

SYLLABUS FOR THE DEGREE OF BACHELOR OF ENGINEERING IN BIOMEDICAL ENGINEERING [BEng(BME)]

SYLLABUS

The syllabus applies to students admitted in the academic year 2026-27 and thereafter under the four-year curriculum.

Definition and Terminology

Foundation Core and Intermediate Core courses are compulsory courses which a candidate must pass in the manner provided for in the Regulations.

Concentration courses refer to any advanced-level course offered by the Programme, or by other affiliated Faculties, that is specifically aligned with one of the three designated concentrations of the Programme: Biomedical Devices and Sensors, Cell and Tissue Engineering, or Intelligent Health Systems. These courses are designed to provide in-depth knowledge and specialized skills within the chosen concentration area and contribute to the fulfilment of the curriculum requirements of the degree.

A Clinical Elective course refers to any course offered by the Programme or by affiliated Faculties that focuses on clinical applications, biomedical instrumentation in healthcare settings, clinical research, or hospital-based technologies. These courses are designed to provide students with exposure to real-world clinical environments and contributing to the curriculum requirements of the Programme.

Curriculum

The Curriculum comprises 240 credits of courses as follows:

Foundation Core Courses

Students are required to complete 60 credits of Foundation Core Courses.

Intermediate Core Courses

Students are required to complete 48 credits of Intermediate Core Courses.

Concentration Courses

Students are required to complete 5 out of 9 courses within any 1 of the 3 streams, equivalent to 30 credits of Concentration courses.

Clinical Elective Courses

Students are required to complete 1 out of 3 courses, equivalent to 6 credits of clinical elective courses

Elective Courses

Students are required to complete 30 credits of elective course(s) offered by the Biomedical Engineering Programme, or other departments at the University.

University Requirements

Students are required to complete:

- a) 6 credits in English language enhancement, including non-credit bearing “CASE1001 Academic Communication in English” and 6 credits in “CAES9531 Technical English for biomedical engineering”;
- b) 6 credits in Chinese language enhancement course “CENG9001 Practical Chinese for engineering students”;
- c) 36 credits of courses in the Common Core Curriculum, comprising at least one and not more than two courses from each Area of Inquiry with not more than 24 credits of courses being selected within one academic year except where candidates are required to make up for failed credits;

- d) 6 credits of artificial intelligence literacy; and
- e) a non-credit bearing course in national education and national security education, and any non-credit bearing courses as required by the University.

Capstone Experience

Students are required to complete the 12-credit “BMED4010 Final year project” to fulfill the capstone experience requirement for the degree of BEng in Biomedical Engineering.

Internship

Students are required to complete the non-credit bearing internship “BMED3020 Professional training (Internship)” for at least 6 weeks which normally takes place in the summer semester of their third year of study.

Degree Classification

The degree of Bachelor of Engineering in Biomedical Engineering shall be awarded in five divisions in accordance with BMED 15 of the Regulations for the Degree of Bachelor of Engineering in Biomedical Engineering and UG 9 of the Regulations for First Degree Curricula.

The details of the distribution of the above course categories are as follows:

The curriculum of BEng (Biomedical Engineering) comprises 240 credits of courses with the following structure:

UG 5 Requirements (54 credits)

Course Code	Course	No. of credits
CAES1001	Academic communication in English	0
CAES9531	Technical English for biomedical engineering	6
CENG9001	Practical Chinese for engineering students	6
CC##XXXX	University common core course (6 courses)*	36
AILT1001	Artificial intelligence literacy I	3
AILT9016	AI literacy for biomedical engineering students	3
Non-credit bearing courses as required by the University		0
Total for UG5 Requirements		54

* Students have to complete 36 credits of courses in the Common Core Curriculum, comprising at least one and not more than two courses from each Area of Inquiry with not more than 24 credits of courses being selected within one academic year except where candidates are required to make up for failed credits.

Foundation Core Courses (60 credits)

Course Code	Course	No. of Credits
BMED2020	BME skills studios	6
BMED2206	Engineering in biology and medicine	6
BMED2301	Essential biochemical concepts for biomedical engineering	6
BMED2302	Introduction to cell biology, anatomy, and physiology	6
BMED2810	Engineering management & society	6
CHEM1011	Chemistry foundations for biomedical engineering	6
ENGG1000	Engineering fundamentals	6
ENGG1330	Computer programming I	6
MATH1851#	Calculus and ordinary differential equations	6
MATH1853	Linear algebra, probability & statistics	6

Students who did not take the Extended Part of Mathematics (M1/M2) in the HKDSE or equivalent in high school curriculum are required to complete MATH1011 “University Mathematics I” (offered in both Semesters 1 and 2) as a free elective in their first year of study before enrolling in MATH1851.

In addition to the above requirements, if students have not reached HKDSE Biology or Chemistry or Combined Science with Biology component or Chemistry component Level 3 or above, or equivalent, they are advised to take the course "BIOL1110 From molecules to cells".

Such courses shall be taken in the first year of study as free electives.

Intermediate Core Courses (48 credits)

Course Code	Course	No. of Credits
BMED2500	Biomedical signals and linear systems	6
BMED2600	Biomechanics for biomedical engineering	6
BMED3010	Integrated Project	12
BMED3301	How your body works: The physiological science behind life	6
BMED3501	Medical imaging	6
BMED3600	Biomedical science and engineering	6
BMED3603	Statistics and mathematical analysis for BME	6

Concentration Courses (30 credits), choose 5 out of 9 courses from either “Biomedical Devices and Sensors”, “Cell and Tissue Engineering” or “Intelligent Health Systems”

Biomedical Devices and Sensors

Course Code	Course	No. of Credits
BMED3500	Electromagnetics in biomedicine	6
BMED4500	Biomedical instrumentation and systems	6
BMED4501	Biomedical optics: Instrumentation and analytics	6
BMED4505	Advanced bioelectronics	6
BMED4509	Neurotechnology	6
BMED4503	Biomedical ultrasonics: Principles and applications	6
DASE2144	Fundamentals of robotics	6
MECH2407	Multivariable calculus and partial differential equations	6
MECH4424	Sensors and actuators for robots	6

Cell and Tissue Engineering

Course Code	Course	No. of Credits
BBMS3012	Stem cell biotechnologies in regenerative medicine	6
BBMS3018	Biomechanics and biomedical technologies	6
BBMS4003	Developmental genetics	6
BMED4601	Biomaterials design and applications	6
BMED4602	Molecular and cellular biomechanics	6
BMED4603	Transport phenomena in biological systems	6
BMED4506	Quantum technologies in biomedical sciences	6
BMED4604	Cell and tissue engineering	6
MECH2407	Multivariable calculus and partial differential equations	6

Intelligent Health Systems

Course Code	Course	No. of Credits
BIOC3605	Sequence bioinformatics	6
BIOF3005	Structural bioinformatics	6
BMED3700	Artificial Intelligence in Biomedical Engineering	6
BMED4507	Deep learning for biomedical image analysis	6
DASE2144	Fundamentals of robotics	6
DASE3128	Human-machine collaboration	6
DASE4145	Data analytics for human-machine systems	6
DASE4538	Healthcare systems engineering	6
MECH2407	Multivariable calculus and partial differential equations	6

Clinical Elective Course (6 credits)

6 credits of courses taken from the following list of discipline elective courses:

Course Code	Course	No. of Credits
BBMS2009	Introduction to clinical research	6
BBMS2010	Fundamentals of clinical trial management	6
BBMS3041	Regulatory Compliance and Quality Management for Health Technology	6

Capstone Experience and Internship (12 credits)

Course Code	Course	No. of credits
BMED3020	Professional training (Internship)*	0
BMED4010	Final year project ⁺	12
Total for Capstone Experience and Internship Courses		12

*Internship

+Capstone Experience

Elective Courses (30 credits)

At least 30 credits of courses offered by the Biomedical Engineering Programme, or other departments at the University.

Elective MSc(Eng) courses

Students may take up to two 6-credit MSc(Eng) courses offered by the Faculty of Engineering as elective courses, subject to the approval of the Programme Director.

Summary of curriculum structure of BEng (Biomedical Engineering)

Course Categories	No. of credits
UG5 Requirements	54
Foundation Core Courses	60
Intermediate Core Courses	48
Concentration Courses	30
Capstone Experience and Internship	12
Clinical Elective Courses	6
Elective Courses	30
Total	240

A suggested study plan is given as follows:

FIRST YEAR

Foundation Core Courses (48 credits)

Semester 1

Course Code	Course	No. of Credits
BMED2206	Engineering in biology and medicine	6
ENGG1000	Engineering fundamentals	6
ENGG1330	Computer programming I	6
MATH1851	Calculus and ordinary differential equations	6

Semester 2

Course Code	Course	No. of Credits
BMED2302	Introduction to cell biology, anatomy, and physiology	6
BMED2810	Engineering management & society	6
CHEM1011	Chemistry foundations for biomedical engineering	6
MATH1853	Linear algebra, probability & statistics	6

University Requirement (UG5) (12 credits)

Course Code	Course	No. of Credits
AILT1001	Artificial intelligence literacy I	3
AILT9016	AI literacy for biomedical engineering students	3
CAES1001	Academic communication in English	0
CC##XXXX	One Common Core Course	6

SECOND YEAR

Foundation Core Courses (12 credits)

Semester 1

Course Code	Course	No. of Credits
BMED2301	Essential biochemical concepts for biomedical engineering	6

Summer Semester

Course Code	Course	No. of Credits
BMED2020	BME skills studios	6

Intermediate Core Courses (24 credits)

Semester 1

Course Code	Course	No. of Credits
BMED3301	How your body works: The physiological science behind life	6
BMED3600	Biomaterials science and engineering	6

Semester 2

Course Code	Course	No. of Credits
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BMED2500	Biomedical signals and linear systems	6
BMED2600	Biomechanics for biomedical engineering	6

University Requirement (UG5) (12 credits)

Course Code	Course	No. of Credits
CC##XXXX	Two Common Core courses	12

Elective Courses (12 credits)

THIRD YEAR

Intermediate Core Courses (24 credits)

Semester 1

Course Code	Course	No. of Credits
BMED3010	Integrated project	12

Semester 2

Course Code	Course	No. of Credits
BMED3501	Medical imaging	6
BMED3603	Statistics and mathematical analysis for biomedical engineering	6

University Requirement (UG5) (18 credits)

Course Code	Course	No. of Credits
CC##XXXX	Two Common Core Course	12
CENG9001	Practical Chinese for engineering students	6

Elective Courses (12 credits)

Clinical Elective (6 credits)

Summer Semester

Internship (non-credit bearing)

Course Code	Course	No. of Credits
BMED3020	Professional Training (Internship)	0

FOURTH YEAR

Capstone Experience (12 credits)

Course Code	Course	No. of Credits
BMED4010	Final Year Project	12

University Requirement (UG5) (12 credits)

Course Code	Course	No. of credits
CAES9531	Technical English for biomedical engineering	6
CC##XXXX	One Common Core course	6

Elective Courses (6 credits)

A suggested study plan for choosing **Concentration: Biomedical Devices and Sensors** is given as follows:

(for fulfilling the requirement of a Concentration, students should have 30 credits selected from the following courses)

FOURTH YEAR

Semester 1

Course Code	Course	No. of Credits
BMED4500	Biomedical instrumentation and systems	6
BMED4509	Neurotechnology	6
MECH2407	Multivariable calculus and partial differential equations	6

Semester 2

Course Code	Course	No. of Credits
BMED3500	Electromagnetics in biomedicine	6
BMED4501	Biomedical optics: Instrumentation and analytics	6
BMED4503	Biomedical ultrasonics: Principles and applications	6
BMED4505	Advanced bioelectronics	6
DASE2144	Fundamentals of robotics	6
MECH4424	Sensors and actuators for robots	6

A suggested study plan for choosing **Concentration: Cell and Tissue Engineering** is given as follows:
(for fulfilling the requirement of a Concentration, students should have 30 credits selected from the following courses)

FOURTH YEAR

Semester 1

Course Code	Course	No. of Credits
BBMS3012	Stem cell biotechnologies in regenerative medicine	6
BBMS3018	Biomechanics and biomedical technologies	6
BBMS4003	Developmental genetics	6
BMED4601	Biomaterials design and applications	6
BMED4602	Molecular and cellular biomechanics	6

Semester 2

Course Code	Course	No. of Credits
BMED4506	Quantum technologies in biomedical sciences	6
BMED4603	Transport phenomena in biological systems	6
BMED4604	Cell and tissue engineering	6
MECH2407	Multivariable calculus and partial differential equations	6

A suggested study plan for choosing **Concentration: Intelligent Health Systems** is given as follows:
(for fulfilling the requirement of a Concentration, students should have 30 credits selected from the following courses)

FOURTH YEAR

Semester 1

Course Code	Course	No. of Credits
BIOF3005	Structural bioinformatics	6
BMED4500	Biomedical instrumentation and systems	6
DASE3128	Human-machine collaboration	6
MECH2407	Multivariable calculus and partial differential equations	6

Semester 2

Course Code	Course	No. of Credits
BIOC3605	Sequence bioinformatics	6
DASE2144	Fundamental of robotics	6
DASE4538	Healthcare systems engineering	6

A suggested study plan for choosing Clinical Elective is given as follows:
(for fulfilling the requirement of Clinical Elective, students should have 6 credits selected from the following courses)

FOURTH YEAR

Semester 1

Course Code	Course	No. of Credits
BBMS2009	Introduction to clinical research	6
BBMS2010	Fundamentals of clinical trial management	6
BBMS3041	Regulatory Compliance and Quality Management for Health Technology	6

Non-credit bearing courses as required by the University

Students will have the flexibility to take the courses in any semester throughout the period of studies.
Note: The arrangement of second 3-credit artificial intelligence literacy course is to be confirmed.

COURSE DESCRIPTIONS

Candidates will be required to do the coursework in the respective courses selected. Not all courses are offered every semester.

University Requirements on Language Enhancement Courses

CAES1001. Academic communication in English (0 credit)

CENG9001. Practical Chinese for engineering students (6 credits)

Please refer to the University Language Enhancement Courses in the syllabus for the degree of BEng for details.

AILT1001. Artificial intelligence literacy I (3 credits)

Artificial Intelligence (AI) literacy is essential for navigating our modern society effectively and responsibly. This course provides students with the skills and knowledge needed to understand AI

concepts, interact with AI systems, and critically evaluate their impact. Through lectures, online learning activities and a practical project, students will explore the ethical, social, and technological dimensions of AI, preparing them to make informed decisions in a world that is increasingly AI-driven.

Assessment: 100% Coursework

AILT9016. AI literacy for biomedical engineering students (3 credits)

This course equips BEng(BME) students with essential digital and artificial intelligence (AI) literacy skills required for modern engineering practice. Students will explore the foundational concepts of digital health, data management, and AI applications in healthcare, focusing on their impact on patient care, clinical decision-making, and professional ethics. Through a series of e-learning videos, discussions, and hands-on activities, students will develop the confidence and competence to leverage digital tools and AI technologies for improved clinical outcomes, interprofessional collaboration, and lifelong learning. The course prepares future biomedical engineers to adapt to rapidly evolving healthcare environments, ensuring they are ready to lead and advocate for safe, ethical, and effective technology integration in biomedical engineering.

Assessment: 100% continuous assessment

CAES9531. Technical English for biomedical engineering (6 credits)

This English in the Discipline course aims to develop Biomedical Engineering students' ability to write and speak in their discipline. The course will focus on developing students' ability to write a technical report and give a technical presentation on a medical device they have developed. The English course will run alongside a disciplinary project-based course(s) as nominated by the Faculty of Engineering. This course requires students to develop a portable medical device, such as electrocardiogram (ECG) recording device or oximeter, from scratch, use the device to gain data, and use the obtained data to gain insights into human physiology. The students then need to write a report and give a presentation which explains a mixture of medical and engineering information. This English course will focus on the English language skills needed to complete these assignments. Students will be assessed using the report and the presentation they produce for the Biomedical Engineering course as well as a final written test and an out of class learning component. Assessment is wholly by coursework.

Co-requisite: BMED3010

Assessment: 100% continuous assessment

Foundation Core Courses

BMED2810	Engineering management & society (6 credits)
ENGG1330	Computer programming I (6 credits)
MATH1851	Calculus and ordinary differential equations (6 credits)
MATH1853	Linear algebra, probability & statistics (6 credits)

Please refer to the Engineering Core Courses in the syllabus for the degree of BEng for details.

BMED2020. BME skills studio (6 credits)

This course provides hands-on training in practical skills fundamental to biomedical engineering. Through tutorials, laboratories and workshop-based activities, students develop competencies in BME

related skillsets, for instance electrical and electronic assembly, microcontroller programming, PCB design and fabrication, sensor interfacing, data acquisition, embedded systems, basic AI-related programming, and mechanical prototyping.

Students will apply these skills to the prototyping and testing of simple biomedical devices and subsystems, with examples drawn from physiological monitoring and point-of-care technologies, such as pulse oximetry and glucose sensing concepts. The course aims to equip students with the practical ability to design, build and test biomedical engineering solutions.

Assessment: 100% practical work

BMED2206. Engineering in biology and medicine (6 credits)

This course is an overview of the essential areas in biomedical engineering, including technologies and applications in life sciences and medicine. The course is broadly divided into 4 areas: biomechanics and biomaterial; cell and tissue engineering; biomedical instrumentations and signals, and medical devices and imaging. The global development and other issues, such as safety, ethics, and industry, will also be addressed. The course has a laboratory component to provide the students with hands-on experience in the subject as well as a group project component to explore and understand current grand challenges in biomedical engineering.

Assessment: 60% continuous assessment, 40% examination

BMED2301. Essential biochemical concepts for biomedical engineering (6 credits)

This course provides a comprehensive overview and understanding of the basic mechanisms underlying life processes. Key topics covered include the chemistry of life, fundamental bioenergetics, the roles of biomolecules and their functions, intermediary metabolism, the functions of enzymes and coenzymes, as well as nucleic acids and genetic information.

Mutually exclusive with BIOC2600

Pre-requisite: Pass in **any one of the following courses**: BMED1207 / CHEM1011 / ENGG1000

Assessment: 50% continuous assessment, 50% examination

BMED2302. Introduction to cell biology, anatomy, and physiology (6 credits)

This course aims to provide a basic understand of the structure and function of cells and tissues within our body, including the structures and functions of the cell; the general organisation of epithelium and glands; the different types and functions of the connective tissues; the general organisation of the nervous tissues, muscle and skin tissues, bone marrow and lymphatic tissues. The second part of the course will provide the students with integrated knowledge of human physiology and pathophysiology that is relevant to biomedical engineering in such areas as organization of the body, homeostasis and excitable tissues; the cardiovascular system; the renal system, and some common disorders of the cardiovascular and renal systems.

Pre-requisite: Pass in **any one of the following courses**: BMED1207 / CHEM1011 / ENGG1000

Assessment: 50% continuous assessment, 50% examination

CHEM1011. Chemistry foundations for biomedical engineering (6 credits)

Chemistry is engineering at the molecular level. It provides the fundamental language for understanding how the composition, structure, and interactions of molecules govern the behaviour of cells, tissues, biomaterials, medical devices, and physiological systems. A solid foundation in chemistry enables students to connect molecular properties to biological function, material performance, transport processes, and device interface behaviour.

This course introduces the core chemical principles required for further study in biomedical engineering. Students learn to describe and analyze chemical systems quantitatively through stoichiometry and concentration calculations, to predict behaviour in aqueous systems through acids and bases, buffers, and chemical equilibria, and to explain why chemical processes occur and how fast they proceed through thermodynamics, kinetics, and redox chemistry. Together, these principles provide a foundation for understanding chemical processes in aqueous environments, living systems, and biomedical materials.

Assessment: 40% continuous assessment, 60% examination

ENGG1000. Engineering fundamentals (6 credits)

This course provides first-year engineering students with a unified foundation in mechanics, electricity, microelectronics, and computing, preparing them for studies in their respective engineering disciplines. It begins with an introductory overview of key concepts, offering students a broad understanding of statics, dynamic mechanics, electricity, microelectronics and computer systems. This foundational knowledge equips students with the necessary tools to analyze and model basic engineering systems while connecting theory to practical applications.

Building on this foundation, students deepen their understanding through focused modules tailored to their field of study. Students specializing in mechanics explore topics such as force systems, stress-strain behavior, kinematics, dynamics, and structural analysis. Those focusing on electricity and computing delve into microelectronics, computer systems, programming, digital logic, and networking. By combining a broad conceptual introduction with discipline-aligned depth, the course prepares students for future coursework and applied problem-solving in their chosen engineering field.

Assessment: 40% continuous assessment, 60% examination

Intermediate Core Courses

BMED2500. Biomedical signals and linear systems (6 credits)

The theory of signals and linear systems is fundamental to all engineering disciplines. This is the first course in signals and linear systems for biomedical engineering students without any pre-requisite knowledge in signal theory or signal processing other than knowledge in fundamental calculus and the use of complex numbers. The course uses simple real-life examples of signals and systems to illustrate how signal theory can be used in biomedical applications. An introduction to MATLAB is included as a tool for basic signal modelling, computational realization of basic signal theory, and analysis of real biomedical signals acquired by students themselves in a lab session.

This course aims to help students gain a firm understanding of fundamental signal and linear system concepts and theory using adequate mathematical and computing techniques to tackle simple signal processing problems. It serves as a pre-requisite course for many other courses, including Integrated Projects, Medical Imaging, Biomedical Engineering Laboratory, Statistics and Mathematical Analysis for Biomedical Engineering, Biomedical Instrumentation and Systems, Digital Signal Processing,

Control and Instrumentation, Communication Systems, Digital Image Processing, and some elective courses, etc.

Specifically, the course covers the following topics: time-domain signal representation, periodic and aperiodic signals; spectral representation of signals, Fourier series and Fourier transform; system responses and linear system modelling; sampling, aliasing and analog-to-digital conversion; convolution and correlation; FIR filters and digital filtering; IIR filters and frequency response of digital filters; continuous-time systems and Fourier transform properties; application examples of biomedical signal analysis and processing.

At the end of the course, students should have a clear understanding of the fundamentals of signals and system theory to enable them to perform simple biomedical signal analysis and processing using both analytical methods and computing tools, link the mathematical representation of signals to some very simple real life signals, and vice versa, and appreciate the applications of linear systems theory in solving some simple real life problems. In addition, students should be aware of the complexity of real-life problems and the need to continue investigation in practice after graduation.

Pre-requisites: MATH1851 and MATH1853

Assessment: 60% continuous assessment, 40% examination

BMED2600. Biomechanics for biomedical engineering (6 credits)

Stress and strain; bending and deflection of beams; structural failure and viscoelasticity; Kinematics of particles, momentum and energy principles; free vibration and kinematics of mechanisms; human gait and motion; bone fracture & fixation.

Assessment: 10% practical work, 20% continuous assessment, 70% examination

BMED3010. Integrated project (12 credits)

Aims of the course:

- To provide structured, hands-on training in the application of GenAI to solve real-world daily living challenges of low-vision patients;
- To foster direct student-patient engagement and deepen students' understanding on needs of low-vision patients;
- To provide an immersive engineering practice environment where students execute the full Software Development Life Cycle (SDLC) by performing stakeholder-driven requirements elicitation, architecting modular GenAI-integrated systems, and managing the iterative deployment of validated solutions within real-world biomedical and ethical constraints.

This course offers a comprehensive experiential learning experience for Biomedical Engineering students to practically apply GenAI technologies in solving real-world medical challenges. Using daily living difficulties faced by low vision individuals as a primary example, students will first receive guided instruction to develop GenAI-driven vision model solutions aiming at resolving daily living difficulties of low vision patients. Working in teams, students will conduct in-person interviews with low-vision individuals to gain firsthand insight into their lived experiences and then identify unique research questions that address unmet needs within the low vision community.

Following the research phase, student groups will design, test, and refine their proposed GenAI-based solutions. To support realistic evaluation, students will first utilize an Augmented Reality (AR)-based visual defect simulator that replicates various visual impairments, enabling them to assess the effectiveness of their GenAI solutions in context by themselves. After that, students are required to invite their respective low-vision interviewees to participate in the testing and evaluation process. This

course will culminate in a final presentation, where each team will present and demonstrate their final solution to a panel of judges comprising low-vision individuals, AI engineers, and ophthalmologists.

Pre-requisites: BMED2206 and BMED2500

Assessment: 100% practical work

BMED3301. How your body works: The physiological science behind life (6 credits)

To provide the students with integrated knowledge of human physiology and pathophysiology that is relevant to biomedical engineering in such areas as

- (1) blood, blood clotting and immune response,
- (2) breathing and gas transport,
- (3) generation and transmission of nerve impulses, muscle contraction, bone,
- (4) the brain and its functions, autonomic system and reflexes, and
- (5) some disorders of the above.

Pre-requisite: BMED2302

Assessment: 50% continuous assessment, 50% examination

BMED3501. Medical imaging (6 credits)

Medical imaging is an indispensable technology in modern healthcare and biomedical research. It provides in vivo anatomical, physiological and functional information of the human body in normal, developing and pathological states. The rapid development in this field not only leads to better disease diagnosis and more accurate treatment efficacy assessment, but also paves the way for better understanding of living biological systems.

This course will focus mainly on the principles of conventional (X-ray and Ultrasound) and modern (Computerized Tomography – CT; Magnetic Resonance Imaging – MRI; Nuclear Imaging and Optical Imaging) imaging techniques applied to biological systems and in medical diagnoses and the interpretations of these images.

At the end of the course, students should gain a clear understanding in the physics, working principles and mathematics involved in the various imaging modalities covered. They should also be able to appreciate the interdisciplinary nature of the subject and learn the latest development or advancement in the field of medical imaging.

Pre-requisite: BMED2500 or ELEC3241

Assessment: 20% practical work, 10% continuous assessment, 70% examination

BMED3600. Biomaterials science and engineering (6 credits)

Bonds and crystal structure; defects in crystalline solids; diffusion; solidification; phase diagram; strength of materials; plastic deformation; recrystallization; grain growth; fracture of materials; fatigue life and fatigue crack growth; creep; corrosion; structure and properties of polymers; analytical and testing techniques; definitions in biomaterials science and engineering; history of biomaterials; structure and properties of biological materials; materials in biomedical applications.

Pre-requisites: ENGG1000 and MATH1851

Assessment: 20% practical work, 10% continuous assessment, 70% examination

BMED3603. Statistics and mathematical analysis for biomedical engineering (6 credits)

The ability to understand the fundamentals of biostatistics and to employ appropriate and quantitative statistical methods to analyze data generated from biomedical studies of different designs is a necessary requirement for biomedical engineering students. This is particularly important in their senior years when they are conducting their final year projects with first hand data to analyze. This course introduces the principles, concepts and methodologies of statistical planning and analysis for biomedical studies. Firstly, basic principles including probability, sampling distributions, hypothesis testing, statistical errors and power will be briefly reviewed using examples extracted from biomedical studies. Secondly, commonly used statistical tests, both parametric and non-parametric, including those for comparison studies such as the analysis of variance (ANOVA) and association studies such as regression and correlation, will be introduced. Thirdly, practical data management and statistical analyses for biomedical data will be conducted through learning the statistical software *R*. Finally, some special topics useful for biomedical studies such as sample size planning, power analysis, sensitivity and specificity of diagnostic and screening tests, will be covered. Mathematical description and computational modeling of physiological systems has been a vastly growing field. The second part of the course thus introduces quantitative, engineering approaches to human physiology. Three major physiologic systems of the human body (nervous, circulatory, and skeletal) will be studied to exemplify the quantitative nature of human physiology. Well-established mathematical models, including the Hodgkin Huxley model, the cable equation, pressure-volume relationship, and the Hill model, will be elucidated. We will familiarize the students with the MATLAB programming language to set up and solve governing (linear system and differential) equations and to analyze the output in response to input variables. We will also provide the students with a Python programming exercise to build a lightweight convolutional neural network to solve the blood flow velocity field. At the end of the course, the students should have fundamental knowledge and natural mathematical/computational capability of investigating biomedical engineering problems beyond the physiological systems studied in this course.

Pre-requisites: ENGG1330, MATH1851, MATH1853, BMED2302, BMED2500 and BMED3301

Assessment: 20% practical work, 30% continuous assessment, 50% examination

Clinical Elective Courses

BBMS2009	Introduction to clinical research (6 credits)
BBMS2010	Fundamentals of clinical trial management (6 credits)
BBMS3041	Regulatory Compliance and Quality Management for Health Technology (6 credits)

Please refer to the syllabus for the Bachelor of Biomedical Sciences for details of the Discipline Elective Courses related to BBMS2009, BBMS2010 and BBMS3041.

Concentration in Biomedical Devices and Sensors

DASE2144	Fundamentals of robotics (6 credits)
MECH2407	Multivariable calculus and partial differential equations (6 credits)
MECH4424	Sensors and actuators for robots (6 credits)

Please refer to the syllabus for the degree of BEng(ME) for details of the Discipline Core and Discipline Elective Courses related to MECH2407 and MECH4424, and to the syllabus for the degree of BEng(DS&E) for details of the Core Courses related to DASE2144.

BMED3500. Electromagnetics in biomedicine (6 credits)

The aim of this course is to provide students with basic knowledge of electromagnetics and its applications in biomedicine. Fundamental physics and mathematics in electricity and magnetism are introduced and discussed. Vector analysis is included. Topics on electricity include electric field, Gauss's law, divergence theorem, electric potential, capacitor, dielectrics, Poisson's and Laplace's equations, and work and electrostatic energy. Topics on magnetism include magnetic field, Ampere's circuital law, Stokes theorem, magnetic flux, magnetic materials, and Faraday's law. Finally, Maxwell equations are introduced. Applications of electromagnetics in biomedicine are emphasized and integrated throughout the course.

Assessment: 10% practical work, 30% continuous assessment, 60% examination

BMED4500. Biomedical instrumentation and systems (6 credits)

This course introduces the essential principles of biomedical instrumentation and systems used for both diagnostic and therapeutic purposes from the level of human body, organs, cells, down to the molecular level. Their applications encompass a wide range of areas, ranging from healthcare, clinical applications to basic life science research. Examples include ECG, EEG; blood pressure sensors; biosensor; flow cytometry, cardiac pacemakers, defibrillators and laser surgery.

Pre-requisite: BMED2500

Assessment: 20% practical work, 40% continuous assessment, 40% examination

BMED4501. Biomedical optics: Instrumentation and analytics (6 credits)

This is an introductory course in biophotonics covering:

- (1) The essential concepts of
 - (i) basic ray optics,
 - (ii) wave optics, e.g. interference and diffraction, and
 - (iii) photon optics, e.g. laser principles.
- (2) Interaction of light with biological cells/tissues and its significances and implications in optical bioimaging and other optical diagnostic and therapeutic applications.
- (3) State-of-the-art biophotonic technologies: optical bioimaging and image analytics (optical coherence tomography (OCT), fluorescence microscopy, multiphoton microscopy), lab-on-chip biosensors, laser therapy, optical-fiber micro-endoscopy.

Assessment: 30% practical work, 30% continuous assessment, 40% examination

BMED4503. Biomedical ultrasonics: Principles and applications (6 credits)

Ultrasound biophysics, scanning modes, data acquisition schemes, transducer basics; applications of ultrasound including imaging, flow analysis, therapy.

Mutually exclusive with ELEC6079

Assessment: 30% practical work, 30% continuous assessment, 40% examination

BMED4505. Advanced bioelectronics (6 credits)

Understanding the role of bioelectronics in emerging biotechnology; fundamental study of electrode-

electrolyte interface; scalable fabrication techniques; design of low-noise amplifier and electronics; low-impedance cellular and biomolecular measurement; point-of-care devices, wearables, implantable devices, and system design of bioelectronics; finalize with practice designing bioelectronic devices for biomedical diagnostics of specific diseases.

Assessment: 30% practical work, 30% continuous assessment, 40% examination

BMED4509 Neurotechnology (6 credits)

This advanced undergraduate course explores the interdisciplinary field of neurotechnology, where neuroscience, engineering, materials science, molecular biology, and clinical medicine converge to develop innovative devices and methods for understanding, monitoring, and modulating the nervous system. Students will gain comprehensive knowledge of neural recording and stimulation technologies, brain-computer interfaces, neuroimaging modalities, optogenetics, biomaterials for neural interfaces, and the translational pathway from laboratory innovation to clinical application. Through lectures, laboratory demonstrations, and hands-on projects, students will develop the technical expertise and critical thinking skills necessary for careers in neural engineering, medical device development, neuroscience research, and healthcare technology. The course emphasizes both fundamental neuroscience principles and practical engineering solutions while addressing the ethical, regulatory, and societal implications of emerging neurotechnologies.

Assessment: 30% practical work, 30% continuous assessment, 40% examination

Concentration in Cell and Tissue Engineering

MECH2407 Multivariable calculus and partial differential equations (6 credits)

Please refer to the syllabus for the degree of BEng(ME) for details of the Discipline Core Courses related to MECH2407

BBMS3012 Stem cell biotechnologies in regenerative medicine (6 credits)

Stem cell research and biotechnology has great promise for the future of regenerative medicine. The course covers the stem cell biology of various organ systems particularly in the context of human diseases, the state-of-the-art biotechnologies for stem cell research and their applications in disease modelling, treatment and drug development. In addition, non-scientific aspects such as bioethics, political developments, future development and challenges of stem cell research will also be discussed. Hands-on laboratory experience will be provided. Upon completion, students should have solid knowledge of stem cell biology and their implications in tissue homeostasis and diseases, as well as the latest biotechnologies for stem cell research and their applications.

Prerequisite: Pass in **any one of the following courses**: BIOC2600 / BIOL2220 / BIOL3401 / BBMS2007 / BBMS3002 / BMED2301.

Assessment: 50% continuous assessment; 50% examination.

BBMS3018 Biomechanics and biomedical technologies (6 credits)

The Biomechanics and Biomedical Technology course provides fundamental understanding of the human anatomy and physiology with application of the modern biomedical technology and prosthetic devices. In general, the course provides an overview of body anatomy and physiology, the structural function and

mechanical properties of biodynamics and biological tissues. Specific course topics will include structure and function relationships in tissues and organs; application of stress and strain analysis to biological tissues; analysis of forces in human function and movement; energy and power in human activity; and introduction to modelling viscoelasticity of tissues. In addition, students will be provided with unique learning approach in theoretical background and cutting-edge laboratory hands-on biomedical technology experience.

Prerequisite: Pass in **any one of the following courses**: BBMS2004 / BBMS2006 / BIOL3205 / BMED2302 / BMED3301.

Assessment: 60% continuous assessment; 40% examination.

BBMS4003 Developmental genetics (6 credits)

This course covers the genetic bases as well as cellular and molecular processes of embryo development. Topics include: genetic control of body plans and pattern formation, morphogenesis, cell fate determination, formation of organ systems such as lung, kidney, vascular, skeletal and nervous systems, germ cells and sex determination, stem cells, regeneration, common congenital malformations, and key signalling molecules involved. Methods and technologies for studying developmental genetics, studies of model organisms, and examples relevant to human diseases and modern medicine are discussed.

Prerequisite: Pass in **any one of these courses**: BBMS2003 / BBMS2007 / BIOL3401 / BIOL3408 / BBMS3002 / BMED2302.

Assessment: 50% continuous assessment; 50% examination.

BMED4506. Quantum technologies in biomedical sciences (6 credits)

“Quantum Sensing” describes the use of a quantum system, quantum properties or quantum phenomena to perform a measurement of a physical quantity, offering maximum precision at the fundamental limits (e.g., Heisenberg Limit). This emerging technology is showing great promise for molecular detection and imaging. This course not only teaches fundamental physical principles of the-state-of-the-art quantum nanosensors, but also gives hands-on experiences for students to learn the quantum technologies.

This course aims to provide students an introduction of a series of selected advanced topics, mainly including the related recent and up-to-date developments in bio-orientated quantum sensing such as nanomagnetism, nanothermometry and etc. Specifically, the course covers the following main topics:

- (1) Diamond quantum sensors;
- (2) Experimental apparatus;
- (3) Nanoscale magnetometry in bio-systems;
- (4) Nanoscale thermometry in bio-systems;
- (5) Other emerging applications in bio-systems.

Assessment: 40% continuous assessment, 60% examination

BMED4601. Biomaterials design and applications (6 credits)

Processing, structures and properties of biomaterials; tissue response to implants; biomaterial degradation; *in vitro* and *in vivo* assessment of biomaterials; implant failure; hard tissue repair; soft tissue repair; blood interfacing implants; drug delivery, nanotechnology in medicine; tissue engineering; prosthetic medical device classification; prosthetic medical device evaluation; prosthetic medical device regulation; medical device standards; ethical issues.

Pre-requisite: BMED3600
Assessment: 30% continuous assessment, 70% examination

BMED4602. Molecular and cellular biomechanics (6 credits)

The focus of this course is on the physics of molecular biology and the mechanics of the cell. Topics include:

- (1) Biopolymer (actin filaments, microtubules, DNA etc.) conformations and dynamics (random walk model of polymers, worm-like chain model, persistence length, entropic driven elasticity);
- (2) Basic statistical mechanics and thermodynamics of solutions (entropy of mixing, Osmotic pressure);
- (3) Mechanics of the cell (membrane elasticity, cell shape, cell adhesion); and
- (4) Introduction to intermolecular interactions (electrostatic force, van der Waals force).

Assessment: 40% continuous assessment, 60% examination

BMED4603. Transport phenomena in biological systems (6 credits)

Basic equations of fluid mechanics; fluid flow in the circulation and tissues; transport in porous media; mass transport in biological systems; kinetics; heat conduction; heat convection; heat exchangers.

Pre-requisite: ENGG1000
Assessment: 40% continuous assessment, 60% examination

BMED4604. Cell and tissue engineering (6 credits)

This course firstly introduces the nature on cell and tissue organization, tissue dynamic processes including development, homeostatis and wound healing. Second, it reviews in detail the basic components of engineered tissues including cells, scaffolds and signals. For cells, important cellular-fate processes such as attachment, migration, proliferation, differentiation and apoptosis, and the cell culture technology will be reviewed before focusing on stem cells and their relevance in tissue engineering. For scaffolds, the analogous role of scaffolds and extracellular matrix of native tissues will be compared and the technological advancement in scaffold design and fabrication will be highlighted. On signals, different types of cell-regulating signals including soluble biofactors, insoluble matrix factors and cell-cell interactions and biophysical signals such as topological and mechanical signals will be introduced before an integrative summary on the application of these signals in designing stem cell niche can be made. Apart from employing these signals extrinsically, direct genetic manipulation of cells can also achieve the purpose of modifying cellular functions. The basic understanding and technological achievement of gene transfer and delivery and its applications in tissue engineering will be covered.

Pre-requisites: CHEM1011, BMED2206, BMED2301, BMED2302 and BMED3301
Assessment: 20% practical work, 20% continuous assessment, 60% examination

Concentration in Intelligent Health Systems

BIOC3605	Sequence bioinformatics (6 credits)
BIOF3005	Structural bioinformatics (6 credits)
DASE2144	Fundamentals of robotics (6 credits)
DASE3128	Human-machine collaboration (6 credits)

DASE4538
MECH2407

Healthcare systems engineering (6 credits)
Multivariable calculus and partial differential equations (6 credits)

Please refer to the syllabus for the BEng(ME) for details of the Discipline Core Courses related to MECH2407; to the syllabus for the BEng(DS&E) for details of the Core, Discipline Core and Discipline Elective Courses related to DASE2144, DASE3128 and DASE4538; and to the syllabus for the Bachelor of Biomedical Sciences for details of the Discipline Elective Courses related to BIOF3005 and BIOC3605.

BMED3700. Artificial intelligence in biomedical engineering (6 credits)

Artificial Intelligence (AI) is reshaping the landscape of biomedical engineering, offering solutions to complex problems and advancing innovation in healthcare and life sciences. This course will provide an expansive introduction to the foundational concepts, classic algorithms, neural networks, and cutting-edge AI models. It is designed to equip students with a broad understanding of AI principles and their applications in biomedical contexts. The course covers a wide range of topics, including:

- (1) Fundamentals of AI covering its core principles, historical development, and basic concepts;
- (2) Key algorithms like linear and logistic regression, support vector machines, decision trees, random forests, and clustering algorithms;
- (3) Advanced concepts such as deep learning, convolutional neural networks, and transformers;
- (4) Latest AI applications in biomedical imaging, genomics, and electronic records for regression and classification tasks.

This course is designed to prepare students with a comprehensive knowledge base and practical skills to understand and apply AI across diverse biomedical problems.

Pre-requisite: ENGG1330 or COMP1117 **and** MATH1853 or MATH2014
Assessment: 60% continuous assessment, 40% examination

BMED4507. Deep learning for biomedical image analysis (6 credits)

Medical imaging plays a pivotal role in modern healthcare, enabling accurate disease diagnosis, treatment planning, and monitoring. However, the increasing complexity and volume of medical image data pose significant challenges for traditional analysis methods. Deep learning, with its ability to automatically learn and extract complex features from large datasets, has emerged as a transformative approach to biomedical image analysis, offering unprecedented accuracy and efficiency. This course provides a focused exploration of advanced deep learning techniques for biomedical image data. Key topics include:

- (1) Fundamentals of deep neural networks;
- (2) Overview of biomedical imaging modalities and characteristics;
- (3) Core tasks in biomedical image analysis;
- (4) Advanced deep learning models in biomedical image analysis;
- (5) Integration of multimodal data in biomedical applications.

Through this course, students will gain comprehensive knowledge of the theoretical foundations and practical applications of deep learning in analyzing and interpreting biomedical images.

Pre-requisite: ENGG1330 or COMP1117 **and** MATH1853 or MATH2014
Assessment: 60% continuous assessment, 40% examination

Capstone Experience and Internship

BMED3020. Professional training (Internship) (0 credit)

This course aims to provide our students with on-the-job training in local or non-local companies or organizations so that they can integrate theory learning with practical applications; understand real-life organizational structure and business operation; learn how to build human relations with seniors and co-workers; and enrich personal resume for becoming engineering professional.

Assessment: 100% continuous assessment

BMED4010. Final Year Project (12 credits)

This course is a core course for all final year biomedical engineering students. It requires students to apply the knowledge they acquired throughout their academic studies to solving real-life biomedical engineering problems. Students are provided with an opportunity to pursue their own research interest under the supervision of teachers from both Engineering & Medicine. At the end of the course, students are required to present a dissertation or report on a topic consisting of design, experimental or analytical investigations. They will develop the ability to formulate and solve problems in biomedical engineering.

Assessment: 100% continuous assessment
