



## PROGRAMMES IN BIOMEDICAL ENGINEERING

### DEPARTMENT OF HUMAN BIOLOGY

UCT Faculty of Health Sciences  
Anzio Road, Observatory 7935  
South Africa

Tel: +27 (0)21 406-6235

Fax: +27 (0)21 448-7226

*Academic co-ordinator:* **Dr Tania Douglas – [tania@ieee.org](mailto:tania@ieee.org)**

*Applications:*

<http://www.uct.ac.za/apply/applications/forms/>

*Enquiries about submitted applications:*

Postgraduate Office  
UCT Faculty of Health Sciences  
Private Bag X3  
Observatory 7935  
South Africa  
tel: +27 21 406-6751

*Financial assistance:* <http://www.uct.ac.za/apply/funding/postgraduate/applications/>

*Websites:*

UCT	<a href="http://www.uct.ac.za">http://www.uct.ac.za</a>
Biomedical Engineering	<a href="http://www.biomedeng.uct.ac.za/">http://www.biomedeng.uct.ac.za/</a>
Medical Imaging	<a href="http://www.miru.uct.ac.za">http://www.miru.uct.ac.za</a>

## FACULTY

### Associate Professors

TS Douglas, BSc(Eng) *Cape Town*, MS *Vanderbilt*, PhD *Strathclyde*  
EM Meintjes, BSc(Hons) MSc *Pietermaritzburg*, MS PhD *Oregon State*

### Senior Lecturers

DA Boonzaier, MBChB *Cape Town*, DIC *London*  
MAJ Poluta, BSc(Eng) *Witwatersrand*

### Lecturers

L John, BSc(Eng) *Natal*, PhD *Cape Town*  
NA Sachs, BS, MS, PhD *Southern California*  
B Spottiswoode, BScEng *Wits*, PhD *Cape Town*

### Scientific Officers

C Andrew, BSc(Eng) MSc *Cape Town*, PhD *TU Graz*  
S Krishnan, BTech *Regional Engineering College Calicut*, ME *Indian Institute of Science*, MS *Rensselaer*  
B Morgan, BSc MBChB *Wits*, PhD *Cape Town*

### Emeritus Professor

CL Vaughan, BSc(Hons) *Rhodes*, PhD *Iowa*

### Honorary Faculty

E Nunziata, LEE *Politecnico di Torino*, MBE *Ohio State*, MSc *London SHTM*  
S Parsons, BSc(Eng) *Cape Town*, MEng *Potchefstroom*, PhD *North-West*

## PROGRAMMES IN BIOMEDICAL ENGINEERING

### INTRODUCTION

To cater for the varying requirements of students entering the department, teaching is structured on a modular basis. This gives students a degree of latitude in tailoring their individual programmes to suit their backgrounds and needs. Postgraduate programmes may be followed which lead to the degrees and diploma shown in the table below. For each, the entrance qualification and typical duration is indicated.

- MSc(Med) in Biomedical Engineering
- M.Phil
- Postgraduate Diploma in Healthcare Technology Management
- PhD

### ENTRANCE REQUIREMENTS AND DURATION OF PROGRAMMES

Degree/Diploma awarded	Entrance Qualification	Duration, Months	
		Min <sup>2</sup>	Typ. <sup>1</sup>
- Postgraduate Diploma in Healthcare Technology Management	University Degree or equivalent	10	18
- M.Phil	MBChB or equivalent	12	18
- MSc(Med)	BSc(Eng), BSc(Hons) <sup>3</sup>	12 <sup>4</sup>	24
- PhD	Honours or Masters level	24	36

### NOTES

1. The durations shown are for programmes followed on a full-time basis. In special circumstances it may be possible for programmes to be followed on a part-time basis, as approved by the Department and the University.
2. The Postgraduate Diploma is a part-time programme requiring students to be on-site at certain times during the academic year.
3. A four-year degree in Engineering or an Honours degree in Mathematics, Physics or Computer Science is required.
4. Candidates for the MSc degree must have completed courses in Anatomy and Human Biology before beginning their degree or must take these courses as part of the degree. The minimum durations shown are for candidates who have already passed Anatomy and Human Biology.

### **MSc(MED) IN BIOMEDICAL ENGINEERING**

The Masters degree is awarded on the basis of a dissertation. The coursework during the first year is therefore regarded as preparation for the dissertation. The coursework consists of Anatomy, Human Biology, Introduction to Healthcare and at least one additional course chosen by the student in conjunction with their supervisor and the academic coordinator. The Head of Department may grant credit for equivalent courses that the student has already passed.

The topic for the dissertation must be chosen by the student. The preparation of the dissertation normally requires at least one academic year of full-time research. A supervisor will be appointed to oversee the project and the student will be required to provide regular progress reports. The student will be required to give oral progress reports to members of staff and fellow students.

### **MPhil (MASTER OF PHILOSOPHY) PROGRAMME**

The MPhil programme is open to students who have a minimum of an Honours degree or equivalent in a field related to the biomedical engineering sciences. Students begin work immediately on a dissertation as there are no prerequisite requirements for course credits.

In most cases, however, it is recommended that students complete one or more modules in conjunction with their dissertation to give them a thorough grounding in the subject they have chosen.

### **POSTGRADUATE DIPLOMA IN HEALTHCARE TECHNOLOGY MANAGEMENT**

The Diploma is a mixture of on-site and distance-learning. The curriculum consists of core and optional courses and a project.

Occasional students may register for individual courses, while Diploma students may accumulate credits towards the full Diploma, i.e. there are multiple entry and exit points to and from the Diploma.

### **PHD (DOCTOR OF PHILOSOPHY) PROGRAMME**

Candidates for the PhD programme must satisfy the general requirements of the Faculty of Health Sciences, as given in the Faculty Handbook ([http://www.uct.ac.za/downloads/uct.ac.za/apply/handbooks/fac\\_health\\_2010.pdf](http://www.uct.ac.za/downloads/uct.ac.za/apply/handbooks/fac_health_2010.pdf)).

The primary commitment is a thesis based on original research, which normally takes two or three years to complete.

### **COURSES OFFERED**

The following courses are offered as part of the MSc and Postgraduate Diploma programmes. MPhil and PhD students may be asked to attend/complete one or more of these courses as a foundation to their research work. Note that certain courses may not be offered if student numbers are too low.

Students registered for the MSc are required to complete the following pre-requisite courses in the first year, in preparation for the dissertation, and in order to be allowed to register for the second year:

HUB2022F, HUB2019F and HUB4014H; and either HUB4007F or HUB4045F

<i>Code</i>	<i>Title</i>
HUB2022F	Anatomy for Biomedical Engineering
HUB2019F	Introduction to Human Biology
HUB4007F	Biomechanics of the Musculoskeletal System
HUB4045F	Introduction to Medical Imaging and Image Processing
HUB4071S	Applied Electrophysiology
HUB4014H	Introduction to Healthcare
HUB4027H	Health Technology Assessment
HUB4028H	Healthcare Technology Planning and Acquisition
HUB4030H	Project Management
HUB4032H	Project in Healthcare Technology Management
HUB4033H	Clinical Engineering Practice
HUB4034H	Hospital Engineering Practice
HUB4036H	Healthcare Orientation
HUB4044H	Health Informatics & Management Information Systems
HUB4065H	Medical Devices & Instrumentation Overview
HUB4066H	Medical Device Innovation & Entrepreneurship
HUB4067H	Infection Control for Health Facilities
HUB4068H	Asset Management of Healthcare Technology & Infrastructure
HUB4069H	Health Facilities Design, Planning & Assessment

A description of the courses as well as their pre- and co-requisites follows.

## HUB2022F ANATOMY FOR BIOMEDICAL ENGINEERING

**Course convener:** G Louw

**Course outline:** A full course of lectures, tutorials and practicals extending over the whole year, with emphasis on practical work. The course includes all aspects of gross anatomy, neuroanatomy and selected topics in applied anatomy and histology.

## HUB2019F INTRODUCTION TO HUMAN BIOLOGY

**Course convener:** E Ojuka

**Course outline:** Physiology of body fluids and excitable tissues; nervous and endocrine systems; organ systems; general metabolism, homeostasis and thermoregulation.

## HUB4007F BIOMECHANICS OF THE MUSCULOSKELETAL SYSTEM

**Course convener:** N Sachs

**Prerequisites:** Mathematics II, Physics II or Applied Mathematics II or equivalent.

**Co-requisite:** Anatomy.

**Course outline:** Body segment parameters; joint forces and torques; kinematic and kinetic data collection; computer techniques of data acquisition and analysis; aspects of electromyography; introduction to muscle, joint and bone force optimisation techniques; rheology of bones, cartilage and collagenous tissues; fracture mechanics; joint lubrication and wear; properties of biomaterials; stress analysis; design of artificial joints; tissue response to implanted materials; implant failure analysis; biomechanics of human gait (walking and running) in health and disease.

## HUB4014H INTRODUCTION TO HEALTHCARE

**Course convener:** DA Boonzaier

**Co-requisites:** Anatomy, Physiology.

**Course outline:** Medical terminology; introduction to medical biochemistry; introduction to clinical engineering; systems analysis; organisation of healthcare; the side-issues of healthcare technology; internal medicine and treatment principles; physical diagnosis; surgery; intensive care; obstetrics; radiotherapy; cardiopulmonary physiology; clinical neurophysiology; clinical chemistry and haematology; clinical microbiology; immunology; blood and tissue transportation; diagnostic radiology and radiotherapy. The course includes invited lectures by relevant clinical departments and practicals/demonstrations in hospital departments which illustrate the applications of the principles introduced during lectures and seminars. Day visits to institutions involved in welfare and public health help broaden the perspective of students from the natural sciences.

## HUB4045F INTRODUCTION TO MEDICAL IMAGING AND IMAGE PROCESSING

**Course conveners:** TS Douglas, EM Meintjes

**Prerequisites:** Mathematics II, Physics II

**Course outline:** An introduction to the physics and engineering principles involved in the acquisition and processing of medical images. Contents: Mathematical Tools of Image Processing; X-ray imaging; Computed Tomography; Ultrasound; Magnetic Resonance Imaging.

## HUB4071S APPLIED ELECTROPHYSIOLOGY

**Course conveners:** N Sachs, L John

**Prerequisites:** Mathematics II and Physics II

**Course outline:** This course is intended to provide the basic principles for design and application of medical devices and instruments that interact with electrically excitable tissues (nerves and muscle) within the body. Topics include instrumentation and signal processing techniques relevant to ECG, EEG, EMG, EOG, pacemakers, defibrillators, auditory implants, retinal implants, and neuromuscular stimulators. The course will include lectures focusing on physiological and electrical theory and laboratory sessions focusing on application and design principles.

## HUB4027H HEALTH TECHNOLOGY ASSESSMENT

**Course convener:** MA Poluta

**Course outline:** Macro- and micro-assessment; assessment criteria and methods; cost-benefit, cost-effectiveness, cost-minimisation and cost-utility analysis; health status, health outcomes and impact analysis; international trends and data; evidence gathering and analysis; case studies.

#### **HUB4028H HEALTHCARE TECHNOLOGY PLANNING AND ACQUISITION**

**Course convener:** MA Poluta

**Course outline:** Technology life-cycles; technology innovation and application cycles; technology transfer; strategic planning; healthcare technology policy frameworks; health service packages; essential health technology packages; life-cycle costing; technology evaluation and options appraisal; tendering and procurement process; standardisation; information resources.

#### **HUB4030H PROJECT MANAGEMENT**

**Course convener:** MA Poluta

**Course outline:** This course underlines the importance of the project management approach in healthcare technology management interventions. Topics include: project definition, project teams, time scheduling, cost estimation and budgeting, project control, risk management, conflict management, project evaluation.

#### **HUB4032H PROJECT IN HEALTHCARE TECHNOLOGY MANAGEMENT**

**Course convener:** MA Poluta

**Course outline:** The research project is intended to consolidate the candidate's understanding of the course material through integrated application in a target environment (to be determined in consultation with the programme convener).

#### **HUB4033H CLINICAL ENGINEERING PRACTICE**

**Course convener:** GP Locke

**Course outline:** Definitions; basic concepts; asset management; risk management; safety (with a focus on electrical safety); standards; performance and cost indicators; quality assurance and accreditation; service models and resource requirements; organisation of technical services; regulation of medical devices, certification and other professional issues.

#### **HUB4034H HOSPITAL ENGINEERING PRACTICE**

**Course convener:** MA Poluta

**Course outline:** The course will cover the following areas: Air flow- and quality guidelines and standards. Best practice for medical gas installations - design and operation. Electrical power distribution design, including uninterruptible and standby power generation systems, and ensuring clean power for medical equipment. Steam generation and distribution; hot water reticulation; water storage and distribution. Control and energy efficiency techniques for engineering plant. Standards and guidelines for health facility finishes. Communications and internal transport systems. Maintenance strategies and related budgeting. Expenditure, prioritisation and resource-balancing. Space utilisation and service configurations – strategy and adaptation. Operations management and related information systems and indicators. Occupational safety legislation and its implications for health facilities.

#### **HUB4036H HEALTHCARE ORIENTATION**

**Course convener:** DA Boonzaier

**Course outline:** This course is highly recommended for those who have not had prior formal exposure to the health sciences. Topics include: functional anatomy, introduction to physiology and medical biochemistry, clinical specialities and procedures, disability, rehabilitation. Course includes visits to hospital departments and community institutions.

#### **HUB4044H HEALTH INFORMATICS & MANAGEMENT INFORMATION SYSTEMS**

**Course conveners:** MA Poluta and E Nunziata

**Course outline:** Use of health information; health and hospital information systems; database design; data storage and retrieval; clinical decision-making; telemedicine; expert systems; regulation and quality control of software; commonly used software packages.

#### **HUB4065H MEDICAL DEVICES & INSTRUMENTATION OVERVIEW**

**Course convener:** MA Poluta

**Course outline:** Medical device nomenclature and classification; design factors and generic models for medical instrumentation; generalised specifications; overview of commonly encountered diagnostic, monitoring & therapeutic medical equipment.

#### **HUB4066H MEDICAL DEVICE INNOVATION & ENTREPRENEURSHIP**

**Course convener:** MA Poluta

**Course outline:** New product management; commercial development of medical devices; human factors in equipment design; good manufacturing practice and quality assurance; reliability; product liability; regulatory systems; international standards; development for specialised markets.

#### **HUB4067H INFECTION CONTROL FOR HEALTH FACILITIES**

**Course convener:** MA Poluta, S Parsons

**Course outline:** This course will bring together a body of technical expertise common to the control of human airborne infections, including tuberculosis (including drug resistant strains), pandemic influenza, SARS, etc. Current and emerging control strategies applicable to preventing transmission in workplaces (including clinics, hospitals and laboratories) and congregate living settings will be covered; this includes air distribution designs for surgical and patient rooms, with emphasis on the necessary considerations for various diagnostic, treatment and support areas. The course will also address clean and bio-containment laboratory design, safety cabinet technology, testing of HEPA filtered systems and safe use of biological safety cabinets.

#### **HUB4068H ASSET MANAGEMENT OF HEALTHCARE TECHNOLOGY**

**Course convener:** MA Poluta

**Course outline:** The *Asset Management Guide* of the SA National Treasury defines Asset Management as the “process of guiding the acquisition, use, safeguarding and disposal of assets to make the most of their service delivery potential and manage the related risks and costs over their entire life”. Asset Management can also be viewed as a systematic and coordinated set of activities and practices through which an organisation optimally manages its physical assets and their associated performance, risks and expenditures over their life-cycles for the purpose of achieving its strategic plan. This course explores issues and provides solutions for proper asset management of healthcare technologies and infrastructure.

Course Contents include: The strategic imperative - stewardship and ownership issues. Needs-based planning and procurement. Life-cycle costing and Cost of Ownership. Maintenance and user support as part of asset management. Nomenclature systems and asset management information systems. Performance-, risk- and expenditure-related indicators. Audit and assessment methodologies.

#### **HUB4069H HEALTH FACILITY DESIGN, PLANNING & ASSESSMENT**

**Course convener:** MA Poluta

**Course outline:** The aim of the course modules will be to provide relevant skills to ensure a quality estate by developing expertise in strategic healthcare service and estate planning, with a focus on sound business approaches to health service delivery, sustainable estate development, project briefing tools, project leadership, evidence-based inclusive design and the healing environment. The course will cover assessment methodologies for the associated performance, risks and expenditure of a health facility over its life cycle for the purpose of achieving its strategic purpose. Course contents also include: Strategic, operational and replacement planning. Condition-based Assessment, Functional Assessment and Risk Assessments. Tools to assist with the evaluation of health service delivery and integrated resource management.

## SOME COMMONLY ASKED QUESTIONS

### ***Who should enrol in Biomedical Engineering?***

There are three groups of students who should consider joining our department. Please note that only postgraduate programmes are offered.

- 1) Engineers (mechanical, electrical, civil, chemical), as well as BSc(Hons) or equivalent graduates with a suitable mathematics and physics background are eligible for the MSc(Med) programme.
- 2) Medical graduates will be considered for the MPhil programme.
- 3) Candidates with a first degree (or the equivalent) are eligible for the postgraduate diploma.

### ***What are the career options and employment opportunities for our graduates?***

Biomedical Engineering graduates are usually involved in product assessment, design and development, as well as in basic and/or applied research. They may be employed by private companies, either full time or as consultants, or by large institutions such as hospitals, universities, statutory government departments (such as the Department of Health) or research organisations (the Medical Research Council or the Council for Scientific and Industrial Research). They may also return to their previous disciplines where they are able to apply their Biomedical Engineering knowledge in order to improve existing products or processes. Opportunities also exist in the field of sports medicine and biomechanics, rehabilitation engineering and product marketing.

Graduates of the healthcare technology management programme would typically work - either as employees or consultants - in the healthcare delivery sector, advising health service organisations on how to optimise healthcare technology interventions. Career possibilities also exist with international health and development organisations and agencies.

### ***What programmes are offered and what do they consist of?***

We offer programmes leading to a an MSc(Med) in Biomedical Engineering, an M.Phil, a PhD and a Postgraduate Diploma in Healthcare Technology Management. The MSc(Med) Biomedical Engineering is directed towards engineering graduates, but may also accommodate BSc(Hons) or equivalent graduates who have the necessary mathematical/physics skills. The programmes consist of the following:

- Postgraduate Diploma in HTM: coursework and a project
- MSc(Med): coursework including anatomy, human biology and a full dissertation
- MPhil: full dissertation (and possible courses at the discretion of the co-ordinator and the project supervisor)
- PhD: full thesis (and possible courses at the discretion of the co-ordinator and the project supervisor)

For the MSc programme, the coursework is usually completed in the first year. Students have the choice of a variety of subjects offered by the various groups within the department. These groups are active in a wide range of areas including rehabilitation, medical signal processing, image processing, biomechanics and healthcare technology management.

### ***Will I receive credit for undergraduate courses?***

Students who have completed courses in anatomy and physiology as part of their undergraduate degree may apply for exemption from these courses.

**Information about bursaries attached to particular projects may be obtained from the project leaders.**