B.Eng. (Bioengineering)

Description of courses

**Year 1 courses**

**BG1101 Introduction to Biomedical Engineering (2 AU)**

This course will contain series of lectures in the fields of biomedical engineering. The topics will include: Bioethics and regulatory issues, anatomy and physiology, biomechanics and rehabilitation engineering, biomaterials and tissue engineering, bioinstrumentations and biosensors, bio-signal processing and physiological modeling, bioelectric, bioinformatics and computational biology, bioimaging, and biomedical optics.

**PH1011 Physics (3 AU) / *PH1012 Physics A (4 AU)*

* Students without A-level Physics are required to take PH1012 Physics A (4AU)*


**BG1103 Chemistry for Engineers (3 AU)**

To learn general college chemistry at a fundamental level. To get introduction and reinforcement about physical chemistry, inorganic chemistry and organic chemistry. Inorganic and physical chemistry cover reaction kinetics, chemical equilibrium, ionic equilibrium, and electrochemistry, while organic chemistry covers organic compounds, their structures, properties, nomenclature, and applications.

**MH1810 Mathematics 1 (3 AU)**

In this course, the basic concepts of limits, differentiation, and integration are introduced. Applications of differential and integral calculus are included. In addition, the course also covers topics on complex numbers, vectors, and matrices to prepare students for other courses in Year 1.

Topics include: Complex numbers, vectors and matrices, limits and continuity of functions, derivatives, applications of derivatives, integration, integration methods, applications of integration.

**BG1105 Materials Science (3 AU)**

Materials Science is an interdisciplinary field where the properties of materials are related to its structure at the atomic, microscopic and macroscopic levels. Understanding this relationship helps us achieve the required combination of properties in a given material for specific functionalities and therefore applications. This is an introductory course where basic scientific concepts are evolved, from fundamental physics and chemistry, to the roles of atomic and micro/macroscopic structures on the properties of different type of materials. Important functional properties such as metallic, semiconducting, optical, magnetic, thermal and mechanical properties are covered in greater details. This course also includes the use of materials in Bioengineering.

**BG1117 Engineering Mathematics (4 AU)**

BG1109 Anatomy and Physiology (3 AU)
Overview of molecular basis, cellular, and organ level organization of the human body. Topics will include bones, joints, and muscular systems; nervous tissue and systems; blood, immune, and cardiovascular systems; endocrine system; respiratory system; digestive system; urinary system.

BG1131 Molecular Cell Biology for Biomedical Engineers (4 AU)
The course will cover the basic and functional aspects of cellular systems. Analysis of components and their functionality in cellular systems is included in this course. Students will also be exposed to aspects of biotechnology, genetic and metabolic engineering which play an increasingly important role in the new era of bioengineering.

BG1801 Bioengineering Lab 1A (1 AU)
Laboratory experiments and projects to provide practical application and understanding of theories relating to bioengineering.

The experiments include: (a) Titration of polyprotic acid, (b) Solubility product, (c) Wave, (d) Diffraction.

*The experiments listed are subject to change per AY.*

BG1802 Bioengineering Lab 1B (1 AU)
Laboratory experiments and projects to provide practical application and understanding of theories relating to bioengineering.

The experiments include: (a) Size exclusion, (b) Plasmid isolation, (c) Iodine thiosulfation, (d) Tensile testing.

*The experiments listed are subject to change per AY.*

HW0188 Engineering Communication I (2 AU)
This course covers basic academic literacy skills as well as written and oral communication skills for the field of engineering.

GC0001 Introduction to Sustainability- Multidisciplinary Approaches & Solution (1 AU)
This course is an introduction to sustainability presented in six modules by six different disciplines, as represented by NTU’s schools and centres. 1. The ecological basis of the natural environment from a regional and planetary perspective. 2. Key requirements and constraints for social development and survival, including energy, water, and the built environment. 3. The intersection of economic markets and financial systems, both from the perspective of driving growth and consumption, as well as playing a role as incentives for positive change. 4. The political economy framework of global and regional sustainability challenges. 5. The interaction and connectedness between the various single disciplines and themes.

ML0001 Absolute Basics for Career (1 AU)
In today's competitive world, it is essential that students learn the crucial career skills early to ensure a competitive edge sharpened with a heightened sense of workplace values and ethics. This course takes students through a journey of career discovery, understanding and polishing of oneself which will then be translated into job application tools such as resumes and interview skills. All students will have the opportunity to undergo a robust Career Assessment Tool, which assesses their career options and career self and helps them chart a career action plan. They will also learn how to identify and articulate the concept of personal branding and applying that to resumes and interviews and online social media. Students will also be exposed to the basics of grooming to ensure that they are aware of the importance of first impressions in all situations.
**Year 2 courses**

BG2104 Electronics for Biomedical Engineers (3 AU)

[Prerequisite: PH1011 or PH1012]

Fundamental of electronics devices and knowledge for design electronics circuits for biomedical applications. The topics include: Introduction to electronics, diodes, bipolar junction transistors (BJT), field effect transistor (FET), operational amplifiers.

BG2109 Biomechanics (3 AU)


BG2110 Bioelectricity (3 AU)

Man-made electronic circuits use electricity to process and transmit information. Biological organisms use electricity for the same purposes. Topics covered include the equivalent electrical circuit of cell membranes, the mechanisms responsible for generation of electrical spikes (action potentials) in excitable cells and qualitative modelling for this process, and bioelectrical phenomena in physiological processes such as vision, hearing, touch, muscle contraction, heart beating and thought.

BG2111 Computational Methods (4 AU)


BG2112 Cardiovascular Engineering (4 AU)

[Prerequisite: BG1117]


BG2131 Biomaterials (3 AU)

[Prerequisite: BG1105]

This is an introductory course to biomaterials. Basic properties of biomaterials. Biomaterial degradation, processing and biocompatibility. In vitro and in vivo testing. Inflammation and the immune response. Wound healing, thrombosis, tumorigenesis and calcification

BG2141 Mechanics of Materials (3 AU)

[Prerequisite: PH1011 or PH1012]


BG2142 Biological Thermodynamics (3 AU)

BG2801 Bioengineering Lab 2A (1 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to bioengineering.

The experiments include: (a) Series resonance, (b) Arithmetic circuits, (c) Anatomy & physiology, (d) Gene transformation.

*The experiments listed are subject to change per AY.*

BG2802 Bioengineering Lab 2B (1 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to bioengineering.

The experiments include: (a) Finite element analysis of deflection of bar (computing), (b) Analysis of cyclic fatigue failure data using least-squares regression (computing), (c) Patch clamp for single cell recording, (d) Evaluation of structure properties in ligament-bone system, (e) Heat treatment of steel, (f) Drug delivery.

*The experiments listed are subject to change per AY.*

HY0001 Ethics and Moral Reasoning (1 AU)

HY0001 will introduce students to three major ethical theories' utilitarianism, Kant's deontology, and virtue ethics. Then, four weeks will be devoted to teaching the ethical principles underlying academic integrity, research ethics, and intellectual property. Finally, students will discuss issues related to the ethics of environmental sustainability and conservation. All the while, students will be challenged apply the ethical theories learned to concrete moral problems, including world poverty, corporate accountability and whistleblowing, and workplace discrimination.

**Year 3 courses**

BG3102 Control in Biosystems (3 AU)

[Prerequisite: BG1117 and MH1810]

Introduction to biomedical control systems. Biomedical control system models. Static Analysis of biomedical control systems. Time domain analysis of biomedical control systems. Frequency domain analysis of biomedical control systems. Stability analysis of biomedical control systems. Control of biomedical systems.

BG3103 Signal Processing in Biosystems (3 AU)

Characteristics of the signal in biosystems. Usage of signal processing techniques in biomedical applications.

BG3104 Biomedical Imaging (3 AU)

This course introduces biomedical imaging at a fundamental level. Medical image processing techniques. X-ray imaging. Magnetic resonance imaging. Ultrasounds and ultrasonic imaging. Nuclear Imaging.

BG3105 Biomedical Instrumentation (3 AU)

This course introduces biomedical instruments and their working principles. Basic concepts of medical instrumentation. Basic sensors and transducers, amplifiers and signal processing. Basic physiology related to each measurement.
BG3801 Bioengineering Lab 3 (1 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to bioengineering.

The experiments include: (a) Orthopedic surgery, (b) MRI CT imaging, (c) Medical image processing, (d) ECG signals, (e) Electrocardiography, (f) Pulse oximetry (g) Electroencephalography, (h) Simulation control system.

*The experiments listed are subject to change per AY.*

### Year 4 courses

BG4103 Biomedical Project Design and Management (4 AU)

[Prerequisite: Year 4 standing]

Biomedical innovation process. Knowledge of project design and management. Patents, regulatory affairs and reimbursement schemes. Design selection and prototyping.

BG4102 Medical Device Design (3 AU)

[Prerequisite: BG3105]

This course introduces two software packages for prototyping shape and function of a medical device, and also teaches principles behind some medical devices being used in clinical setting. Students will use their creativity to finish their group project that uses both software skills and electronic circuit knowledge. Following items are included in lecture contents: 1. Sensors, signal amplifiers, and data acquisition 2. Pro/Engineer hands-on for 3D CAD 3. LabVIEW hands-on for instrument function prototyping 4. Cardiovascular device, blood flow probe, optical clinical devices, etc

BG4801 Final Year Project (8 AU)

Independent research project in a topic related to bioengineering.

BG0491 Engineers & Society (3 AU)

The course comprises 4 main topics: Evolution of Modern Singapore; Technology & Society: Ethics and Professionalism and The Environment. The students are made aware of ‘Current Issues’ at the time of their study.

HW0310 Professional Communication (2 AU)

[AY1617 will be the final year that it will be offered for AY13 matriculated students or earlier]

This course aims to equip students with the oral and written communication skills essential for functioning effectively in the workplace. Teaching and learning is conducted in the context of a globalised and constantly changing work environment with emphasis placed on flexibility and persuasiveness in communication. The focus is on written as well as oral professional communication.
**BIE electives (all 3 AUs unless otherwise stated)**

**BG4214 Biomedical Optics**

This course involves a fusion of optics and biological matter. The fundamental of light and the interactions between light and matter will be involved. The principle of laser and their current technologies in biomedical engineering will be discussed. Basic principles, operations and applications of biomedical imaging, such as optical coherence tomography are discussed in this course. The principle of optical fiber and the application in biomedical area such as endoscope is also given in this course. Introduction of the optics. Principle of optical spectroscopy. Principle of laser and its applications in biomedical areas. Principle of optical fiber and its applications in biomedical areas.

**BG4215 Biomedical Nanotechnology**

This course will explore the world of micro/nanotechnology for applications in biomedical engineering. Topics that will be covered are prospects of nanomedicine and its importance in medical diagnostics, pathways to molecular manufacturing, molecular transport, and nano-sensor for medical applications.

**BG4234 Stem Cell Fundamentals**

"Stemness" Definitions, Criteria, and Standards; Stem Cell R&D Related Regulations and Ethics; Fundamental Embryonic/Fetal/Adult Stem Cell Biology; and Applications and Application Perspectives of Stem Cells.

**BG4309 Tissue Engineering and Gene Therapy**

Tissue Engineering Part: Definitions of Tissue Engineering, Engineered Tissue, Engineered Therapeutics and Regenerative Medicine; Therapeutic Cells Delivery and Settlement for Tissue Engineering; Tissue Engineering Scaffolding with Functional Biomaterials; Tissue Engineering Strategy with Developmental Biology; Engineered/Native Tissue Integration; and Model/Clinical Applications and Evaluations of Engineered Tissues. Gene Therapy Part: Definitions of Gene Therapy and Genetic Therapeutics; Related Criteria, Standards, R&D Regulations and Ethics; Gene Delivery: Viral and Non-Viral Vectors; Therapeutic and Regenerative Remedies by Transfer of Genes and Antisense; and Applications and Application Perspectives of Gene Therapy.