET2430	Digital Circuits and Microprocessors	E3
ELET2450	Embedded Systems	E3
INFO2180	Dynamic Web Development I	E3

Semester 2: 11 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
COMP2111	Analysis of Algorithms	E3
COMP2130	Systems Programming	E3
ELET2405*	Practices in Electronics Designs I	C3
MATH2240	Probability and Statistics	E2

* Special case will be made to offer ELET2405 in semester 2

Summer Course : 3 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
COMP3911	Internship in Computing	3

LEVEL 3 (31 credits)

Students taking Level 3 courses must register for all core courses and any two electives.

Year-Long (compulsory): 6 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG3020	Engineering Capstone Project	C6

Semester 1

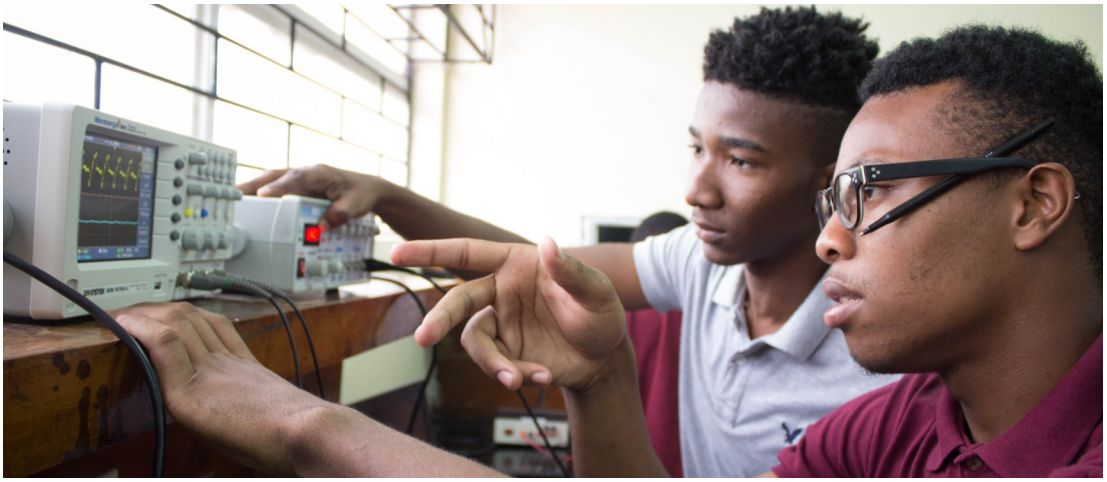
COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CORE COURSES		
COMP3101	Operating Systems	E3
COMP3191	Principles of Networks	E3
ECNG3021	Introduction to Engineering Management and Accounting Systems	E4
ELET 2460	Signals and Systems	E3
ELECTIVES (select one)		
INFO3155	Information Assurance and Security	E3
ELET3485	Introduction to Robotics	E3

Semester 2

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CORE COURSES		
COMP3801	Real Time Embedded Systems	E3
MGMT3136	New Venture Creation and Entrepreneurship	C3
ELECTIVES (select one)		
ECNG3016	Advanced Digital Electronics	E3
MATH2230	Engineering Mathematics II	E3

3.4 BSc in Electrical Power Engineering

Coordinator: Dr Paul Aiken



All Electrical Power Engineering students are required to complete a minimum of 101 credits for the award of the BSc in Electrical Power Engineering. The Foundation courses are not shown.

PROGRAMME STRUCTURE AND CONTENT

Note: E = Examination, C = Coursework, and the numeral after E or C = Number of Credits

LEVEL 1

Semester 1: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG1009	Introduction to Programming	C3
ELET1400	Introduction to Electronics	E3
ELNG1101	Physics for Engineers	E3
ENGR1000	Introduction to Engineering	E3
ENGR1180	Engineering Mathematics I	E3

Semester 2: 16 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
CVNG1001	Mechanics of Fluids I	E3
ECNG1000	Electrical Circuits	E3
ECNG1006	Laboratory & Project Design I	C3
ECNG1012	Engineering Science and Technology	C4
ECNG1015	Introduction to Electrical Energy Systems	E3

LEVEL 2

Semester 1 : 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG2000	Electromechanical Energy Conversion Systems	E3
ECNG2004	Laboratory & Project Design II	C3
ELET2450	Embedded Systems	E3
ELET2460	Signals and Systems	E3
MATH2230	Engineering Mathematics II	E3

Semester 2 : 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG2005	Laboratory & Project Design III	C3
ECNG2009	Control Systems	E3
ELET2410	Design and Analysis of Analogue Circuits	E3
EPNG2010	Nuclear Physics and Reactor Theory	E3
EPNG2020	Renewable Energy Systems	E3

LEVEL 3

Core Courses: 25 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG3013	Electrical Transmission and Distribution Systems	E3
ECNG3015	Industrial and Commercial Electrical Systems	E3
ECNG3020	Special Project (1 year)	C6
ECNG3021	Introduction to Engineering Management and Accounting Systems	E4
ELET3405	Practical Analysis of Advanced Circuits and Systems	E3
PHYS3385	Electromagnetism	E3
MGMT3136	Venture Capital and Entrepreneurship	E3

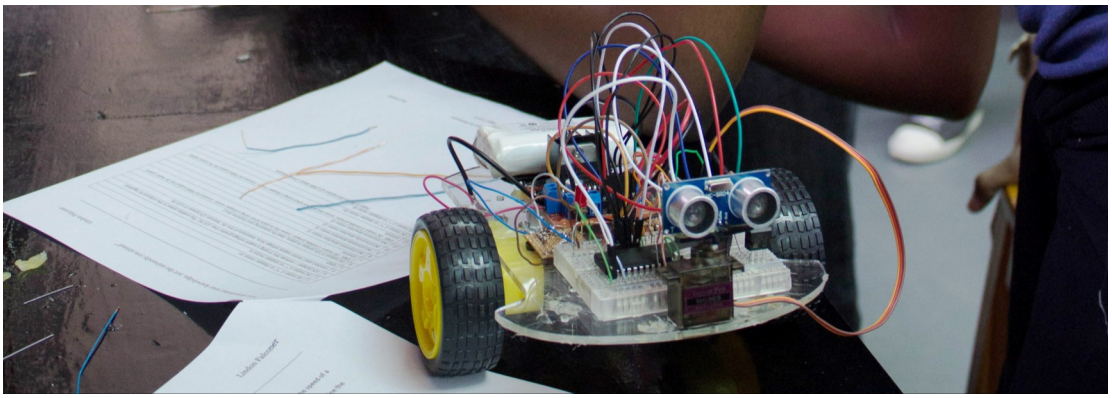
Electives: 6 Credit (Select any two courses)

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG3010	Electrical Machines & Drive	E3
ECNG3012	Power Systems Analysis	E3
ELNG3030	Power Electronics**	E3
EPNG3010	Nuclear Power Systems**	E3
EPNG3030	Integrating Electrical Power Systems	E3

** These two are available for 2017-18

3.5 BSc in ELECTRONICS ENGINEERING

Coordinators: Dr Paul Aiken and Mr Lindon Falconer



Students are required to complete a minimum of 101 credits for the award of the BSc in Electronics Engineering. The Foundation courses are not shown.

PROGRAMME STRUCTURE AND CONTENT

Note: E = Examination, C = Coursework, and the numeral after E or C = Number of Credits

LEVEL 1 (all courses compulsory)

Semester 1: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG1009	Introduction to Programming	C3
ELET1400	Introduction to Electronics	E3
ELNG1101	Physics for Engineers	E3
ENGR1000	Introduction to Engineering	E3
ENGR1180	Engineering Mathematics I	E3

Semester 2: 16 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
COMP1161	Object-Oriented Programming	E3
ECNG1000	Electrical Circuits	E3
ECNG1006	Laboratory & Project Design I	C3
ECNG1012	Engineering Science and Technology	C4
ECNG1015	Introduction to Electrical Energy Systems	E3

LEVEL 2 (all courses are compulsory)

Semester 1: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ELET2405	Practices in Electronics I	C3
ELET2430	Digital Circuits and Microprocessors	E3
ELET2450	Embedded Systems	E3
ELET2460	Signals and Systems	E3
MATH2230	Engineering Mathematics II	E3

Semester 2: 15 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG2009	Control Systems	E3
ELET2410	Analysis and Design of Analogue Circuits	E3
ELET2415	Practices in Electronics II	C3
ELET2420	Semiconductor Devices	E3
ELET2480	Modern Communications	E3

Summer Apprenticeship/Internship

- **Approved Industry (Summer between Level 2 and Level 3)**

  Summer Apprenticeship is meant to expose students to the practical applications of the concepts learnt in classes and is expected to be a source of motivation and inspiration. It also provides an opportunity to identify potential projects.

- **HEART NTA**

  Complete selected certification courses.

LEVEL 3

Students taking Level 3 courses must:

1. Register for all courses listed as compulsory and core (for chosen option).
2. Select one of the following options:
   a. Telecommunications or
   b. Industrial Instrumentation
3. Select a year-long project (ECNG3020) from the Project Listing.

YEAR-LONG (compulsory): 6 Credits

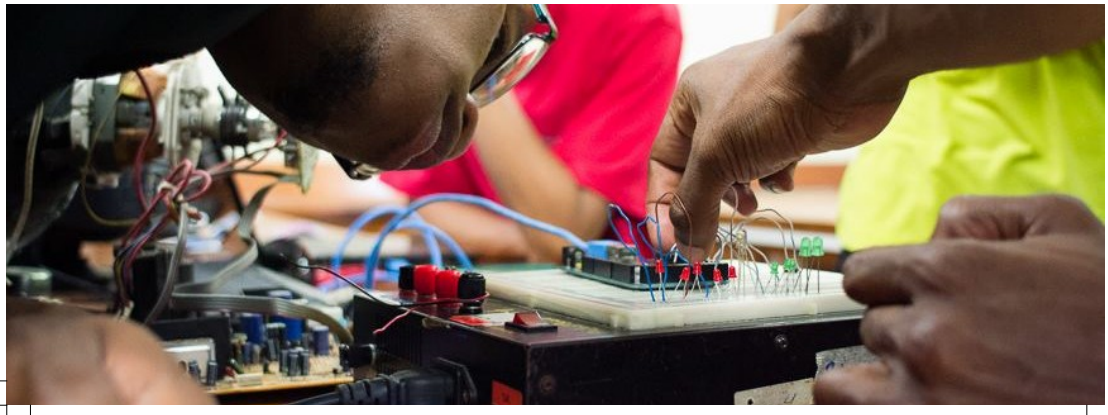
COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG3020	Special Project	C6

One Semester (compulsory): 13 Credits

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ECNG3021	Introduction to Engineering Management and Accounting Systems	E4
ELET3405	Practical Analysis of Advanced Electronics	C3
MGMT3136	Entrepreneurship and New Venture Creation	E3
PHYS3385	Electromagnetism	E3

Option 1: Telecommunications (compulsory) *(12 Credits)*

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ELET3460	Digital Signal and Image Processing	E3
ELET3470	Wireless Transmission & Fiber-Optics	E3
ELET3480	Wireless Communication Systems	E3
ELNG3050	Broadband Networks	E3

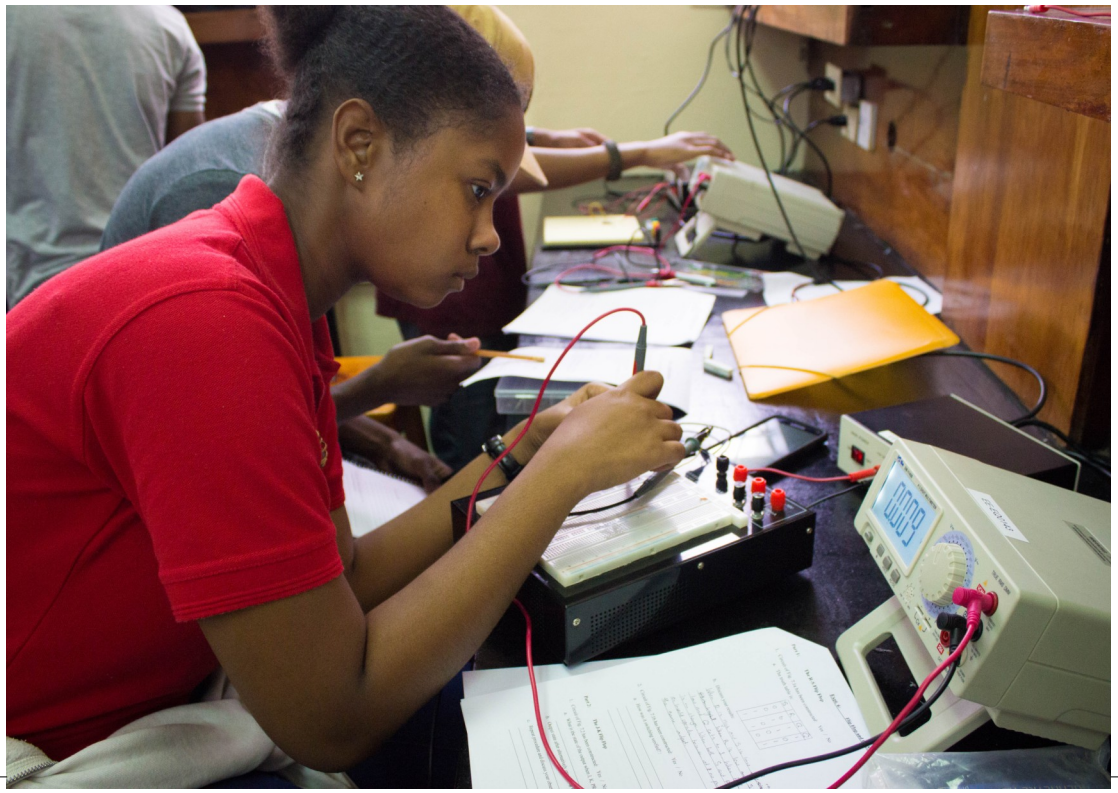


Option 2: Industrial Instrumentation (compulsory) *(12 Credits)*

COURSE CODE	COURSE TITLE	NUMBER OF CREDITS
ELET3430	Instrumentation and Measurements	E3
ELNG3030	Power Electronics and Protection Circuits	E3
ELNG3040	Industrial Automation	E3
ELNG3060	Power Plant Instrumentation	E3

Electives (3 credits)

Choose any other level 2 or level 3 course from FST or a language course from Faculty of Humanities and Education (FHE).



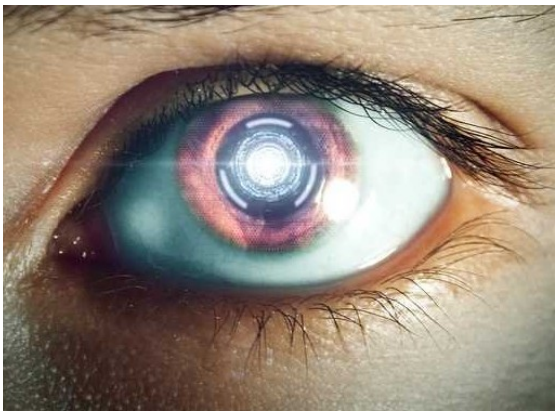
SECTION 4: COURSE DESCRIPTIONS

SEMESTER: **2**
COURSE CODE: **BMNG1210**
COURSE TITLE: **INTRODUCTION TO BIOMEDICAL ENGINEERING**
NUMBER OF CREDITS: **3**
Course Description: This course provides an introduction to biomedical engineering principles using foundational resources from molecular and cellular biology and physiology, and relating them to various subspecialties of biomedical engineering. The essential molecular biology, cellular biology, and human physiology background are included for students to understand the context in which biomedical engineers work. The course also highlights important advances made over recent years, including iPS cells, microRNA, Nano medicine, imaging technology, biosensors, and drug delivery systems, giving students a modern description of the various subfields of biomedical engineering. Further, this introductory course will provide concrete examples of applying engineering knowledge to solve problems related to human medicine as well as concrete examples of recent technological breakthroughs.

SEMESTER: **2**
COURSE CODE: **BMNG2210**
COURSE TITLE: **BIOMEDICAL INSTRUMENTATION I**
NUMBER OF CREDITS: **3**
Course Description: This course will expose the students to the basic principles of biomedical instrumentation and measurements employed in the health care industry. Emphasis will be placed on how the biological signals of human body can be acquired and used in a successful manner. This course is part 1 of a two-part course in biomedical instrumentation and will explore the operation and application of a range of medical equipment dealing with instrumentation techniques for measuring common physiological signals, including bioelectric and biochemical sensors bio-stimulation, electronic circuit design issues, digital signal acquisition, electrical safety, signal conditioning and protection against noise. The practical work required in the use, servicing and maintenance of these instruments/equipment will be explored in ECNG2005 Laboratory and Project III.

SEMESTER:
COURSE CODE: **BMNG3110**
COURSE TITLE: **BIOMEDICAL INSTRUMENTATION II**
NUMBER OF CREDITS: **3**
Course Description: This course This course covers the advanced principles, concepts, and operations of medical sensors and devices. The origin and nature of measurable physiological signals are studied, including chemical, electrochemical, optical, and electromagnetic signals. The principles and devices used to make the measurements, including design of electronic instrumentation, will be rigorously presented. This course will cover emerging frontiers of general diagnostics, including Electrophysical methods like ECG, EEG, EMG, defibrillator and pacemaker; imaging techniques: X-rays, nuclear medicine, ultrasound, and magnetic resonance. Supporting instrumentation such as incubators, respirators, anaesthesia and dialysis machines. Surgical techniques with diathermy and laser.

SEMESTER:
COURSE CODE: **BMNG3230**
COURSE TITLE: **CLINICAL ENGINEERING**
NUMBER OF CREDITS: **3**
Course Description: This course covers the critical issues relating to the risk management and implementation of new technologies in the healthcare sector. It represents a comprehensive summary of the advances in clinical engineering and presents guidance on compliance and safety for hospitals and engineering teams. Students will solve common problems in the area of healthcare technology. Topics include compliance with the European Directive on Medical Devices 93/42/EEC, European Norms EN 60601-1-6, EN 62366, and the American Standards ANSI/AAMI HE75: 2009. Content coverage includes decision support systems, clinical complex systems, and human factor engineering. Examples are fully supported with case studies, and global perspective is maintained throughout. The course emphasizes how to assess new



healthcare technologies and what are the most critical issues in their management, and provides information on how to carry out risk analysis for new technological systems or medical software. Various tactics on how to improve the quality and usability of medical devices will be explored .

SEMESTER:
COURSE CODE: **BMNG3240**
COURSE TITLE: **REHABILITATION ENGINEERING AND DESIGN**
NUMBER OF CREDITS: **3**
Course Description: This course introduces the fundamentals and applications of rehabilitation engineering and assistive technologies (ATs). It is an introduction to a field of engineering dedicated to improving the lives of people with disabilities. A range of disabilities and assistive technologies will be investigated. The course will examine the three basic approaches of assistive technologies and rehabilitation engineering, namely: design for use by the broadest possible population, design for subpopulations, and design for the individual. The relationship between engineering innovation, the engineering design process, the human-technology interface, and the physical medicine and rehabilitation medical community will be explored. The course highlights the models for AT service delivery, the design tools and principles of universal design, and various technology-transfer mechanisms, models, and principles. It explains the process for creating assistive device standards, followed by a review of seating biomechanics and soft tissue biomechanics, followed by the design and service delivery principles of wheelchairs and scooters, functional electrical stimulation and its applications, wheelchair-accessible transportation legislation, and the applications of robotics in medical rehabilitation. Prosthetic and orthotic design and usage, visual and hearing impairment, and augmentative and alternative communication (AAC) technology are also discussed .

SEMESTER: **1**
COURSE CODE: **COMP1126**
COURSE TITLE: **INTRODUCTION TO COMPUTING I**
NUMBER OF CREDITS: **3**
Course Description: The style of programming used is functional, and the language used is Python. The choices of programming style and language are intended to encourage students to think about solutions to problems in terms of the requirements of those solutions, rather than the mechanics of how to fulfill them. This entry level course into both the Computing sub-disciplines of Computer Science and Information Technology leans more towards the functional-first approach although basic concepts of Object- Oriented Programming are introduced. It is a first programming course and focuses attention on basic programming concepts (such as computation, function, operation) and structures (such as basic and structured data, procedures).

SEMESTER: **1**
COURSE CODE: **COMP1127**
COURSE TITLE: **INTRODUCTION TO COMPUTING II**
NUMBER OF CREDITS: **3**
Course Description: The primary goal of the course is to introduce students to the big ideas in Computer Science, and how they are used to control the complexity of developing large computational systems. In this course, recognizing patterns of problem solving is more important than the efficiency of the solutions themselves. An interpreted language is used to facilitate rapid feedback to the student as she experiments with proposed solutions to a problem. We hope that this mode of interaction will build confidence in students as they learn the joys and challenges of programming. This course continues the entry level course COMP1126. It covers concepts and tools that are essential in strengthening the learning of programming. These include data structures and higher order functions.

SEMESTER: **2**
COURSE CODE: **COMP1161**
COURSE TITLE: **OBJECT-ORIENTED PROGRAMMING**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ECNG1009**
Course Description: Class of objects; methods; members; message passing; encapsulation and information hiding; separation of behavior and implementation. Imperative control structures, assignment state, parameter passing models. Inheritance; polymorphism; class hierarchies. Interface vs. multiple inheritance. Templates/ generics. Using APIs; class libraries. Module/ packages; name space solution; primitive types; array, string processing; I/O processing; pointers and references; linked structures; strategies for choosing the right data. Collection classes and iteration protocols; event -driven and concurrent programming; exception handling; Introduction to GUI programming; thread programming. OO testing; debugging tools. Object-Oriented Methods: analysis and design, design for re-use; modeling tools, comparison of OOD and top-down/bottom-up design; intro to the concept and use of design patterns.

SEMESTER: **1**
COURSE CODE: **COMP2101**
COURSE TITLE: **DISCRETE MATHEMATICS FOR COMPUTER SCIENCE**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP1125 and COMP1160**
Course Description*:* Background, Asymptotic Analysis, Limits Orders of Growth Counting Permutations Combinations Inclusion-exclusion principle Elementary Probability Theory Counting in event space Probability Tree Bernoulli distribution Geometric distribution Binomial distribution Poison distribution Elementary Number Theory Modular Arithmetic Chinese Remainder Theorem Groups formed from Z modulo a prime Generating Functions and their Applications Convergence Properties Convolution Applications to: signal processing image compression solving linear recurrences probability theory error detection and correction Graph Theory Trees Planarity Spanning Trees Eulerian and Hamiltonian Cycles Colouring Matching.

SEMESTER: **2**
COURSE CODE: **COMP2111**
COURSE TITLE: **ANALYSIS OF ALGORITHMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP1125 and COMP1160**
Course Description: Recursive Data structures (lists and trees) and recursion as a Problem-solving tool. Divide and conquer algorithm. Solving recurrence equations, the Master Theorem. Heaps as implementations for priority queues. Sorting. Binary search trees, Red-Black trees. Dynamic programming (matrix multiplication, longest substring) Graphs. Selected algorithms from: Fast exponentiation, Euclid's algorithm, Discrete logarithm RSA cryptography. Matrix computations. Representation of and computation with polynomials. NP-completeness.

SEMESTER: **2**
COURSE CODE: **COMP2130**
COURSE TITLE: **SYSTEMS PROGRAMMING**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP1126, COMP1127 and COMP1161**
Course Description: This course teaches students how to become more effective programmers especially in dealing with issues of debugging, performance, portability, and robustness. Students will also learn how to read simple assembly code generated by a compiler in order to understand layout of functions, data, function calls, parameters, and simple programming for optimization of assembly code. The course covers data representation, machine-level code, computer arithmetic, elements of code compilation, performance evaluation and optimization, memory organization and management, and systems calls. Possible labs and projects include writing simple device drivers and writing simple programs that interface with peripherals.

SEMESTER: **1**
COURSE CODE: **COMP2140**
COURSE TITLE: **SOFTWARE ENGINEERING**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP1125 and COMP1160**
Course Description: Introduction to Software Engineering—Overview and relevance of Software Engineering. Professional and ethical responsibility. Process Models—Sequential, iterative/incremental and rescue-based paradigms. Process activities. Project

Management—Project planning, Project scheduling, Risk Analysis, Identification, analysis and planning. Software Requirements—Preparing software requirements document, Requirement elicitation, analysis and management. System models—Object-Oriented Software Design, System modeling using UML, CRC cards. Verification and Validation—Static and dynamic models Testing System and dynamic methods Test case design. Software Evolution: Software maintenance Evolution process.

SEMESTER: **1**
COURSE CODE: **COMP 2190**
COURSE TITLE: **NET-CENTRIC COMPUTING**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP1110, COMP1120, COMP1126, COMP1127 & COMP1161**

Course Description: The underlying principle of Net-Centric Computing is a distributed environment where applications and data are downloaded from servers and exchanged with peers across a network on as as-needed basis. This is in stark contrast to the use of powerful personal computers that rely primarily on local resources. The course will provide students with an understanding of the various technologies involved in developing systems and providing services in such distributed environments. It examines the protocols that underpin the interaction among the heterogeneous platforms, the services that are provided by combining various elements of these platforms and ways in which these end systems are presented. End users impose many requirements upon the systems and services they interact with and these requirements play an important role during development. Security is foremost among these requirements and as such, the course also exposes students to important aspects of secure systems development including cryptography, intrusion detection and malware detection. The course will also provide students with the opportunity to experiment with the knowledge they gain. They will be required to engage in weekly laboratory exercises using various tools and/or development environments, and demonstrate an understanding of the concepts by completing graded projects. Bi-weekly lectures and weekly tutorials provide the main avenue for the introduction and discussion of the material.

SEMESTER: **1**
COURSE CODE: **COMP3101**
COURSE TITLE: **OPERATING SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP2340**

Course Description: This course introduces the fundamentals of operating system design and implementation. The major components of an operating system - process management and resource scheduling, concurrency control, memory management, device management, file management, security, and the interrelations between these components are presented. Consideration is given to how design decisions can affect system performance. This course

covers the core body of knowledge in operating systems and other key aspects that the IEEE/ ACM Computing Curricula recommends for computing graduates, and the content and learning outcomes are informed by these guidelines. It also includes practical experience with an operating system at the system administration and system programming levels.

SEMESTER: **1**
COURSE CODE: **COMP3191**
COURSE TITLE: **PRINCIPLES OF COMPUTER NETWORKING**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP2140 and COMP2340**
Course Description: This course builds upon the introductory content that was presented in COMP2190 with an emphasis on computer networking, and covers the fundamental concepts underlying computer networks and the Internet. These concepts are examined from the viewpoints of the application, transport, network, and link and physical layers. This course also surveys the design trade-offs inherent in various communications protocols implemented at different networking layers.

SEMESTER: **1**
COURSE CODE: **COMP3801**
COURSE TITLE: **REAL TIME EMBEDDED SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP2190**
Course Description: Overview of Embedded Systems; Models of computation used in designing Embedded Systems: State Machines, State Charts, UML Specification of Embedded Systems; Hardware/Software Co-design Concepts; Organization of Embedded Systems; Embedded Inputs/Outputs: Characterization and Methods; Embedded Volatile and Non-Volatile memory dev ices; Fundamentals of Real-time theory; Scheduling executions of tasks; Real-time Synchronization and Implementation Challenges; HW/SW Architectures for real-time services; CPU architectural effects on Real-time performances; Architecture of existing embedded real-time OS: uClinux, uCOS, VxWorks, RTEMS, Windows CE.net, and ecos. Embedded Internet; Case studies: Applications of Embedded Systems in robotics, medicine and telecommunications; Development of software tools for Embedded Systems; Fault-tolerant Embedded Systems.

SEMESTER: **2**
COURSE CODE: **COMP3900**
COURSE TITLE: **CAPSTONE PROJECT**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP2111 and COMP2140 and 8 other credits from level 2 or 3 CS courses**
Course Description: Groups of 2-4 students implement a substantive software system under the supervision of a staff member. The software may address a problem in any domain, but must meet minimum standards of design and functionality, appropriate for a capstone course of a B.Sc. degree.

SEMESTER: **Summer**
COURSE CODE: **COMP3911**
COURSE TITLE: **INTERNSHIP IN COMPUTING I**
NUMBER OF CREDITS: **3**
PREREQUISITES: **PERMISSION FROM THE HEAD OF DEPARTMENT**
Course Description: This internship course will provide students an opportunity to develop a professional understanding of computing so that they are prepared for employment. During this course students will develop the ability to apply the concepts learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment. The course also provides an opportunity for students to develop positive work habits, to test aptitude for or interest in a selected field and ensures a natural transition to the highest level of professional preparation as a complement to the education/training goals of the department.

SEMESTER: **1**
COURSE CODE: **CVNG1000**
COURSE TITLE: **MECHANICS OF SOLIDS**
NUMBER OF CREDITS: **E3**
Course Description: Simple static forces, stress, strain. Hardness, impact & temperature effects. Two-dimensional stress and strain, torsion, combined stresses. Statically determinate beams and plane frames. Bending theory and moment, shearing, force, slope, deflexion, moment-area.

SEMESTER: **2**
COURSE CODE: **CVNG1001**
COURSE TITLE: **MECHANICS OF FLUIDS I**
NUMBER OF CREDITS: **E3**
Course Description: Physical properties of fluids — statics: pressure distribution, forces on plane and curved surfaces, floating stability. Kinematics: ideal and real fluid, streamlines, path lines, streak lines; graphical plotting of streamlines. Dynamics: continuity, momentum and energy equations for one-dimensional flow. Laminar and turbulent flow, flow in pipes, flow Measurements. Introduction to dimensional analysis. Dynamic similarity. Boundary layers. Pipe friction. Darcy Equation. Rotodynamic machines: selection; performance, cavitation.

SEMESTER: **2**
COURSE CODE: **CVNG1002**
COURSE TITLE: **CIVIL ENGINEERING DESIGN I**
NUMBER OF CREDITS: **C3**
Course Description: Concept of design and its contribution to the quality of life; Civil Engineering Design, the role of geomatics, the environment, and scientific laws in design; Introduction to the design of buildings and Civil Engineering Infrastructure, site appraisal; Risk and vulnerability in design; Health and safety in Civil Engineering Design, environmental impact assessment; Civil Engineering drawing, CAD techniques, introduction to GIS techniques. (Coursework)

SEMESTER: **1**
COURSE CODE: **CVNG1005**
COURSE TITLE: **SCIENCE OF MATERIALS**
NUMBER OF CREDITS: **E3**
Course Description: Fundamental structure, properties and behaviour of other major materials used in Civil Engineering; concrete, asphalt, timber, soil, rock, paints, polymers, adhesives, composite materials; Durability and deterioration; Hazardous materials, classification and handling ion; Hazardous materials, classification and handling.

SEMESTER: **2**
COURSE CODE: **CVNG1007**
COURSE TITLE: **INTRODUCTION TO GEOTECHNICAL ENGINEERING**
NUMBER OF CREDITS: **C2**
Course Description: The course starts with a general description of typical geotechnical works. The main issues and timescales for these works are discussed, and the roles and responsibilities of the geotechnical engineer working as part of an engineering team are discussed. The characterization of soil is introduced, in terms of particle sizes and shapes, plasticity, consistency, and strength. Some practical activities involved in the preparation of ground are described. The student is given an introduction to the design issues associated with all of the typical geotechnical works.

SEMESTER: **2**
COURSE CODE: **CVNG1008**
COURSE TITLE: **BUILDING SERVICES ENGINEERING**
NUMBER OF CREDITS: **E4**
Course Description: The course aims to provide an introduction to, and a basic understanding of the scientific principles underlying the major environmental issues related to the built environment. The module also incorporates knowledge of design techniques and issues relating to the internal 'indoor' environment.

SEMESTER: **1**
COURSE CODE: **CVNG1009**
COURSE TITLE: **ENGINEERING GRAPHICS**
NUMBER OF CREDITS: **C3**
Course Description: Sketching as communication of design ideas: types of drawings; components of drawing; drawing standards; plans, sections, elevations, perspectives, projections, isometrics; introduction to typical production drawings of Civil Engineering components; fundamentals of using AUTOCAD for civil engineering design drawings.

SEMESTER: **2**
COURSE CODE: **CVNG1010**
COURSE TITLE: **INFORMATION TECHNOLOGY FOR ENGINEERS**
NUMBER OF CREDITS: **E2**
Course Description: Numerical analysis methods – f(x)=0; integration; solutions of differential equations, introduction to computer programming – flow charts; algorithms; variables, types, storage, scope; sequence, branch, loop; graphical output; introduction to using MATLAB for numerical analysis.

SEMESTER: **2**
COURSE CODE: **CVNG1011**
COURSE TITLE: **GEOLOGY**
NUMBER OF CREDITS: **E3**
Course Description: Fundamental geology for Civil Engineers: The Rock Cycle Structure and geological history of the Earth, surface geological processes, structural geology, geologic maps and their interpretation. Engineering geology – topics and concepts: Principles of rock mechanics, engineering properties of rocks, the stability of slopes and cuttings, industrial rocks and minerals, hydrogeology, geotechnical investigation, engineering seismology, dams and reservoirs. Field trips, tutorial sessions.

SEMESTER: **2**
COURSE CODE: **CVNG1012**
COURSE TITLE: **CIVIL ENGINEERING LAW**
NUMBER OF CREDITS: **E2**
Course Description: An introduction to the different legal systems. The impact of law on the delivery of engineering goods and services; Law and the construction sector. The making of law and the courts; litigation. The elements of contract law and relation with the construction sector. Types of contracts; Different procurement systems; Standard form building contracts (specifications codes of practice; Standards, statutes and local government regulations); The elements of the Law of Tort, disputes and conflict resolution methods; professional associations, codes of ethics, professional liability; Construction claims; Different forms of business organizations; Business law and the company act; Health and safety legislation; Environmental law; Introduction to intellectual property; Confidentiality of information; Warranties and indemnity.; Introduction to international law.

SEMESTER: **1**
COURSE CODE: **CVNG2001**
COURSE TITLE: **STRUCTURAL MECHANICS**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **CVNG1000 MECHANICS OF SOLIDS**
Course Description: Introductory concepts, equilibrium and compatibility, statical determinacy; compatibility of deformations, flexibility method applied to simple flexural systems; analysis of beams (flexure, shear, thin-walled sections); compression members, strain energy and related theorems. Analysis of beams

(asymmetrical bending); simple plastic theory (hinges, mechanism, equilibrium diagram method, redistribution of bending moments, moment capacity, fundamental theorems of plastic collapse), approximate methods of analysis; influence lines for statically determinate systems.

SEMESTER: **YEAR-LONG**
COURSE CODE: **CVNG2003**
COURSE TITLE: **CIVIL ENGINEERING DESIGN II**
NUMBER OF CREDITS: **C3**
PREREQUISITES: **CVNG1002 CIVIL ENGINEERING DESIGN I**
Course Description: Innovation and creativity in conceptual design; sustainability; health and safety; investigative procedures. The use of analysis, synthesis and optimisation in design; project planning, networks and graphs. Design of embankments, dams; drainage design; route location and alignment design of roads; assessment of natural hazard impacts and environmental impacts. (Coursework)

SEMESTER: **1**
COURSE CODE: **CVNG2005**
COURSE TITLE: **MECHANICS OF FLUIDS II**
NUMBER OF CREDITS: **E3**
PREREQUISITE: **CVNG1001 MECHANICS OF FLUIDS I**
Course Description: Rotational and irrotational flow; potential flow. Euler and Navier-Stokes equations. Bernoulli theorem, Reynolds stresses, lift and drag, curved flow, vortices. Open channel flow, energy and momentum principles, critical depths, hydraulic jump, backwater curves, surges, resistance to flow, waves, model analysis, and sediment transport.

SEMESTER: **YEAR-LONG**
COURSE CODE: **CVNG2006**
COURSE TITLE: **STRUCTURAL DESIGN I**
NUMBER OF CREDITS: **C4**
PREREQUISITES: **CVNG1000 MECHANICS OF SOLIDS**
Course Description: Conceptual design of structures; structural design of steel, reinforced concrete, timber and masonry structures, use of construction materials in design. (Coursework)

SEMESTER: **1**
COURSE CODE: **CVNG2008**
COURSE TITLE: **SOIL MECHANICS I**
NUMBER OF CREDITS: **E2**
PREREQUISITE: **CVNG1007 INTRODUCTION TO GEOTECHNICAL ENGINEERING**
Course Description: Calculations for various different measures of particle packing and density are developed, culminating in Terzaghi's Fundamental Principle of Effective Stress. The theory of elasticity is applied to soils, and practical calculations are developed for short-term elastic settlements of various types of foundation. Concepts of different types and timescales for stress, deformations, and strength are developed. Terzaghi's Theory of Primary Consolidation is introduced.

SEMESTER: **2**
COURSE CODE: **CVNG2009**
COURSE TITLE: **SOIL MECHANICS II**
NUMBER OF CREDITS: **E2**
PREREQUISITE: **CVNG2008 SOIL MECHANICS II**
Course Description: Starting from the principles developed in the previous course Soil Mechanics 1, an introduction is presented to the procedures, stages, and approaches of a geotechnical job. After recalling Darcy's Law, calculations are developed for aquifers, pumping from wells, and more generally the flow of water through soils and its effects on compositional and mechanical stability. The ideas of limit equilibrium and mechanisms are introduced and used to analyze the stability of slopes. Some aspects of landslide stabilization and avoidance are also covered.

SEMESTER: **2**
COURSE CODE: **CVNG2010**
COURSE TITLE: **CIVIL ENGINEERING MANAGEMENT**
NUMBER OF CREDITS: **E3**
PREREQUISITE: **NONE**
Course Description: Introduction to management theory; human resource management, leadership, corporate strategy, communication, conduct of meetings; Management Information Systems (MIS); resolution of engineering ethics, Civil Engineering case studies, resources and reasoning methods; Civil Engineering project management, networks and graphs, quality management; Facilities Management, maintenance management, managing Health and Safety; Introduction to Management Accounting and Financial Management.

SEMESTER: **2**
COURSE CODE: **CVNG2011**
COURSE TITLE: **ENGINEERING HYDROLOGY**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **CVNG2005 MECHANICS OF FLUIDS II**
Course Description: The water resource system, meteorology, hydrologic cycle, hydro-meteorologic measurements and instrumentation, hydrologic statistics, rainfall and run-off, unit hydrographs, low flows, impoundment reservoirs, reservoir safety, groundwater flow, flow to wells, seawater intrusion, and contaminant transport.

SEMESTER: **1**
COURSE CODE: **CVNG3002**
COURSE TITLE: **STRUCTURAL ANALYSIS**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **CVNG2001 STRUCTURAL MECHANICS; CVNG2006 STRUCTURAL DESIGN I**
Course Description: Symmetry and anti-symmetry, indeterminacy, slope deflection, moment distribution, structural dynamics, stability, pre-stressed concrete, plates, combined bending and axial loads, arches, influence lines, suspension cables.

SEMESTER: **1**
COURSE CODE: **CVNG3003**
COURSE TITLE: **STRUCTURAL DESIGN II**
NUMBER OF CREDITS: **C2**
PREREQUISITES: **CVNG2001 STRUCTURAL MECHANICS; CVNG2006 STRUCTURAL DESIGN I**
Course Description: Computer modelling, hurricane resistant design, earthquake resistant design of concrete and steel moment frames, pre-stressed concrete. (Coursework)

SEMESTER: **1**
COURSE CODE: **CVNG3005**
COURSE TITLE: **FOUNDATION ENGINEERING**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **CVNG2008 SOIL MECHANICS; CVNG2009 SOIL MECHANICS II**
Course Description: Site investigations, bearing capacity and settlement, design of spread footings and rafts, pile foundations, sheet pile walls.

SEMESTER: **1**
COURSE CODE: **CVNG3007**
COURSE TITLE: **ENVIRONMENTAL ENGINEERING I**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **NONE**
Course Description: Environmental needs and priorities, pollution, the role of environmental engineering, water quality standards, unit operations in water treatment, sources of wastewater, wastewater quality and effluent standards, unit operations in wastewater treatment, on site treatment and disposal, stream purification processes, sources of solid wastes, treatment of solid and fecal wastes, control of leachates, recycling, environmental

impact assessment, soil conservation systems and mitigation of forest destruction.

SEMESTER: **2**
COURSE CODE: **CVNG3008**
COURSE TITLE: **ENVIRONMENTAL ENGINEERING II**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **CVNG3005 and CVNG3007**
Course Description: Water supply systems, wastewater collection and disposal systems, hydraulics of treatment plants, pumping stations, urban storm water drainage systems, industrial wastewater and pollutants, treatment systems for industrial and agricultural waste water, solid waste collection systems disaster mitigation, environmental engineering in the built environment.

SEMESTER: **1**
COURSE CODE: **CVNG3009**
COURSE TITLE: **HIGHWAY ENGINEERING**
NUMBER OF CREDITS: **E3**
PREREQUISITES: **MATH2230, MATH2240, CVNG2003, CVNG2009**
Course Description: Highway traffic characteristics, capacity of roadways and intersections, design of intersections, traffic management, parking studies; environmental impact, road safety; route location, economic analysis, introduction to transportation planning; pavement materials, pavement and drainage design; quality control and pavement maintenance management systems.

SEMESTER: **2**
COURSE CODE: **CVNG3010**
COURSE TITLE: **TRANSPORTATION ENGINEERING**
NUMBER OF CREDITS: **E3**
PREREQUISITE: **CVNG3009 HIGHWAY ENGINEERING**
Course Description: Transport policy, economics and mathematics; design operation and management of air, land and sea transportation systems; Transportation planning, Intelligent Transportation Systems (ITS), architecture design and management; Road safety management systems; managing the environmental impact of transportation.

SEMESTER: **2**
COURSE CODE: **CVNG3011**
COURSE TITLE: **PAVEMENT DESIGN & MANAGEMENT**
NUMBER OF CREDITS: **E3**
PREREQUISITE: **CVNG3009 HWY ENG**
Course Description: Roads and highways pavement design, airport runway design, seaports and special pavements, pavement management systems, road rehabilitation and maintenance.

SEMESTER: **2**
COURSE CODE: **CVNG3013**
COURSE TITLE: **COASTAL ENGINEERING**
NUMBER OF CREDITS: **E3**
PREREQUISITE: **CVNG2005 MECH OF FLUIDS II**
Course Description: Introduction to coastal zone management; The marine environment, coastal processes; Wave generation and propagation; Coastal sediment transport, sediment budget; Port and marine structures. Design of coastal defense works; Port-planning and management. Coastal pollution control, EIA and waste disposal in the coastal zone.

SEMESTER: **YEAR-LONG**
COURSE CODE: **CVNG3014**
COURSE TITLE: **CIVIL ENGINEERING DESIGN PROJECT**
NUMBER OF CREDITS: **C6**
PREREQUISITES: **NORMALLY ALL LEVEL 1 AND LEVEL 2 COURSES**
Course Description: The purpose of this course is to develop the student's ability in Civil Engineering Design as well as the ability to work in a team. The emphasis is on self -learning, creativity, design, understanding, project team working and communication skills, as well as

engineering judgment and problem solving. The project gives professional orientation to work in the final year by simulating as closely as is possible, the investigation and design works which are required for substantial Civil Engineering works and projects in the provision of buildings, lifeline facilities and Civil Engineering infrastructure. The integration of health and safety, and risk and vulnerability in the design process gives the student a complete outlook on the design process.

SEMESTER: **YEAR-LONG**
COURSE CODE: **CVNG3015**
COURSE TITLE: **SPECIAL INVESTIGATIVE PROJECT**
NUMBER OF CREDITS: **C6**
PREREQUISITES: **NORMALLY ALL LEVEL 1 AND LEVEL 2 COURSES**
Course Description: This course is a project-based one, designed to generate an investigative learning atmosphere. The project work is carried out year-long, engenders a sense of enquiry, research and verification in the student, and draws on the first two years of learning in the programme. The emphasis is on self-learning, creativity, understanding, communication skills, as well as on engineering analysis and problem solving. The projects are supervised by tutors from the Department of Civil & Environmental Engineering. Special permission may be sought to pursue a relevant engineering-based project in other Departments in the Faculty of Engineering.

SEMESTER: **1**
COURSE CODE: **ECNG1000**
COURSE TITLE: **ELECTRICAL CIRCUITS**
NUMBER OF CREDITS: **3**
Course Description: This course introduces students to the fundamental building blocks of electrical circuit theory. These include the basic electrical circuit analysis tools required to analyse the behaviour and functional as well as performance characteristics of electrical subsystems containing resistors, inductors and capacitors. These tools are applied to obtain both the full dynamic performance of circuits and the steady state performance of sinusoidal systems. Topics include: concepts of basic electrical quantities such as electric charge, current, voltage, power and energy; network theorems such as The venin's theorem, Norton's theorem, superposition and maximum power transfer; Laplace transform and the Laplace model; steady state and dynamic responses of simple networks; ac steady state analysis and the complex power model.

SEMESTER: **2**
COURSE CODE: **ECNG1006**
COURSE TITLE: **LABORATORY & PROJECT DESIGN I**
NUMBER OF CREDITS: **3**
PREREQUISITES: **NONE**
Course Description: This course is the first in a series of three Laboratory and Project Design courses. It consists of laboratory exercises to develop models for, and demonstrate the behaviour of energy storage devices operating under various conditions. The properties of energy storage devices would be utilised in a design project which is of use to industry. Students would be exposed to the recommended approach and procedure required to execute a design from a design brief, utilising project planning, time management and safe operating procedures. This course also includes a group project which aims to build team skills.

SEMESTER: **1**
COURSE CODE: **ECNG1009**
COURSE TITLE: **INTRODUCTION TO PROGRAMMING**
NUMBER OF CREDITS: **3**
Course Description: This course introduces students to the field of computing for the purpose of problem solving. Basic concepts of computer architecture and operating systems

are discussed leading to compilers and interrupters. Students will be able to describe and analyze data structures, such as those created by using arrays, lists and pointers. This course also involves knowledge of the concepts of loops and iteration techniques, and recursion, in algorithms which include character codes and mathematical operations such as base converters, masking and base arithmetic. The uses of algorithms are introduced for basic problem solving such as brute force/exhaustive methods, greedy methods and divide and conquer. Students are introduced to programming in C and C+ and the visual studio environment, along with data base concepts.

SEMESTER: **2**
COURSE CODE: **ECNG1012**
COURSE TITLE: **ENGINEERING SCIENCE AND TECHNOLOGY**
NUMBER OF CREDITS: **4**
Course Description: This is an introductory course in Engineering Science and consists of five modules to expose students to the following: the science of materials used in the production of electrical engineering components; an understanding of the mechanics of fluids when driven by electrical machines; the techniques involved in the production of engineering drawings, and the function and utilization of basic mechanical workshop tools and equipment. On the electrical side, students would be taught to use the oscilloscope, meters, power supplies and signal generators; verify network theorems; design simple circuits, and perform computer simulation on these circuits.

SEMESTER: **2**
COURSE CODE: **ECNG1015**
COURSE TITLE: **INTRODUCTION TO ELECTRICAL ENERGY SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **NONE**
Course Description: This course presents an introduction to Electrical Energy Systems. It is divided into two sections, introduction to the electromechanical energy conversion process and the analysis of three-phase electrical systems. In the first section, electromagnetic systems are analyzed utilizing the law of conservation of energy to develop mathematical models to represent energy conversions from electrical to magnetic and magnetic to mechanical. These mathematical models are used to develop equivalent circuits to represent the electrical, magnetic and mechanical systems. In the second section on three-phase electromagnetic systems, the analysis of these systems are performed by utilizing their electric and magnetic equivalent circuits to produce the vector voltage and current phasors associated with the electromagnetic system. These vector voltage and current phasors are used to analyse the system and deduce and improve its performance.

SEMESTER: **1**
COURSE CODE: **ECNG2000**
COURSE TITLE: **ELECTROMECHANICAL ENERGY CONVERSION SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ECNG1000 and ECNG1015**
Course Description: This course provides an introduction to the more common types of electrical machines for students, who, as engineers, will treat with electrical machines as a critical element of a system or subsystems. Electronic and mechanical drive systems, control systems and power systems depend on the functioning characteristics of electrical machines. This course will provide the depth necessary for students requiring a comprehensive understanding of the steady state behaviour of the basic electrical machines. The principles of operation, steady state analysis and application of four machines, in particular, will be discussed. These are transformers, three-phase induction motors, synchronous machines and DC machines.

SEMESTER: **1**
COURSE CODE: **ECNG2004**
COURSE TITLE: **LABORATORY & PROJECT DESIGN II**
NUMBER OF CREDITS: **3**
PREREQUISITES: **NONE**
Course Description: This course is the second in a series of Laboratory and Project Design courses. It consists of laboratory exercises to demonstrate the principles presented in ECNG1014 Digital Electronics and ECNG2012 Electronics and Instrumentation. The knowledge gained in these two courses, together with the principles demonstrated in the laboratory exercises would then be utilised in a project to design and fabricate an electronic system to meet quality, safety, and environmental

standards, and take industry performance parameter requirements and legal issues into consideration.

SEMESTER: **2**
COURSE CODE: **ECNG2005**
COURSE TITLE: **LABORATORY & PROJECT DESIGN III**
NUMBER OF CREDITS: **3**
PREREQUISITES: **NONE**
Course Description: This course is the last in a series of Laboratory and Project Design courses. It consists of laboratory exercises to demonstrate the principles presented in Communication Systems (ECNG 2001, Introduction to Microprocessors (ECNG 2006) and Control Systems (ECNG 2009).The knowledge gained in these courses, together with the principles demonstrated in the laboratory exercises would then be utilised in a project to design and fabricate a system to solve an industrial problem. The project must meet quality, safety, and environmental standards, and take industry performance parameter requirements and legal issues into consideration, while utilising project planning and time management techniques. This course also includes a group project, which builds team skills. This project aims to meet a socioeconomic need of a particular community.

SEMESTER: **2**
COURSE CODE: **ECNG2009**
COURSE TITLE: **CONTROL SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ENGR1180**
Course Description: The area of automatic control involves the use of procedures and strategies for forcing dynamic systems to behave in a specified fashion. We are all directly engaged in the control of dynamic systems on a continual basis – consciously or otherwise. For example, driving requires control of both direction and speed of an automobile; effective walking and running requires control of direction, speed and balance; our body systems control body parameters such as heart-rate, blood-pressure, temperature etc. with little conscious intervention This course uses what is termed the "classical or frequency domain" approach to control systems design. The techniques borrow heavily from the telecommunications industry of the early 1920's when engineers like Bode and others developed frequency response methods for solving problems encountered in the design of equalisers and amplifiers for long distance communication over the transatlantic cable. This course emphasises industrial application of theoretical concepts. Students require a good grasp of signals and systems theory as well as mathematics to successfully navigate this course.

SEMESTER**: 1**
COURSE CODE: **ECNG3013**
COURSE TITLE: **ELECTRICAL TRANSMISSION AND DISTRIBUTION SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ECNG3015**
Course Description: This is a 3 credit mandatory course for the students who opt for the Energy Systems option. The current energy systems offering focuses on the generation of the electricity and the general health of the system. This course addresses the void existing in the engineering analysis and the application of technology to the transmission and distribution area. The course is divided into 33 lecture and 6 tutorial one hour sessions. There will also be three research papers/projects and a mid-semester exam.

SEMESTER**: 2**
COURSE CODE: **ECNG3015**
COURSE TITLE: **INDUSTRIAL AND COMMERCIAL ELECTRICAL SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ECNG2000**
Course Description: This is a 3-credit compulsory course for all students in the Electrical and Computer Engineering Department. This course provides all the knowledge required to analyse an industrial power network from determination of the design ratings of equipment to the setting of protection relays. Human safety issues, in the handling of electrical equipment, are emphasised in all the topics covered. Topics delivered in the course are all linked as all topics depend on theory delivered in the previous topics. All topics are done by first delivering the required theory and then the application of the theory to a typical industrial design problem. This course is divided into 34 lecture and 5 tutorial sessions, each of one hour duration. Evaluation is done through 4 investigative laboratory experiments,

a maximum of 5 take-home assignments, a midterm exam and a final exam.

SEMESTER**: N/A (1 YEAR)**
COURSE CODE: **ECNG3020**
COURSE TITLE: **SPECIAL ENGINEERING PROJECT**
NUMBER OF CREDITS: **6**
PREREQUISITES: **ELET2405, ELET2415 and at LEVEL 3**

Course Description: This is the capstone course of the entire BSc Engineering Programme. The course is a student-driven, research and development project. Monthly seminars, intended to support the student in the research process are held and students are assessed by a final project submission and dissertation presentation. The course is year-long and counts for 6 credits and contributes 20% of the final weighted average used in the determination of honours. ECNG 3020 Special Project is designed to develop technical skills in the following areas: Design to specification; Formulation of creative solutions to engineering problems; Engineering analysis and enquiry; Validation and testing against benchmarks; Project management; Time management; and Communication. The course presents the opportunity to build upon the core of engineering skills gained in the earlier years and to broaden the scope of knowledge already gained. Project details are provided in a Project Handbook.

SEMESTER**: 1**
COURSE CODE: **ECNG3021**
COURSE TITLE: **INTRODUCTION TO ENGINEERING MANAGEMENT AND ACCOUNTING SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **at LEVEL 3**

Course Description: This course provides final year engineering students with a background in management and accounting skills to equip them to function in the business world. It provides a working understanding of the main elements of the successful planning, operation and control of industries and businesses as they relate to the following essential areas: Accounting and Finance; Management and Organizational Theory; Project Management, Production Planning and Control Techniques; and Introduction to Business Law. The course is loaded with examples of its applications in engineering firms and industries.

SEMESTER: **2**
COURSE CODE: **ELET1400**
COURSE TITLE: **INTRODUCTION TO ELECTRONICS**
NUMBER OF CREDITS: **3**

Course Description: Introduction to Semiconductor Theory and the P-N Junction: Review of the atomic structure and bonding; Energy level diagrams; Intrinsic and Extrinsic semiconductors; Electrical properties; the Fermi Dirac Distribution function; The P-N Junction and the diode; light emitting diodes (LED); The Bipolar Junction Transistor (BJT); the Field Effect transistor; Biasing the transistor circuit; DC Transistor circuits. Introduction to Digital Electronics: Analog and digital concepts; binary digits and logic levels; digital waveforms; logic gates and truth tables; Boolean algebra and logic simplification; DeMorgan's theorem; Circuit minimization; Terminologies used in logic designs; Combinational logic circuits: BCD; Latches, Flip-Flops; Memory circuits and devices; Simple programmable arrays: ADC and DAC Circuits. Introduction to Analog Electronics and Communication Systems: Introduction to alternating current (AC); Frequency dependent RLC circuits; Bandwidth and half-power. The Operational Amplifier and its applications; Fundamentals of analog and digital Communication Systems; Noise and its effect on communication systems.

SEMESTER: **1**
COURSE CODE: **ELET2405**
COURSE TITLE: **PRACTICES IN ELECTRONICS DESIGNS I**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101, ELET1400 and ELET1405**

Course Description: *Investigative labs (30%)*: Six lab exercises will be assigned that are consistent with the electronics courses that the student has undertaken for semester 1. A report of the results, analyses and discussions must be handed in at the end of each lab session. A *Design Project (70%):* An electronics design project based on the application of digital circuits and embedded systems will be assigned. In addition to working on their project during the assigned lab sessions, students are also expected to do the necessary background/ research work outside of classes. A complete project report and demonstration of prototype will be individually presented at the end of the semester.

SEMESTER: **2**
COURSE CODE: **ELET2410**
COURSE TITLE: **ANALYSIS AND DESIGN OF ANALOGUE CIRCUITS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ELET1400**
Course Description: The purpose of this course is to introduce the student to the fundamentals of the analysis and design of analogue circuits. It continues on the basic concepts of operational amplifiers, diodes and DC transistor circuits that were explored in ELET1400. Topics to be covered include circuit application of solid state devices to the designs of various diode and transistor circuits. The differential amplifier and its use in the design of operational amplifiers are discussed. The students are also introduced to the functional operation of commonly used linear ICs along with the basic concepts of oscillations. The course ends with some examples of data conversion circuits that demonstrate the operational relationships between analog and digital circuits. The use of manufacturers' data sheets for the design of analog circuits is an integral part of this course. The learning experience is enhanced with computer-based exercises and assignments. SPICE simulation tools will be used throughout this course.

SEMESTER: **2**
COURSE CODE: **ELET2415**
COURSE TITLE: **PRACTICES IN ELECTRONICS DESIGNS II**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101, ELET1400 AND ELET1405**
Course Description: *Investigative labs (30%)*: Six lab exercises will be assigned that are consistent with the electronics courses that the student has undertaken for semester 2. A report of the results, analyses and discussions must be handed in at the end of each lab session. A *Design Project (70%):* An electronics design project based on the application of analogue circuits and communication systems will be assigned. In addition to working on their project during the assigned lab sessions, students are also expected to do the necessary background/ research work outside of classes. A complete project report and demonstration of prototype will be individually presented at the end of the semester.

SEMESTER: **2**
COURSE CODE: **ELET2420**
COURSE TITLE: **SEMICONDUCTOR DEVICES**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ELET1400**
Course Description: This course provides the basic foundation for understanding electronic semiconductor devices and their circuit applications and limitations. It has introductory elements of quantum mechanics as a requirement for understanding the dynamics of the behaviour of charge carriers and energy distributions within a semiconductor lattice and across p-n junctions. As such, reasonably strong mathematical and electrical field theory backgrounds are required – as obtained from the prerequisites. The three fundamental areas of semiconductor devices; semiconductor theory, p-n junction devices and field effect devices, are adequately covered in this course. The learning experience is enhanced with computer-based exercises and assignments. Math lab and SPICE simulation tools will be used throughout this course.

SEMESTER: **1**
COURSE CODE: **ELET2430**
COURSE TITLE: **DIGITAL CIRCUITS AND MICROPROCESSORS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ELET1400**
Course Description: The main objective of this course is to familiarize students with digital circuits and systems and in particular, the internal designs and operations of microprocessors, including Reduced Instruction Set computers (RISC) and Complex Instruction Set Computers (CISC). The course starts with a review of Flip flops and its application to counters, shift registers, memory architectures and arrays, and state diagrams. Basic processor designs will be covered, including Sequential Logic and Memory Design. Having set a good foundation, advanced processing techniques such as Microprogramming, Cache Memory Management and an introduction to parallelism will be covered.

SEMESTER: **1**
COURSE CODE: **ELET2450**
COURSE TITLE: **EMBEDDED SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ELET1400**
Course Description: The goal of this course is to provide students with an understanding of the inner workings of embedded system solutions and the underlining technology, which include the development of circuits and embedded software programs. It exposes students to the structure and component of embedded controllers and the tools necessary for the development of embedded systems solutions. Students will also be exposed to the design and implementation processes of embedded system solutions. In addition, students will develop the skills necessary to construct circuits and design algorithms to interface devices such as modem, GPS receivers, LCD and other input/output devices with a microcontroller based embedded system.

SEMESTER: **1**
COURSE CODE: **ELET2460**
COURSE TITLE: **SIGNALS AND SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ELET1400**
Course Description: This course is concerned with predicting and analyzing the response of linear time invariant (LTI) systems when certain signals such as the unit impulse. The unit step and the sinusoid, are furnished as inputs. Transfer function models of LTI systems will be developed and analyzed using a number of powerful techniques based on the Laplace Transform and the Fourier Transform. These techniques will also be used extensively in other engineering courses, for example telecommunications, control systems and signal processing. To enhance the learning experience, MATLAB will be used to explore some of the concepts discussed and to verify some of the predictions.

SEMESTER: **2**
COURSE CODE: **ELET2480**
COURSE TITLE: **MODERN COMMUNICATION SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and ELET1400**
Course Description: This course seeks to familiarize students with the basic foundations of communications systems, covering the concepts from signal preparations, signal transmission, and signal reception of both digital and analog systems. It specifically deals with analog and digital modulation techniques, transmission of the signal across a carrier, and the acquisition and demodulation of these signals. This leads to an introduction to modern technologies such as wireless transmission, GNSS systems, cellular technology and GSM.

SEMESTER: **1**
COURSE CODE: **ELET3405**
COURSE TITLE: **PRACTICAL ANALYSIS OF ADVANCED ELECTRONIC CIRCUIT AND SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2405 and ELET2415**
Course Description: This course is divided into three main sections. Section 1 will run for the first 5 weeks of the semester and will expose students to general troubleshooting and problem solving techniques for advanced electronics circuits and systems. Sections 2 and 3 will run concurrently for the remainder of semester and are strongly focused on problem solving and effective troubleshooting of circuits and systems for telecommunication and for instrumentation and control, respectively. Manufacturers' datasheets, schematic diagrams, systems design specifications and operation and service manuals will be provided. Students are required to use this information along with their knowledge of electronic circuits and systems designs to implement effective repairs or redesigns. Although fixed 4-hour sessions are timetabled each week students are encouraged to use the open lab hours to work on their assigned weekly task. Students will be normally required to complete two sections - Section 1 and either Section 2 or Section 3 depending of their area of specialization (telecommunication or industrial automation).

SEMESTER: **1**
COURSE CODE: **ELET3430**
COURSE TITLE: **INSTRUMENTATION AND MEASUREMENTS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2410 and ELET2430 or ELET2460**
Course Description: In modern measurement processes, the parameter to be measured is sensed and converted to an electrical signal for processing and display. The apparatus and methods used to perform this task include the use of a wide range of transducers and conditioning circuits that are usually interface to computers for final signal processing and display. This course highlights this measurement process and the design and operation of the electronic circuit and systems that enable it. In depth analyses of the physics of the operation of sensors and their interfaces to analogue and digital electronic circuits will

be studied. Examples of Industrial measurement systems will be discussed with particular attention to their design details. Students will be exposed to the real world instrumentation and measurement system during their industrial case study sessions. This aspect of the course has proven to be very informative and eye-opening for the students creating high motivation levels and increased interest.

SEMESTER: **2**
COURSE CODE: **ELET3440**
COURSE TITLE: **INTRODUCTION TO ROBOTICS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2450 and ELET2430**
Course Description: This course introduces students to the field of robotics and its applications in today's technologically advanced society. In addition it covers the different components that constitute a robot, its operation and how it fits together to form a complete system. The course also investigates and discusses the use of robot technology in several areas of application. Specific topics covered include embedded controllers, sensors, actuators, wireless communication and mobile robots design and application.

SEMESTER: **2**
COURSE CODE: **ELET3450**
COURSE TITLE: **SATELLITE COMUNICATION & GNSS SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2480**
Course Description: This course is made up of two Sections: Section I, "*Satellite Communication*," introduces students to the fundamental communications principles behind current state-of-the-art satellite communications systems. Section II, "*Global Navigational Satellite Systems (GNSS),*" provides an overview of the principles of operation of satellite navigation systems with primary emphasis on the U.S. Global Positioning System (GPS).

SEMESTER: **1**
COURSE CODE: **ELET3460**
COURSE TITLE: **DIGITAL SIGNAL AND IMAGE PROCESSING**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2460**
Course Description: This course reviews the basics of DSP – building on the fundamentals taught in ELET2460 – before moving to more advanced concepts of signal processing. In the first part of the course the students will be taken through the processes required for digital filter design, starting with the basic methods and moving on to more sophisticated techniques. Digital imaging processing will be covered in the second module. The tools and techniques employed in basic image processing (compression and de-noising) will be addressed; this will provide the student with the capacity to grasp the more complex concepts and techniques employed in modern image processing applications. Given that DSP is essentially about the manipulation of real-world signals, the tools, techniques and approaches to problem-solving taught in this course can be applied in disparate fields, from telecommunications to medical imaging, video and audio processing for law enforcement, to investment banking.

SEMESTER: **1**
COURSE CODE: **ELET3470**
COURSE TITLE: **WAVE TRANSMISSION AND FIBER OPTICS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2480**
Course Description: This course starts with coverage of the basic background in electromagnetic theory that is required for understanding the behaviour of waves in various mediums. It continues with the fundamentals of wave propagation and waveguiding of all kinds; the essentials of propagation along optical fibers; and the concepts underlying integrated optics systems. It details the theoretical analyses of various transmission line including twisted wire pairs, coaxial cables, and traces on printed circuits boards. A study of antennas and their interfacing to transmission line is included. A thorough analysis is done on the theory of fiber optic and dielectric transmission medium with extended discussions on their practical application. Finally practical fiber optic

communication system, its signals and its components are studied.

SEMESTER: **1**
COURSE CODE: **ELET3480**
COURSE TITLE: **WIRELESS COMMUNICATION**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2480**
Course Description: This course offers a definitive professional's overview of wireless communications technology and system design. Virtually every important new wireless standard and technological development, including W-CDMA, cdma2000, UMTS, and UMC 136/EDGE; IEEE 802.11 and HIPERLAN WLANs; Bluetooth, LMDS, and more, have been reviewed. The technologies and applications that drive the development of 2G, 2.5G, and 3G systems are explored. An overview of the 4G technologies is presented.

SEMESTER: **1 and 2**
COURSE CODE: **ELNG1101**
COURSE TITLE: **PHYSICS FOR ENGINEERS**
NUMBER OF CREDITS: **3**
Course Description: This is calculus-based course covering the basic laws and phenomena in electricity and magnetism, oscillation and waves, rotational mechanics and modern Physics. It revises and expands on selected areas of the CAPE Physics content so as to reinforce and expand the student understanding of the fundamental concepts and their application to solving engineering problems.

SEMESTER: **1**
COURSE CODE: **ELNG3030**
COURSE TITLE: **POWER ELECTRONICS AND PROTECTION CIRCUITS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET2410 and ELET2420**
Course Description: Power electronics refers to control and conversion of electrical power from one form to another by power semiconductor devices that are usually operate as switches. This course offers a comprehensive coverage of power electronic devices and circuits. It provides a basic knowledge of circuitry for the control and conversion of electrical power with high efficiency. It begins with the introduction of power semiconductor devices, their basic operations and characteristics. The required semiconductor physics background would have been covered in ELET2420 (semiconductor devices) which is a prerequisite for this course. The application of these devices to the design of controlled rectifiers, inverters, choppers, cyclo-converters, and dual converter circuits are presented. Typical commercial and industrial applications along with their waveform analyses are also discussed. These converters can change and regulate the voltage, current, or power; dc-dc converters, ac-dc rectifiers, dc-ac inverters, and ac-ac cyclo-converters are in common use. Several low and high power applications are included. All high power circuits require some form of cooling and protection from over-current and/or over-voltages. The components, circuit design techniques and application of several cooling and protection circuits are presented.

SEMESTER: **1**
COURSE CODE: **ELNG3040**
COURSE TITLE: **INDUSTRIAL AUTOMATION**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ECNG2009 and ELET2450**
Course Description: This course provides the student with basic skills useful in identifying the concepts of automated machines and equipment and describes the terms and phrases associated with industrial automation. A range of automated control systems will be studied in depth with special emphasis on the use of ladder Logic and F- Logic for PLC programming. The industry standards and protocols are covered. The design and operation of distributed control systems (DCS) is emphasized. The methods of programming for the various automated controllers are an integral part of this course. Examples of automation in selected industries are discussed to highlight the various applications of the automated systems. The practical component for this class will be covered in the advanced electronics lab course.

SEMESTER: **2**
COURSE CODE: **ELNG3050**
COURSE TITLE: **WIRELESS BROADBAND NETWORKS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET3480**
Course Description: This course starts with a description of the latest techniques in block based transmission with strong emphasis on Orthogonal Frequency Division Multiplexing

(OFDM). Multiple input/output antennas systems with applications to ultra wideband systems are then analyzed. Access control and management to ensure quality data transmission is discussed. The introduction of WIMAX and LTE systems and standards are detailed as examples of 4G systems.

SEMESTER: **2**
COURSE CODE: **ELNG3060**
COURSE TITLE: **POWER PLANT INSTRUMENTATION**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELET3430, ELNG3030 and ELNG3040**
Course Description: This course provides a comprehensive study of the instruments that are used to measure and control the processes of electricity power generation. The student is first exposed to an in-depth analysis of the processes of controlling the generation of electricity from tradition fuel sources. This is followed by a study of the instrumentation and control aspects of alternative form of electricity generation. Special emphasis is made to sensitize students to the environmental impact of these systems. Design ethics and design for safety are embedded in this course. A Case study of specific application of instruments in the control processes of power plants is an integral part of this course.

SEMESTER: **1**
COURSE CODE: **ENGR0110**
COURSE TITLE: **PRE-ENGINEERING PHYSICS I**
NUMBER OF CREDITS: **3**
Course Description: This course is a pre-calculus-based physics course primarily intended for engineering students. It covers fundamental topics in mechanics, oscillations and heat, with emphasis on the study of forces, motion and the properties of matter and heat. This is the first of two introductory physics courses that revises and expands on selected areas of the high school physics and prepares the engineering student for more advanced topics in physics and engineering. Selected assignments and laboratory exercises are included and are designed to reinforce and expand the student understanding of the fundamental concepts and their application to solving engineering problems.

SEMESTER: **1**
COURSE CODE: **ENGR0120**
COURSE TITLE: **PRE-ENGINEERING MATHEMATICS I**
NUMBER OF CREDITS: **4**
Course Description: A practical introduction to the core mathematics required for engineering study and practice. Students will be led through basic geometry, algebra and pre-calculus to an introduction to calculus, and will cover topics in

algebra ranging from polynomial, rational, and exponential functions to conic sections. Trigonometry concepts such as Law of Sines and Cosines will be introduced. An introduction to probability and statistics is also be included. The mathematical theories will be explained in a straightforward manner, being supported by practical engineering examples and applications.

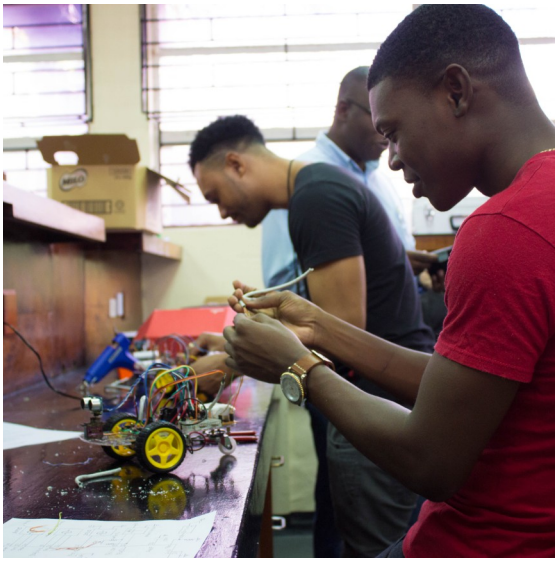
SEMESTER: **1**
COURSE CODE: **ENGR0130**
COURSE TITLE: **CHEMISTRY FOR ENGINEERS**
NUMBER OF CREDITS: **3**
Course Description: This course provides an introduction to chemistry that prepares students for further study in any engineering field. It offers a balance of conciseness, rigor, and depth needed to prepare students for more advanced coursework and careers in various engineering specialties, such as civil, environmental, electrical, computer, mechanical, and biomedical engineering. It elucidates the key concepts and skills important for entering engineering students, including problem solving, qualitative and quantitative thinking, and importance of units. It emphasizes the connection between molecular properties and observable physical properties and the connections between chemistry and other subjects studied by engineering students, such as mathematics and physics. Examples are drawn from problems of interest to modern engineers, including alternative energy, advanced materials, and the environment. Selected assignments and laboratory exercises are included and are designed to reinforce and expand the student understanding of the fundamental concepts and their application to solving engineering problems.

SEMESTER: **2**
COURSE CODE: **ENGR0150**
COURSE TITLE: **TECHNICAL COMMUNICATIONS**
NUMBER OF CREDITS: **2**
Course Description: This course will prepare students for any workplace writing situation. It offers a comprehensive introduction to the field while still delivering practical, effective support for students at every level. The course also includes the work of technical communicators in the context of today's highly collaborative, rapidly evolving digital practices. Fresh, social-media driven sample documents and coverage of the latest tools and technologies ensure that students work with the kinds of processes and products they will encounter on the job.

SEMESTER: **2**
COURSE CODE: **ENGR0210**
COURSE TITLE: **PRE-ENGINEERING PHYSICS II**
NUMBER OF CREDITS: **3**
Course Description: This course continues from the introduction of fundamental physics concepts in ENGR0110 to explore topics in electricity and magnetism, nuclear physics and optics. The fundamental theories of electromagnetism are used to describe the operation of electrical circuit components and measurements, and encompass the description and application of Coulomb's law, Faraday's law, Ohm's law, Kirchhoff's laws, Lenz's law to the electric and magnetic fields. The concept of light as an electromagnetic wave and its various manipulations are also studied. The course closes of with a basic introduction of nuclear model of the atom and the phenomenon of radioactivity. Selected assignments and laboratory exercises are included and are designed to reinforce and expand the student understanding of the fundamental concepts and their application to solving engineering problems.

SEMESTER: **2**
COURSE CODE: **ENGR0220**
COURSE TITLE: **PRE-ENGINEERING MATHEMATICS II**
NUMBER OF CREDITS: **4**
Course Description: This course will introduce students to the topics of differential and integral calculus. Emphasis is placed on concepts of limits and continuity, differentiation and integration and their applications to solving problems. Concepts in probability and statistics will be explored. The theoretical concepts will be supported by practical engineering examples and applications .

SEMESTER: **1**
COURSE CODE: **ENGR0230**
COURSE TITLE: **BIOLOGY FOR ENGINEERS**
NUMBER OF CREDITS: **3**
Course Description: This is an introductory course of biology for a student in the engineering discipline to develop their



engineering career in a bio-related field. The contents of the course include the basic knowledge of biological functions at the organ, tissue, cellular, and molecular level. It introduces students to modern biology with an emphasis on the evolution of biology as a multi-disciplinary field, to make them aware of the application of engineering principles in biology, and engineering robust solutions inspired by biological examples. This course is designed to convey the essentials of cell and molecular biology to provide a framework for more advanced courses.

SEMESTER: **2**
COURSE CODE: **ENGR0240**
COURSE TITLE: **COMPUTER APPLICATIONS FOR BEGINNER ENGINEERS**
NUMBER OF CREDITS: **2**
Course Description: This course introduces students to the fundamentals for computational analyses using Matlab and Excel. The focus of this course is on the fundamentals of engineering computing and involves algorithm development, selection of appropriate tools, documentation of solutions, and verification and interpretation of results. Students will be exposed to the characteristics of a procedure-oriented language, the representation of information, and an introduction to algorithms. Emphasis will be placed on the solution of characteristic problems arising in engineering. Selected assignments and laboratory exercises are included and are designed to reinforce and expand the student understanding of the fundamental concepts and their application to solving engineering problems.

SEMESTER: **1**
COURSE CODE: **ENGR1000**
COURSE TITLE: **INTRODUCTION TO ENGINEERING**
NUMBER OF CREDITS: **3**
Course Description: An introduction to the following: historical development of engineering; formation of the engineer; roles and functions of engineers and professional organizations; creative and critical thinking; technical communication; Ethics; liability; safety; legal forms of association; contracts, company law; intellectual property; engineering economics and business operations; infrastructure; energy systems and economics, environment and sustainable development; approaches to design. Field trips to local industries are an integral part of the course.

SEMESTER: **1**
COURSE CODE: **ENGR1180**
COURSE TITLE: **ENGINEERING MATHEMATICS I**
NUMBER OF CREDITS: **3**
Course Description: Vectors: plane and space vectors, dot and cross product, vector equations of lines and planes. Elementary linear algebra: geometric interpretation of linear equations, Gaussian elimination, definition of a vector space, span and subspace, basis, dimension. Matrices: transpose, determinants, rank and its application to linear systems, matrix inversion by cofactors. Series: partial sums, comparison and ratio tests, Maclaurin and Taylor series. Complex numbers: definition and properties, complex roots of a quadratic equation, complex numbers as vectors, modulus and argument, products and quotients, De Moivre's theorem, exponential form, hyperbolic functions, loci in the Argand diagram. Ordinary differential equations: definitions, direction fields, linear first order differential equations, separable differential equations, modeling with first order equations, exact equations, numerical approximations, homogeneous second order equations with constant coefficients, fundamental solutions, complex and repeated roots of the characteristic equation, reduction of order, method of undetermined coefficients.

SEMESTER: **2**
COURSE CODE: **EPNG2010**
COURSE TITLE: **NUCLEAR PHYSICS AND REACTOR THEORY**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101**
Course Description: This course introduces the basic concepts of atomic and nuclear physics, subatomic particles and the mechanisms involved in nuclear reactions. It establishes basic radiation safety principles and highlights the effects of radiation on the human body as well as introduces students to fundamental principles of nuclear reactor theory and operation.

SEMESTER: **2**
COURSE CODE: **EPNG2020**
COURSE TITLE: **RENEWABLE ENERGY SYSTEMS**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ECNG1000 and ELNG1101**
Course Description: This course covers all the technologies available to produce electrical energy from renewable sources, including solar, wind, hydro, geothermal and biomass. The physics governing the operation of these devices will presented combined with the engineering application of monitoring, controlling and connecting to the electrical grid. Students will do engineering calculations of power and energy availability of renewable energy sources and learn about requirements for integrating renewable energy sources into production, distribution and end-use systems.

SEMESTER: **1**
COURSE CODE: **GEOM2015**
COURSE TITLE: **GEOMATICS FOR CIVIL AND ENVIRONMENTAL ENGINEERS**
NUMBER OF CREDITS: **3**
PREREQUISITE: **NONE**
Course Description: Principles and field practice of Geomatics as applied to tasks in Civil and Environmental Engineering. Introduction to Geomatics; Measurement Basics. Leveling Techniques. Procedures and Applications. Distance and Angle Measurements. Adjustment of measurements. Traversing and Control Surveying; Volumetric Applications; Earthwork Applications; Profiles and Cross Sections; Construction Applications; Transportation Applications. Global navigation satellite systems (GNSS).

SEMESTER: **2**
COURSE CODE: **GEOM 2017**
COURSE TITLE: **GEOINFORMATICS FOR CIVIL & ENVIRONMENTAL ENGINEERS**
NUMBER OF CREDITS: **3**
PREREQUISITE: **NONE**
Course Description: The principles of Geoinformatics techniques and their applications for typical problems in Civil and Environmental Engineering. Basics of aerial and satellite imageries; extraction of graphical and numerical data. Integrated approach for addressing Civil and Environmental Engineering problems using Geoinformatics.

SEMESTER: **2**
COURSE CODE: **INFO2180**
COURSE TITLE: **DYNAMIC WEB DEVELOPMENT I**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP1126, COMP1127 and COMP1161**
Course Description: This course covers the foundations of the technologies that enable the creation of interactive websites that process and modify server-based data. This includes fundamental networking technologies, data representation for the web, web UI design and site design, client-server architecture and client-side and server-side programming. It covers the fundamentals of ecommerce, web security, ethical and social issues, and relevant software engineering concepts such as the three-tier architecture and frameworks for the web. It also provides an introduction to mobile web issues and web multimedia.

SEMESTER: **2**
COURSE CODE: **INFO3155**
COURSE TITLE: **INFORMATION ASSURANCE AND SECURITY**
NUMBER OF CREDITS: **3**
PREREQUISITES: **COMP2190 and (COMP2201 or INFO2100)**
Course Description: Building upon the concepts introduced in Net-Centric Computing, this course explores the security issues that every IT professional must be aware of. The course will inform the student on the various attack surfaces and defensive approaches that must be considered during all phases of life of an organisation's information technology assets. The course will also provide an opportunity for students to gain hands-on experience with the tools needed to protect an organisation from

the various forms of attack it can be subjected to.

SEMESTER: **2**
COURSE CODE: **MGMT3136**
COURSE TITLE: **ENTREPRENEURSHIP AND NEW VENTURE CREATION**
NUMBER OF CREDITS: **3**
PREREQUISITES: **at LELVEL 3**
Course Description: This course deals with one of the most challenging issues confronting developing countries. It focuses on understanding and appreciating the entrepreneurial mindset in relation to the ability to create new ventures successfully. The course also focuses on "intrapreneurship" or in the reinvigoration of existing enterprises with an attitude of innovation, responsiveness and receptivity to change, and it considers entrepreneurship in an international context.

SEMESTER: **1**
COURSE CODE: **MATH2230**
COURSE TITLE: **ENGINEERING MATHEMATICS II**
NUMBER OF CREDITS: **3**
PREREQUISITE: **ENGR1180**
Course Description: Vector calculus: parametric curves and arc length, review of partial differentiation, vector fields, line integrals and double integrals, Green's theorem, surface integrals, triple integrals and Divergence theorem. Laplace transforms: definition and existence of Laplace transforms, properties of Laplace transforms (linearity, inverse transform, shift formulae, Laplace transform of derivatives), applications and further properties of Laplace transforms (solving differential equations, convolution and integral equations, Dirac's delta function, differentiation of transforms, Gamma function). Fourier series: definitions, convergence, even and odd functions, half range expansions. Partial differential equations: definitions, heat equation (derivation, solution by separation of variables, insulated ends as boundary conditions, nonhomogeneous boundary conditions), wave equation (derivation, solution by separation of variables), Laplace's equation in Cartesian and polar coordinates.

SEMESTER: **2**
COURSE CODE: **MATH2240**
COURSE TITLE: **PROBABILITY AND STATISTICS**
NUMBER OF CREDITS: **2**
PREREQUISITE: **ENGR1180**
Course Description: Statistics and probability; frequency distribution, frequency polygons and histograms; introduction to probability; basic axioms; conditional probability, Bayes theorem, mutual independence; introduction to random variables; probability distribution, Bernoulli trials, the binomial distribution and the Poisson distribution; probability density and mass functions of a continuous random variable; expectation and variance; the exponential and normal distributions; distributions of sample means; point estimates; confidence intervals; statistical inference - tests of significance; linear regression.

SEMESTER: **2**
COURSE CODE: **PHYS3385**
COURSE TITLE: **ELECTROMAGNETISM**
NUMBER OF CREDITS: **3**
PREREQUISITES: **ELNG1101 and MATH2230**
Course Description: Derivation of Maxwell's equations in differential form. Equation of continuity. Poisson's equation. Derivation of the electro-magnetic wave equation. Solution for plane waves in dielectrics. Electro-magnetic nature of light. Energy flow and the Poynting vector. Boundary conditions. Reflection and refraction of electro-magnetic waves at dielectric boundaries. Derivation of Snell's law. Fresnel's equations. Total reflection. Brewster's angle. Transmission and reflection co-efficients. Propagation of electro-magnetic waves in conducting media. Skin depth. Energy flow in conductors. Reflection of Electro-magnetic waves by a conductor. Dispersion of electro-magnetic waves in various media. Sources of Electromagnetic waves.

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