

## DIPLOMA IN BIOMEDICAL ENGINEERING (BME) (3-YEAR COURSE)

**SCHOOL OF ENGINEERING**  
BIOMEDICAL CLUSTER



The **Diploma in Biomedical Engineering (BME)** course is a multi-disciplinary and practice-oriented programme that bridges engineering with the life sciences, tapping into the fast-growing biomedical sciences and medical technology sectors. In Singapore, the BME segment accounts for more than half of all personnel employed in the entire biomedical sciences industry.

As the pioneering diploma in this field in Singapore, our BME diploma equips students with a strong grounding in engineering that complements the life sciences, including areas such as electronics, biophysics, medical instrumentation, cell and molecular biology, biomechanics and implants.

Students devote about 40 per cent of the curriculum to practical training through laboratory experiments, workshops, projects and internships. They also acquire knowledge and understanding in the design and operation of medical devices and equipment.

Final-year students focus on specialised topics in clinical engineering, biomaterials and implants, diagnostic and therapeutic medical equipment, and medical imaging technology. They also work in teams to design and develop biomedical projects.

In addition, students can pursue a six-month internship in relevant local or overseas biomedical companies, or choose to do an in-house project. Some participating organisations, such as the BME Departments of local hospitals and a number of multinational corporations, prefer students from our BME course for attachments.

### ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results and fulfill the aggregate computation requirements:

Subject	'O' Level Grade
English Language	1-7**
Mathematics (Elementary/Additional)	1-6
Science (With Physics or Chemistry or Biology component) or Design & Technology or Computer Studies	1-6

The aggregate computation for selection is based on grades obtained for English, Mathematics, Science or Design & Technology or Computer Studies and two other subjects.

\*\* Candidates with English as a second language must have attained a minimum grade of 6.

Candidates with severe vision deficiency should not apply for the course. Those with colour appreciation deficiency may be considered, subject to an in-house test.

## CAREER PROSPECTS

BME graduates can look forward to many exciting careers in the medical and healthcare sectors. They can work in sales and marketing and in engineering support. There are also ample career opportunities in biomedical engineering research. They can also be involved in research and design, and the development of new medical devices to improve healthcare.

BME graduates doing R&D are at the forefront of cutting-edge technologies. Their work can range from investigative clinical studies, analysis and synthesis, design and development, product prototyping, quality assurance and certification; to clinical trials and cutting-edge research leading to scientific publications.

Those who choose to work in a medical environment like hospitals will be involved in evaluating, purchasing, installing and commissioning of medical equipment, maintenance and service work. They will instruct and train end-users in the principles and proper use and care of the equipment. Outside of hospitals, they may work in healthcare equipment companies, handling the sales, marketing and technical support of medical instruments and devices.

## ACCREDITATION FOR FURTHER STUDIES

Our BME diploma has been accredited by both local and overseas universities. Many of these institutions grant either credit exemptions or direct entry into the second or third year of their courses. An impressive 65 per cent of our BME graduates in 2007 secured places in the universities by July in the same year. Some of them even received multiple offers.

In Singapore, BME graduates may further their studies at:

- **Nanyang Technological University**  
Bioengineering, Electrical & Electronic Engineering, Computer Engineering, Materials Engineering, Physics and Applied Physics or Biological Sciences courses
- **National University of Singapore**  
Bioengineering, Electrical Engineering or Computer Engineering courses
- **Singapore Management University**  
Business Management
- **SIM University (UniSIM)**  
Biomedical Engineering or Electronics courses
- **University of New South Wales (Australia)**  
1.5 years of advanced standing for Bachelor of Electrical Engineering or Bachelor of Telecommunications Engineering (pre-requisite for Master of Biomedical Engineering)
- **University of Sheffield (UK)**  
Two years of study to obtain a Bachelor of Engineering degree in Biomedical Engineering or Biomaterial Science

## COURSE CURRICULUM (INTERNSHIP)

Module Name	Credit Units
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### YEAR 1

#### Level 1.1 (27 hours per week)

Electrical Technology	6
Electronic Practical Skills	4
Engineering Mathematics 1	5
Engineering Mechanics	5
Introduction to Biomedical Engineering	3
Sports & Wellness <sup>^</sup>	2
Creativity & Applied Thinking Skills <sup>^</sup>	2

#### Level 1.2 (27 hours per week)

Analogue Electronics	5
BioPhysics	4
Computer Programming	4
Digital Electronics	5
Engineering Mathematics 2	5
Communication Toolkit <sup>^</sup>	4

### YEAR 2

#### Level 2.1 (24 hours per week)

Applications Programming	4
Cell & Molecular Biology	3
Electronic Design & Prototyping	4
Engineering Mathematics 3A	4
Medical Instrumentation	5
Interdisciplinary Studies (IS) module <sup>^</sup>	2
Interdisciplinary Studies (IS) module <sup>^</sup>	2

#### Level 2.2 (23 hours per week)

Electronic Project Design Practice	4
Embedded System (ARM)	6
Fundamentals of Control Systems	5
Physiological Systems	4
Innovation & Enterprise in Action <sup>^</sup>	4

### YEAR 3

#### Level 3.1 (18 hours per week)

BME Project Design	7
Clinical Engineering	4
Diagnostic, Therapeutic & Laboratory Equipment	3
World Issues: A Singapore Perspective <sup>^</sup>	2
Interdisciplinary Studies (IS) module <sup>^</sup>	2

#### Level 3.2 (25 hours per week)

Six-month Internship	25
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#### Across Level Modules (Level 1.2 onwards) (6 hours per week)

School of Engineering (SoE) elective module*	3
School of Engineering (SoE) elective module*	3

## COURSE CURRICULUM (NON-INTERNSHIP)

Module Name	Credit Units
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**YEAR 1****Level 1.1 (27 hours per week)**

Electrical Technology	6
Electronic Practical Skills	4
Engineering Mathematics 1	5
Engineering Mechanics	5
Introduction to Biomedical Engineering	3
Sports & Wellness <sup>^</sup>	2
Creativity & Applied Thinking Skills <sup>^</sup>	2

**Level 1.2 (27 hours per week)**

Analogue Electronics	5
BioPhysics	4
Computer Programming	4
Digital Electronics	5
Engineering Mathematics 2	5
Communication Toolkit <sup>^</sup>	4

**YEAR 2****Level 2.1 (24 hours per week)**

Applications Programming	4
Cell & Molecular Biology	3
Electronic Design & Prototyping	4
Engineering Mathematics 3A	4
Medical Instrumentation	5
Interdisciplinary Studies (IS) module <sup>^</sup>	2
Interdisciplinary Studies (IS) module <sup>^</sup>	2

**Level 2.2 (23 hours per week)**

Electronic Project Design Practice	4
Embedded System (ARM)	6
Fundamentals of Control Systems	5
Physiological Systems	4
Innovation & Enterprise in Action <sup>^</sup>	4

**YEAR 3****Level 3.1 (21 hours per week)**

Biomaterials & Implants	3
Biomechanics & Rehabilitation Engineering	3
Diagnostic, Therapeutic & Laboratory Equipment	3
Project Design and Development 1	8
World Issues: A Singapore Perspective <sup>^</sup>	2
Interdisciplinary Studies (IS) module <sup>^</sup>	2

**Level 3.2 (22 hours per week)**

Clinical Engineering	4
Telecommunication Principles	6
Project Design and Development 2	12

**Across Level Modules (Level 1.2 onwards)  
(6 hours per week)**

School of Engineering (SoE) elective module*	3
School of Engineering (SoE) elective module*	3

**Notes:**

<sup>^</sup> For more details on Interdisciplinary Studies (IS) modules, please log on to [www.np.edu.sg/is/](http://www.np.edu.sg/is/).

\* For more details on School of Engineering elective modules, please refer to page 165.

Students are required to own Notebook Computers.

**IS Modules**

The School of Interdisciplinary Studies (IS) delivers the interdisciplinary curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge-based economy. IS modules challenge boundaries and offer insights into Communication, Entrepreneurship, Life Skills, Media & the Arts, and Science & Technology.

**School of Engineering (SoE) Elective Modules**

The SoE elective modules fall under a wide range of clusters under both Engineering and Non-Engineering categories. The aim is to provide students with the opportunity to broaden their knowledge and deepen their discipline specific areas. Each cluster comprises a minimum of three 3-hour modules. Students are required to take two modules in order to satisfy the minimum graduating requirement.

## COURSE MODULES

**LEVEL 1.1****Electrical Technology**

This module introduces the necessary foundation for electrical circuit analysis covering electrical theorems and techniques for analysing and solving direct and alternating current circuit problems. Laboratory assignments include basic electrical measurement skills and concepts learnt in lectures and tutorials.

**Electronic Practical Skills**

This is a hands-on module that aims to equip students with the necessary practical skills in electronic circuit construction, testing, measurement and analysis. Students will also put into practice concepts covered in the level 1 module Electrical Technology.

**Engineering Mathematics 1**

This module is designed to provide students with the fundamental skills in mathematics required to solve basic engineering problems. Topics are introduced in an order that is intended to keep abreast of the application requirements in engineering modules. The emphasis in each topic is on simple applications and problem solving. Throughout the module, there is appropriate use of a Computer Algebra System. Topics include algebra, trigonometry, logarithms, matrices and complex numbers.

**Engineering Mechanics**

This module introduces students to the study of external forces in two dimensions and their effect on particles and rigid bodies that are at rest. Students learn the skills to analyse the forces acting on the bodies by

drawing free-body diagrams and applying the conditions of equilibrium. Topics include forces and resultants, moments and couples, equilibrium, and the concepts of plane friction. This module also aims to equip students with the skills to analyse problems of rigid bodies in motion. Only linear and rotational motion in two dimensions will be covered. Topics include Kinematics of linear and rotational motion, and Kinetics of linear and rotational motion.

#### Introduction to Biomedical Engineering

This module aims to provide students with an understanding and appreciation of the field of Biomedical Engineering. Students will learn a list of common roots, prefixes and suffixes in order to have a strong foundation of medical terminology. They will be introduced to the wide range of medical devices & equipment. The functions and responsibilities of the biomedical technician/engineer will be explored. Basic concepts of medical instrumentation will be taught which encompasses transducers and signal conditioning/processing. Finally students learn the types of medical device classes and the various safety standards.



#### LEVEL 1.2

##### Analogue Electronics

This module aims to introduce the fundamental concepts of analogue electronic devices and circuits. It covers semiconductor physics as well as the device characteristics, operating principles and common applications of diodes and transistors. The module will equip students with a thorough understanding of DC biasing and AC operation of transistor amplifier circuits. This will be achieved through worked examples, tutorials, laboratory sessions and e-learning materials.

##### BioPhysics

In this module, students are introduced to various principles of Physics as they apply to the human body. These include energy, work, power, heat, temperature, pressure and electricity within the body. They are also exposed to the use of Physics in medical applications such as hearing, sight and radiation. This module provides a strong foundation for subsequent Biomedical Engineering modules.

##### Computer Programming

This practice-oriented module equips students with the basic knowledge and skills in computer programming using C language. The main topics include basic computing concepts, fundamentals of C, branching, loops, and C functions. On completion of the module, students will be able to explain and write C programs for simple engineering applications.

##### Digital Electronics

This module covers the fundamentals of digital electronics. The basic principles and techniques of digital system and design are covered. It is also intended to prepare students for subsequent subjects involving microprocessors and microcomputers. The main topics covered are number systems, Boolean Algebra, combinational logic circuits and minimisation techniques, flip-flops and multivibrators, IC counters, and data-handling devices.

##### Engineering Mathematics 2

This module equips students with further mathematical skills to solve engineering problems. Topics include trigonometry, coordinate geometry, differentiation and integration with applications.

#### LEVEL 2.1

##### Applications Programming

This practice-oriented module equips students with the fundamental skills required to develop Windows applications. The students will develop conceptual understanding to design and develop applications to solve business and engineering problems. Main topics include branch and loop, array, bitwise operation, datafiles accessing and methods.

##### Cell & Molecular Biology

This module provides a solid foundation in the area of cell and molecular biology. The topics covered include Eukaryotic cell structure and function, molecular biology, bioinformatics, cell communication and differentiation, and cancer.

##### Electronic Design & Prototyping

The main objectives of this module are to introduce students to the techniques of PCB computer-aided design, and to provide opportunities for the acquisition of practical skills in electronic project design. Students will learn the planning, development, construction and testing of electronic prototypes. The focus of the module is on hands-on practice for basic PCB design, PCB fabrication and technical writing skills. Fault finding on electronic circuits, an essential skill in construction, is also introduced.

##### Engineering Mathematics 3A

This module is a continuation of Engineering Mathematics 2. Topics include integration with applications, differential equations, Laplace transform and Fourier Series.

##### Medical Instrumentation

In this module, students will gain an understanding of electronic instrumentation and measurements with a focus on physiological signals. Topics covered include measurement errors, transduction of bioelectric signals, different types of amplifiers and filters, signals and noise, power supplies, batteries, oscillators, timers, ultrasound, fibre optics and lasers.



## LEVEL 2.2

### Electronic Project Design Practice

The main objective of this module is to enable students to appreciate the importance of project design from theory to practice. Students will learn the correct approach to the development, construction and testing of projects. The hands-on practice involves basic hardware design techniques and implementation. Fault-finding on electronic circuits is introduced to enhance the skills of the students. Hands on practice, design of printed circuit boards using self-generated component footprints and report writing skills are also essential components of this module.

### Embedded System (ARM)

This module introduces the fundamentals of a typical modern embedded system based on the 32-bit Advanced RISC Microprocessor (ARM). It presents the basic processor architecture together with the concept of System-On-Chip (SoC). It covers the use of C programming language in modern embedded systems and is supplemented by assembly language. The Motorola i.mx application processor is used to demonstrate the basic hardware interfacing architecture of a typical integrated ARM SoC.

### Fundamentals of Control Systems

This module provides students with a basic coverage of feedback control systems. The topics cover the basic concepts of automatic control, the components of control systems, simple analytical tools, and stability analysis of systems. Students are also introduced to the use of Matlab/Simulink as a computer tool in control systems analysis.

### Physiological Systems

Students will study the anatomy and physiology of the human body. This module emphasises the importance of the cardiovascular and neurological systems in the integration of our physiological processes. The respiratory, endocrine, skeletal, muscular, digestive and excretory systems will also be studied.

## LEVEL 3.1 AND 3.2

### COMMON MODULES

#### Diagnostic, Therapeutic & Laboratory Equipment

In this module, students will learn the functions, features and limitations of the most important hospital diagnostic and therapeutic equipment, as well as clinical lab instruments. Examples of diagnostic equipment are patient monitoring systems, respiratory measurement equipment and electroencephalography. Defibrillators, cardiac pacemakers and surgical equipment are some of the therapeutic equipment covered. The clinical lab instrumentation includes spectrophotometers, chromatographs and blood cell counters.

#### Clinical Engineering

Students will be taught biomedical equipment procurement, management, operation, calibration, testing and maintenance in order to provide quality patient care. They will discover the physiological effects of electricity and study the application of various electrical safety devices in a hospital environment. The IEC601-1 Electrical Safety Test procedures and safety limits are emphasised. Patient and operator safety, including the handling of chemicals, lasers, X-rays and radio-isotopes, are also taught. Other topics include inferential statistics and hypothesis testing.

### INTERNSHIP PATHWAY

#### BME Project Design

In this module, small groups of students will start project work during their Level 2.2 vacation (full-time over five weeks) and continue over the first semester in Level 3. Students will gain practical experience in the design and implementation of a project to demonstrate their engineering and presentation skills, and knowledge gained in the various academic subjects, especially in medical devices and equipment. This module provides the opportunity for students to demonstrate their creativity and initiative.

#### Six-month Internship

In this module, students will be attached to sponsoring companies for a period of approximately six months. During their attachments, students will undertake projects assigned by the company or be involved in operations or maintenance-related work. Student attachments may be undertaken locally or overseas.

### NON-INTERNSHIP PATHWAY

#### Biomaterials & Implants

This module covers the types of biomaterials that can be used inside the human body, both for short- and long-term implantations, and their composition, properties and applications in skeletal, cardiovascular, dental, facial and breast implants. Students will also find out how the host body may react to the implantation of these foreign bodies. Current research on tissue engineering, which is seen as the alternative to implants, will also be covered.

### Biomechanics & Rehabilitation Engineering

This module introduces students to the application of engineering statics and dynamics to perform simple force analyses of the musculo-skeletal system. They will learn to appreciate the kinematics and kinetics of human motion. They will also learn about the role of an engineer in rehabilitation under different medical conditions.

### Project Design & Development 1

In this module, students will work together in teams of three to design and implement a project that demonstrates their engineering skills as well as teamwork over a period of two semesters. The module is structured to encourage creativity and innovative thinking. This will also help students develop a positive work attitude and good team spirit.

### Telecommunication Principles

This module is the introductory module to radio communication. This module gives an understanding of the basic concepts of analog communication systems. Characteristics of a basic communication system and the environmental factors that affect communication will be first discussed. A review of the mathematical groundwork of signal analysis will also be done and the concepts that are necessary for the understanding of linear systems will be developed, with emphasis on resonance and filters. Students will be taught the fundamental concepts of analog modulation techniques like AM and FM and their applications. The demodulation process will subsequently be taught so that the students can understand the electrical characteristics underlying AM/FM reception and learn to appreciate the features of a good quality receiver.

### Project Design & Development 2

This module follows on from Project Design and Development 1. Students are required to demonstrate their ability and resourcefulness in implementing their selected project design solution. The scope of work includes printed circuit board fabrication, wiring, assembly and testing of the final prototype according to the specifications and requirements defined in Project Design and Development 1. In addition, software based projects may require database coding, operating system implementation and testing, server and client system design, portable design field test and Web-based integration.



## ACROSS LEVEL MODULES (LEVEL 1.2 ONWARDS)

### School of Engineering Elective Modules and the Diploma Plus Programme

Students take two modules from a wide range of clusters under the engineering and non-engineering elective clusters to complete their diploma. Furthermore, students can qualify for a diploma plus by simply topping up with two additional modules from the same cluster as one of the electives. The Diploma Plus Certificate helps students if they wish to pursue a university degree or increase their employability in discipline-specific areas. Students can choose electives from the range listed below.

#### Engineering Clusters

- Advanced Engineering Mathematics\*
- Aerospace Electronics
- Applied Physics\*
- Biomedical Engineering
- Computer & Communication Systems
- Industrial Electronics
- Microelectronics

#### Non-engineering Clusters

- Economics & Financial Applications
- Green Development
- Leisure & Retail Management

#### Other Available Diploma Plus Certificates

- Business
- Innovation Management
- Languages (Japanese)

\* Designed in collaboration with the Department of Electrical and Computer Engineering, National University of Singapore (NUS). The syllabus is based on the first-year engineering mathematics and science curricula of NUS.

For detailed module descriptions under each cluster, please refer to page 165.