

## **B.Eng. (Bioengineering)**

### **Description of courses**

#### **Year 1 courses**

##### **BG1102 Engineering Physics (3 AU)**

Electricity and magnetism. Geometrical and physical optics. Modern physics, covering photons, electrons and atoms, quantum mechanics and nuclear structure.

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

This course introduces general chemistry at a fundamental level. Physical chemistry: fundamentals of thermodynamics, kinetics, equilibrium and electrochemistry. General inorganic chemistry. Organic/polymeric chemistry fundamentals.

##### **BG1004 Mathematics 1 (3 AU)**

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)**

Introduction and significance of materials science, bonding between atoms. Building blocks of materials. Crystal defects and diffusion. Structural properties of materials. Functional properties of materials. Phases and microstructures. Applications to bioengineering.

##### **BG1106 Mathematics for Engineers A (3 AU)**

Modeling chemical and biomedical engineering systems. First order differential equations. Second order differential equations. Laplace transforms. Linear algebra. Eigenvalues and eigenvectors. Systems of first order differential equations.

##### **BG1107 Mathematics for Engineers B (3 AU)**

Partial differentiation. Multiple integrals. Vector algebra and vector calculus. Fourier series, integrals, and transforms. Partial differential equations.

##### **BG1108 Organic Chemistry and Spectrophotometry (3 AU)**

This course introduces organic chemistry and spectroscopy at a more intermediate level. Study main organic reactions. Mechanism of organic transformations. Spectroscopy of organic compounds.

##### **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 Biomolecular Engineering I (3 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.

##### **BG1802 Bioengineering Lab 1B (1 AU)**

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

##### **FE1011 Physics (3 AU)**

Vectors. Kinematics. Forces and torques. Newton's laws of motion. Impulse and momentum. Work and energy. Thermal physics. Electric field. Magnetic field. Motion of charged particles and applications. Circuits.

##### **HW0110 Effective Communication (2 AU)**

The communication process. Intrapersonal and interpersonal communication. Oral and written communication.

## Year 2 courses

### **BG2104 Electronics for Biomedical Engineers (3 AU)**

Fundamental of electronics devices and knowledge for design electronics circuits for biomedical applications.

### **BG2105 Biomolecular Engineering II (3 AU)**

This course covers fundamental concepts of biochemistry that are highly relevant to biomedical engineering. Analysis of the metabolic processes and pathways will be included in this course. This course will also introduce the mechanisms of cellular control and biophysical responses of the cell. Students will be exposed to aspects of biochemical, genetic, and metabolic engineering which play important roles in the new era of biomedical engineering.

### **BG2109 Biomechanics (3 AU)**

Biomechanics at different length scales. Mechanics of biomolecules. Mechanics of biomembranes and cells. Muscles and movement. Skeletal biomechanics. Terrestrial locomotion. Fracture fixation devices.

### **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 modeling for this process, and bioelectrical phenomena in physiological processes such as vision, hearing, touch, muscle contraction, heart beating and thought.

### **BG2111 Computational Methods in Biomedical Engineering (3 AU)**

Linear and non-linear algebraic equations. Least-squares regression and interpolation. Numerical differentiation and integration. Numerical solutions of ordinary differential equations (ODE).

### **BG2112 Bio-fluid Systems (4 AU)**

This course introduces fundamental fluid dynamics and its applications in biological systems. Hydrostatics and the conservation laws. Fluid dynamics and flow in pipes. Blood rheology and flow in circulation. Transport in biological systems.

### **BG2131 Biomaterials (3 AU)**

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)**

Fundamentals of statics. Concept of stress. Stress and strain. Axial loading. Torsion loading. Bending. Transformation of stress and strain. Deflection of beams.

### **BG2142 Biological Thermodynamics (3 AU)**

This course introduces fundamental thermodynamics and its applications in biological systems. Gas law and the laws of thermodynamics. Gibbs Free energy and thermodynamic relations. Biological applications of the Gibbs Free energy. Phase equilibria. Reaction Kinetics and mechanisms.

### **BG2801 Bioengineering Lab 2A (1 AU)**

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

### **BG2802 Bioengineering Lab 2B (1 AU)**

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

### **HW0210 Technical Communication (2 AU)**

Principles of technical communication. Conveying technical information in writing and orally. Types of technical reports. Technical writing style.

## Year 3 courses

### **BG3102 Control in Biosystems (3 AU)**

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.

### **BG3106 Advanced Bio-computational Methods (3 AU)**

Modelling biochemical systems: kinetic models for biochemical reaction networks, metabolic flux and control analysis, parameter estimation and Monte Carlo simulations. Biomolecular modelling: molecular mechanics, molecular dynamics, and applications to biomolecules.

### **BG3801 Bioengineering Lab 3 (1 AU)**

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

## **Year 4 courses**

### **BG4103 Biomedical Project Design and Management (3 AU)**

Knowledge for product design and management. Documentation and regulation for design product. Ethics for biomedical product design.

### **BG4801 Final Year Project (8 AU)**

Independent research project in a topic related to bioengineering.

### **BG4901 Engineers & Society (3 AU)**

Evolution of modern Singapore. Technology and society. Ethics and professionalism. The environment.

### **BG4903 Environmental Sustainability (3 AU)**

Environmental problems, their causes, and sustainability. Food and soil resources. Water resources. Nonrenewable energy resources. Energy efficiency and renewable energy. Air pollution. Climate change and ozone loss. Water pollution. Solid and hazardous waste.

### **HW0310 Professional Communication (2AU)**

Interpersonal communication in professional settings. Intercultural communication. Negotiating skills. Job search skills. Professional oral presentations. Working effectively in a team.