



Department of Biomedical Engineering Faculty of Engineering

Undergraduate Module Descriptions

BN2001 Independent Study

Modular Credits: 4
Workload: 0-0-0-6-4
Pre-requisite: BIE Stage 2 standing
Preclusion: Nil
Cross listing: Nil

This module encourages students to become independent and self-motivated learners, and promote students' interest in research-based work. It consists of a series of laboratory-based projects or other academic prescriptions for the students' independent study. The academic scopes worked out between the student and the supervising faculty members.

BN2102 Bioengineering Data Analysis

Modular Credits: 4
Workload: 2-2-0-2-4
Pre-requisite: MA1506 Mathematics II
Preclusion: Nil
Cross listing: Nil

This course will introduce concepts relevant to the interpretation and statistical analysis of experimental results in the bioengineering field. Theoretical explanations will be followed by hands-on tutorials with relevant computational software. Students will learn how to perform some of the most commonly used statistical analysis of experiments (*e.g.*, *z* and *t* tests, ANOVA analysis) as well as to interpret the results of typical bioengineering experiments by building a suitably fitted mathematical model.

BN2103 Bioengineering Design Workshop

Modular Credits: 2
Workload: 1-1-0-2-1
Pre-requisite: Stage 1 & 2 Students
Preclusion: Nil
Cross listing: Nil

This course is a practical introduction to workshop practice and prototype creation in bioengineering design. Students will be introduced to workshop safety, risk assessment and standard operating procedures. They will get hands on experience with rapid prototyping equipment and techniques, and will learn how to use 3D CAD modelling to convert their design ideas into a realizable form.

BN2201 Quantitative Physiology for Bioengineers

Modular Credits: 4
Workload: 2-1-0.5-1.5-5
Pre-requisite: BIE Stage 2 standing
Preclusion: DY103 Physiology, LSM3212 Human Physiology, PY1105 Physiology I, PY1106 Physiology II Cross listing: Nil

This module provides students interested in bioengineering with a basic foundation in the physiology of the human body. In contrast to traditional physiology, engineering concepts will be used as a basis to explain and quantify physiological function. The goal of this module is to give students an overview of how the body functions from an engineering perspective in preparation for more advanced bioengineering modules. The major topics that will be covered are biotransport systems, bioenergy systems and biocontrol systems.

BN2202 Introduction to Biotransport

Modular Credits: 4
Workload: 2-1-0.5-1.5-5
Pre-requisite: MA1505 and MA1506
Preclusion: Nil
Cross listing: Nil

This module will present fundamental transport solutions which model the major features of biological flow. The conservation of mass, momentum, and energy in a system will be studied and applied to blood flows in the cardiovascular system. Basic knowledge of non-Newtonian fluid mechanics will also be covered. Bifurcation flow and Hemorheology in macrocirculation and microcirculation will be discussed. Mass transfer will be introduced to the students for applications in drug delivery, dialysis devices and bioreactors.

BN2203 Introduction to Bioengineering Design

Modular Credits: 4
Workload: 1.5-0.5-0-4-4
Pre-requisite(s): BIE Stage 2 standing
Preclusion(s): Nil
Cross-listing(s): Nil

This module introduces the students to the basic elements for design of medical devices through a hands-on design project performed in teams. Examples of engineering analysis and design are applied to representative topics in bioengineering, such as biomechanics, bioinstrumentation, biomaterials, biotechnology, and related areas. Topics include: identification of the technological needs, design methodology, evaluation of costs and benefits, quality of life and ethical considerations

BN3101 Biomedical Engineering Design

Modular Credits: 6
Workload: 2-1-0-6-6
Pre-requisite: BIE Stage 3 standing
Preclusion: Nil
Cross listing: Nil

Preparation of formal engineering reports on a series of engineering analysis and design problems illustrating methodology from various branches of applied mechanics as applied to bioengineering problems. Statistical analysis. A term project and oral presentation are required. Students are exposed to the entire design process: design problem definition, generation of a design specification, documentation, design review process, prototype fabrication, testing and calibration.

BN3201 Introduction to Biomechanics

Modular Credits: 4
Workload: 2.5-0.5-0.5-2-4
Pre-requisite: EG1109
Preclusion: Nil
Cross listing: Nil

The module aims to introduce students to the applications of engineering statics and dynamics to perform simple force analysis of the musculoskeletal system; give an appreciation of kinematics and kinetics of human motions; apply the fundamentals of strength of materials, i.e. stress and strain in biological systems, shear force, bending moment and torsion; introduce biomechanics of soft and hard tissues.

BN3301 Introduction to Biomaterials

Modular Credits: 4

Workload: 2.5-0.5-0.5-2-4

Pre-requisite: [CM1121 or CM1501 and LSM1101 or LSM1401 or MLE1101] or ML 3101

Preclusion: Nil

Cross listing: Nil

The objective of this module is to give students a strong materials science and engineering base to biomaterials engineering. The principles of materials science and engineering with particular attention to topics most relevant to biomedical engineering will be covered. This would include atomic structures, hard treatment, fundamental of corrosion, manufacturing processes and characterisation of materials. The structure-property relationships of metals, ceramics, polymers and composites as well as hard and soft tissues such as bone, teeth, cartilage, ligament, skin, muscle and vasculature will be described. Behaviour of materials in the physiological environment will be a focus. The target students are those who have no background in materials science and engineering but would like to study to biomaterials as a subject in bioengineering.

BN3401 Biomedical Electronics and Systems

Modular Credits: 4

Workload: 2-1-0.5-2-4.5

Pre-requisite: EE2009

Preclusions: Students from the Dept of Electrical and Computer Engineering

Cross listing: Nil

The module emphasizes the importance of real-time signal processing in medical instrumentation. The main topics covered are: physical principles governing the design and operation of instrumentation systems used in medicine and physiological research, application of modern signal processing techniques in medicine to improve the accuracy and the validity of medical diagnosis, and theory and application of advanced non-invasive imaging techniques used in modern medical diagnostics.

BN3402 Bio-Analytical Methods in Bioengineering

Modular Credits: 4

Workload: 2-1-1-3-3

Pre-requisite: (CM1121 or CM1501), and (LSM1101 or LSM1401) Preclusion:

Nil

Cross listing: Nil

The aim of the course is to give a theoretical and practical introduction into selected analytical methods for the characterization of biomaterials, tissues, biomolecules and immobilized biological molecules. The methods are focused to obtain: structural, topological (e.g. atomic force microscopy), chemical (e.g. spectrometry) and functional (e.g. surface plasmon resonance and bioassays) information for the characterization of biomolecules, biomaterials, tissues and biomodified materials.

BN3501 Biothermodynamics & Transport Processes

Modular Credits: 4

Workload: 2-1-0.5-2-4.5

Pre-requisite: MA1506, PC1432, CN2122 or ME2134 or BN2202

Preclusion: Nil

Cross listing: Nil

This module is designed to impart fundamental concepts of equilibrium thermodynamics and reaction kinetics that may be applied to the study of biological systems. The student is expected to acquire an understanding of the role of thermodynamic reasoning and kinetic analysis in providing a deeper insight into many biochemical and biophysical problems. The topics covered will include thermodynamic functions, chemical potential, chemical reaction and phase equilibria, multicomponent systems, electrochemical potential, solubility, ligand binding equilibria, calorimetry, enzyme kinetics, microbial fermentation, ligand binding kinetics.

BN4101R B.Eng. Dissertation

Modular Credits: 12 (normally over 2 semesters)
Workload: 0-0-0-0-15
Pre-requisite: Stage 4 standing
Preclusion: Nil
Cross listing: Nil

This module consists mainly of a research-based project carried out under the supervision of one or more faculty members. It introduces students to the basic methodology of research in the context of a problem of current research interest. The module is normally taken over two consecutive semesters.

BN4109 Special Topics in Bioengineering

Modular Credits: 4
Workload: 3-0.5-0-2-4.5
Pre-requisite: Stage 4 standing
Preclusion: Nil
Cross listing: Nil

The module comprises topical materials of a specialised nature that will not be taught on a regular basis. The requirements and syllabus will be specified as and when the module is offered

BN4201 Musculoskeletal Biomechanics

Modular Credits: 4
Workload: 3-0.5-0-2-4.5
Pre-requisite: BN3201
Preclusion: Nil
Cross listing: Nil

The module aims to provide an understanding of the relationship between structure and function in the musculoskeletal system; introduce quantitative and qualitative assessment of musculoskeletal tissues as in normal and pathological states; inculcate critical and constructive thinking to research current literature and explore the potential application in clinical environment. The major topics include mechanics properties of bone and musculoskeletal connective tissues; osteoporosis, aging and fracture risk prediction of whole bones; bone remodeling; forces and moments on human joints and bones for various activities; gait analysis and dynamics effects; orthopaedic implants; design of artificial hip and knee joints.

BN4202 Biofluid Dynamics

Modular Credits: 4
Workload: 3-0.5-0-2-4.5
Pre-requisite: Either CN2122 or ME2134 or BN2202
Preclusion: Nil
Cross listing: Nil

This module introduces fluid dynamic principles and their application in natural organs. Also studied are their substitutes, particularly the flow consideration in their design. Topics include: whole heart, intra-aortic balloon pump, blood pump, heart valve, blood substitutes, blood vessels, oxygenator, kidney, pancreas, liver. Special student projects involve the design of diagnostic and therapeutic instruments and devices for cardiovascular applications.

BN4203 Rehabilitation Engineering

Modular Credits: 4
Workload: 3-0.5-0-2-4.5
Pre-requisite: BN3201
Preclusion: Nil
Cross listing: Nil

The module aims to introduce students to different medical conditions, which demands rehabilitation engineer's attention. Conditions include neuromuscular disorders, congenital orthopaedic disorders, traumatic injuries, amputation, osteopathy and anthropathy. The students will learn engineering approaches to managing these conditions. Applying methods and materials to design and manufacture devices suited to individuals, in order to achieve functional recovery. The subject focuses on the latest technologies that have impacted the field of rehabilitation.

BN4301 Principles of Tissue Engineering

Modular Credits: 4
Workload: 2-0.5-1-2-4.5
Pre-requisite: BN3301
Preclusion: Nil
Cross listing: Nil

The module aims to provide the students with the background to understand and assess the currently applied basic principles of tissue engineering. Student would learn to (1) nurture an appreciation of how tissue engineering will influence health care in the next century, (2) acquire a basic understanding of the central principles of tissue engineering, (3) derive a working knowledge of how engineers can participate in tissue engineering research and commercial applications.

BN4402 Electrophysiology

Modular Credits: 4
Workload: 2-1.5-0-2-4.5
Pre-requisite: EG1108 or PC1432
Preclusion: Nil
Cross listing: Nil

This module aims to provide a basic foundation into the electrical biophysics of nerve and muscle; electrical conduction in excitable tissue, with an emphasis on neuroscience; quantitative models for nerve and muscle including the Hodgkin Huxley equations; biopotential mapping, cardiac electrophysiology, and functional electrical stimulation.

BN4403 Cellular Bioengineering

Modular Credits: 4
Workload: 3-1-0-2-4
Pre-requisite: LSM2103
Preclusion: Nil
Cross listing: Nil

A multidisciplinary module which describes the processes on a cellular level. It provides the link between molecular level biochemical and biophysical phenomena and the processes on the physiological level, where specifics of tissue and organs become important. Cellular mechanisms of solvent, noncharged solutes and ions transport through ion channels in relationship to bioelectric phenomena and cellular homeostasis will be described. The module explains how do the cells maintain their composition, structure and volume, how do they form membrane potential and how do they communicate and form the contacts in epithelium.

BN4404 Biomicroelectromechanical Systems-BioMEMs

Modular Credits: 4
Workload: 2-1-0-2-5
Pre-requisite: Stage 3 & 4 Engineering students
Preclusion: Nil
Cross listing: Nil

Students are advised to have fundamental knowledge in biochemistry and/or organic chemistry. This module is designed as an elective module to the bioengineering undergraduates. It will provide students with background and basic knowledge of bioMEMs and introduce some useful techniques as well. Students will have a basic understanding of the principles, current state and prospects of bioMEMs using what they have learned. The module will focus on major topics such as microfabrication technologies, micropatterning of biocompatible materials, microengineering of biomolecules, cells and tissues, biochips, biosensors, and the frontiers in bioMEMs.

BN4406 Biophotonics and Bioimaging

Modular Credits: 4
Workload: 2-1-0-2-5
Pre-requisite: EE2009
Preclusion: Nil
Cross listing: Nil

The purpose of this course is to introduce the principles of light-tissue interactions and frontier topics of biomedical optics and biophotonics techniques on biomedical diagnostics and therapy. The major topics covered are the fundamentals of lasers and optics in biomedicine, tissue optics, biospectroscopy, microscopy and imaging, and the development and applications of advanced biophotonics techniques in tissue diagnosis and treatment, and nanobiotechnology. Students will be able to grasp the important biophotonic concepts and instrumentation that are necessary for developing techniques and devices that use light to probe tissues and cells. The target students are bioengineering undergraduate and graduate major students.