DIPLOMA IN BIOMEDICAL ENGINEERING

Intrigued by how the marriage of engineering technology and life sciences can benefit mankind? That's where biomedical engineering comes into play. This forward-thinking field is responsible for the design of sophisticated medical equipment such as diagnostic and therapeutic machines and lifesaving devices like the artificial heart and dialysis machine. In fact, you can be part of this fascinating industry when you join the Diploma in Biomedical Engineering [BME]

The first diploma of its kind in Singapore, BME is jointly delivered by Ngee Ann Polytechnic's School of Engineering and School of Life Sciences & Chemical Technology. Besides teaching you how to develop medical equipment, BME also gives you a firm grounding in research that could lead to discovery of new treatments for medical conditions.

In your first year, you will acquire a strong foundation in engineering in topics covering electrical, electronic and mechanical engineering. You will also gain an overview of biomedical engineering. Then in your second year, you will study cell and molecular biology alongside medical instrumentation and physiological systems. You will also be equipped with electronic design prototyping skills.

In your final year, you will focus on areas such as clinical engineering as well as various types of medical equipment. You will also work in teams to design and develop biomedical products. What's more, you will have the opportunity to go on a six-month local or overseas internship with a university, hospital, MNC or research institute.

COURSE MODULES

LEVEL 1.1

Career & Professional Preparation I
This module helps to give students a foundational introduction to their three-year diploma course curriculum and how it prepares them for industry. It will help them to embark on their three-year course with the end in mind, through guided reflection of their personal characteristics, and producing an overall game plan for their future education and career goals. The module aims to deepen students' commitment to the sector that the course prepares them for.

Programming
This practice-oriented module equips students with basic knowledge and skills in computer programming using C language. The main topics include basic computer programming concepts, fundamentals of C programming including branching, loops, and functions.

Electrical Engineering Fundamentals
This module provides a foundation in electricity covering basic concepts of electrical circuits and the methods used to analyse them. The module emphasises the understanding of the basic electrical circuit laws (Ohm’s Law, Kirchhoff’s Voltage and Current Laws) and network theorems, and their application to electrical network analysis. Topics covered include fundamentals of electricity, network theorems, capacitance, electromagnetic induction and inductance.

Integrated Real-world Project 1
This module aims to integrate the knowledge learnt in the semester and apply to a real-world project and further enhanced through relevant contextualization. Students will work in teams and undertake the project development underpinned by the design thinking approach. On completion of the module, students will be able to apply the skills and develop confidence in tackling projects. Data analytics will be introduced using case-based approach and applied in the integrated real-world project.

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.
Topics include algebra, trigonometry, logarithms, plane analytic geometry, matrices and complex numbers. Throughout the module, there is appropriate use of a Computer Algebra System.

**Mechanical Engineering Fundamentals**
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 motion in two dimensions will be covered. Topics include kinematics and kinetics of linear motion.

**Innovation Made Possible (IS Module)**
This module aims to help students discover and hone their innate ability to think creatively and come up with innovations to tackle problems close to their hearts. Underpinned by the Design Thinking framework, students will be sensitized to the process of user-centric problem solving. They will be introduced to concepts such as empathy, problem-definition, ideation, prototyping and testing through a practical approach featuring engaging out-of-classroom activities, just-in-time master-classes and a hands-on, “learning by doing” delivery format. Ultimately, the module will help students recognize that innovation is attainable and fun and develop creative confidence to explore new ideas in their studies and beyond.

**LEVEL 1.2**

**Analogue Electronics**
The aim of this module is to lay the foundations in analogue electronics. At the end of this module, students will acquire content knowledge and understanding on the basic concepts of analogue electronics and some applications. Key topics covered in this module include operating characteristics, working principles and applications of discrete electronic devices such as various types of diodes, MOSFETs and BJTs. Practical circuits will be used to enhance and strengthen the learners’ knowledge so that they will acquire the relevant competencies to move on to more specialized modules.

**Digital Fundamentals**
This module introduces the basic principles of digital systems. It covers combinational and sequential logics circuits, multiplexers/demultiplexers and decoders. Flip-flops and their application in counters and registers will also be discussed. This basic knowledge is essential for students to be able to analyse, troubleshoot and design basic digital circuit system.

**AC Circuits**
The aim of the module is to provide first year students with a basic knowledge of the fundamental principles in electric circuit analysis. The module first explores DC network theorems such as Kirchhoff’s Laws, Thevenin’s Theorem and Principle of Superposition. Application of the theorems are then extended to AC circuits which involve impedances such as capacitance and inductance. The module also includes analysis of simple AC series, parallel and series-parallel combination circuits, concept of AC power and understanding of power factor and its effect on electrical energy usage.

**Integrated Real-world Project 2**
This module aims to integrate the knowledge learnt in the semester and apply to a real-world project and understand the relevance and application of the modules learnt. Students will work in teams and undertake the project development underpinned by the design thinking approach. On completion of the module, students will be able to apply the skills and develop confidence in tackling projects at the higher levels.
**Engineering Mathematics 2**
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 trigonometry, differentiation and simple integration with applications.

**Engineering & Society**
The module aims to imbue students with a sense of purpose as they pursue an engineering education and providing students with a moral compass in their journey as engineering professionals. The sense of purpose is encapsulated by the development and application of professional skills, within the engineering context, that would allow students to make a contribution to society. The module will develop students’ cultural quotient (CQ) capabilities and mould their mental disposition to understand and collaborate across diverse cultures. CQ is crucial in the engineering profession due to the proliferation of global connectivity and collaboration, which requires an engineer to empathise, relate, adapt and work effectively with people from diverse backgrounds and cultures. The module will also feature our signature pedagogies, namely, design thinking and service-learning, so that students will be sensitised to the challenges of working as engineers in new and unfamiliar settings.

**Sports and Wellness (IS Module)**
This module helps you to learn a sport as a recreational activity to keep you fit and healthy. Team-building and collaboration skills are developed as you network with other students. There is a total of 19 sports electives to choose from: Aerobics, Badminton, Basketball, Cheerleading, Dance Movement, Dancesport, Flag Football, Hip Hop, Life Saving / Swimming, Netball, Orienteering, Street Soccer, Soccer, Softball, Tennis, Touch Rugby, Volleyball, Wellness Programme and Yoga. Outstanding students are awarded a Pass with Merit.

**Communication Essentials (IS Module)**
This module aims to develop written and spoken communicative competence in students by exposing them to a range of contemporary issues. Through researching on and discussing different topics from different disciplinary perspectives, students acquire lexis and syntax through critical reading and writing while developing awareness of self in society. The integration of critical thinking and analysis will enable students to articulate their thoughts and perspectives through oral presentations and written texts. The module will also develop an awareness of cultural intelligence with global viewpoints.

**COURSE CURRICULUM**

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Credit Units</th>
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<tbody>
<tr>
<td><strong>YEAR 1</strong></td>
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<tr>
<td><strong>Level 1.1 (23 hours per week)</strong></td>
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<tr>
<td>Engineering Mathematics 1</td>
<td>4</td>
</tr>
<tr>
<td>Mechanical Engineering Fundamentals</td>
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</tr>
<tr>
<td>Electrical Engineering Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>Programming</td>
<td>4</td>
</tr>
<tr>
<td>Integrated Real-world Project 1</td>
<td>4</td>
</tr>
<tr>
<td>Career &amp; Professional Preparation I</td>
<td>2</td>
</tr>
<tr>
<td>Innovation Made Possible ^</td>
<td>3</td>
</tr>
<tr>
<td><strong>Level 1.2 (27 hours per week)</strong></td>
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</tbody>
</table>
Engineering Mathematics 2 4
AC Circuits 4
Analogue Electronics 4
Digital Fundamentals 4
Integrated Real-world Project 2 4
Engineering & Society 2
Sports & Wellness ^ 2
Communication Essentials ^ 3

Notes:
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IS Modules
The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students’ competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.
COURSE MODULES

LEVEL 2.1

BioPhysics
This module provides a strong foundation for Biomedical Engineering modules in subsequent levels. It introduces students to the usual physics topics other than those topics that will be covered in other modules of the course. Additionally, examples taken from the human body or from biomedical applications will be used to illustrate the physical principles. It is the intention of this module to provide a broad scope of content without excessive depth in order to prepare students for the diverse and multidisciplinary nature of biomedical engineering.

Cell & Molecular Biology
This module provides an introduction to Cell and Molecular Biology concepts. It equips students with an understanding of eukaryotic cell biology, including fundamental chemicals necessary for life, structure and function of cells and organelles, cellular transport mechanisms, cell divisions, DNA replication, protein synthesis, genetics, principles of inheritance, cell-to-cell interactions and cell development.

Electronic Design Prototyping 1
The main objectives of this module are to introduce students the techniques to construct an electric circuit and practical skills in measurement and troubleshooting. Students will learn the process for planning, construction and testing of a project. The focus of the module is on the hands-on practice for bread boarding, PCB design and assembly and test & measurement. Simple troubleshooting techniques and CAD tools will also be introduced to aid in their design of the PCB.

Engineering Mathematics 3A
This module is designed to provide students with further mathematical skills to solve basic engineering related problems. The topics are introduced in an order that is intended to keep abreast of the application requirements in their other engineering modules. Topics include integration with applications, differential equations, Laplace Transform and Fourier Series.

Healthcare IT
Students are introduced to the concept of networking in healthcare industry. Nowadays, medical equipment and devices are integrated with network capability. The involvement of information technology in clinical engineering is constantly of increased importance. In this module, students will gain knowledge in the area of inter-networking in the healthcare environment such as hospitals. Students will learn to configure, examine and troubleshoot network systems. Extensive laboratory sessions provide hands-on experience for the students to acquire the skills to build and maintain flat, switched, routed and wireless networks. In addition, they will learn techniques to identify and isolate connectivity problems from equipment failures.

Medical Instrumentation
This module presents an understanding of electronic instrumentation and measurements with a focus on physiological signals. It covers measurement errors, transduction of bioelectric signals, different types of amplifiers and filters, signals and noise, power supplies, batteries, oscillators, timer, ultrasound.

Career & Professional Preparation II
This module helps students with skills necessary to seek and secure work. They will also be equipped to communicate their personal brand in a positive way. As students sharpen their communication skills, they will also learn how to market themselves effectively.

Interdisciplinary Elective Module (IS Module)
Students embark on a general module from categories ranging from Communication, Life Skills, Entrepreneurship, Media & the Arts to Science & Technology.

LEVEL 2.2
Applications Programming
This practice-oriented module equips students with the fundamental knowledge and 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, data files accessing and methods.

Electronic Design Prototyping 2
The main objectives of this module are to introduce students the prototyping techniques on electronic assembly and practical skills in electronic project design. Students will learn the process for planning, construction and testing of a project. The focus of the module is on the hands-on practice for CAD design, bread-boarding, point-to-point wiring, PCB assembly, test & measurement, and fault finding on electronic circuits.

Embedded System
This module introduces the fundamentals of a modern embedded system based on the 32-bit Advanced RISC Machines (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 system and is supplemented by assembly language. Freescale i.mx (media extension) application processor is used to demonstrate the basic hardware interfacing architecture of a typical integrated ARM SoC which includes memory, LCD display, touch panel, I2C, USB etc. The eLinux is used to cover the concept of ‘Real Time Operating System (RTOS)’ used in modern day embedded systems.

Fundamentals of Control Systems
This module provides students with a basic coverage of feedback control systems. The topics cover basic concepts of automatic control, control systems’ components, 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. A brief overview of programmable logic controllers is also included.

Physiological Systems
This module provides the fundamental understanding of the anatomy and physiology of the human body, which is an essential foundation for subsequent modules. The cardiovascular, neurological and respiratory systems will be highlighted in this study. Other systems in the human physiology will be briefly mentioned.

World Issues: A Singapore Perspective (IS Module)
This module takes a global approach to significant current and historical events. The aim is to enhance students’ understanding of such events and issues in the context of Singapore, as well as challenge students to think critically about choices and decision-making vis-à-vis the nation state.

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Credit Units</th>
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<tbody>
<tr>
<td><strong>YEAR 2</strong></td>
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<tr>
<td><strong>Level 2.1 (27 hours per week)</strong></td>
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<tr>
<td>BioPhysics</td>
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<tr>
<td>Cell &amp; Molecular Biology</td>
<td>3</td>
</tr>
<tr>
<td>Electronic Design Prototyping 1</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Mathematics 3A</td>
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<tr>
<td>Healthcare IT</td>
<td>4</td>
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<tr>
<td>Medical Instrumentation</td>
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<tr>
<td>Career &amp; Professional Preparation II</td>
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<td>Interdisciplinary Studies (IS) elective</td>
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<td>Course</td>
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<td>Applications Programming</td>
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<tr>
<td>Electronic Design Prototyping 2</td>
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<tr>
<td>Embedded System</td>
<td>5</td>
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<tr>
<td>Fundamentals of Control Systems</td>
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<tr>
<td>Physiological Systems</td>
<td>4</td>
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<tr>
<td>World Issues: A Singapore Perspective</td>
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COURSE MODULES
LEVEL 3.1

BME Project Design
The module aims at providing students with 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 the field related to a range of medical devices & equipment, the implementation of various designs in electronics for diagnostic and therapeutic treatments are taught and performed. Creativity and initiative will be evaluated during the course of the project. The project also inculcates in students positive work attitude, team spirit and co-operation.

Clinical Engineering
Students are introduced to the tools and techniques required for understanding the management and organization of a modern clinical engineering department. Students will gain a firm foundation in biomedical equipment usage, operation, calibration, testing and maintenance in order to meet the demands of quality patient care. Patient and operator safety including handling of chemicals, lasers, X-rays and radio-isotopes are emphasized. Other topics include procurement, maintenance and management of medical equipment; inferential statistics & hypothesis testing; medical device tests; equipment calibration. Students will gain a working knowledge of the physiological effects of electricity and understand the application of various electrical safety devices (e.g. GFCI & LIM) in a hospital environment. The IEC601-1 Electrical Safety Test procedures & safety limits are emphasised. Students learn to perform these tests using electrical safety analysers.

Diagnostic, Therapeutic & Laboratory Equipment
This module exposes students to a broad range of biomedical equipment and prepares them to understand and work with important hospital-based diagnostic, therapeutic and clinical lab equipment. Students will be taught the principles, functions, features & limitations of these equipment, which will help them understand and perform better maintenance, testing and calibrations. Examples of diagnostic equipment taught are electrocardiographs, patient monitors, respiratory measurement equipment, electroencephalographic amplifiers, etc. Examples of therapeutic equipment taught are defibrillators and cardiac pacemakers. Surgical equipment and clinical laboratory instrumentation are also taught which includes spectrophotometers, chromatographs and blood cell analysers.

Medical Imaging Technology
This module aims to provide students with an understanding and appreciation of the field of Medical Imaging. Students will be taught the different types of medical imaging principles and their application in diagnostic therapy. Image processing theory and concepts are introduced before the various imaging technologies are taught. Specific areas of radiology include topics such as ultrasound imaging, radionuclide imaging, X-ray, Computer Tomography (CT) and Magnetic Resonance Imaging (MRI) are taught. This activity-based module helps students to learn through web research, assignment and exercises, and to identify themselves with their future profession in Biomedical Engineering.

Project ID - Connecting the Dots (IS Module)
This module aims to prepare students for an increasingly globalized and interconnected world where problems are multi-faceted and require interdisciplinary research and collaboration to solve. Using a project-based learning approach, students will have the opportunity to work in a multi-disciplinary team to investigate and propose comprehensive recommendations for a pressing real-world problem affecting Singapore. They will be guided to step out of their disciplinary silos and effectively communicate and collaborate with peers from different backgrounds. Ultimately, the module seeks to develop independent learning skills and the ability to synthesize diverse strands of knowledge to solve a complex problem, while impressing on students the importance of being a responsible global citizen.

LEVEL 3.2
**Six-Month Local/Overseas Internship**
In this module, students will be attached to sponsoring companies for a period of approximately six months. During their internships, students will undertake projects assigned by the company / institution. Activities may be related to operations, research, project, maintenance, etc.

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Credit Units</th>
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<tbody>
<tr>
<td><strong>YEAR 3</strong></td>
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<tr>
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<td>BME Project Design</td>
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<td>Clinical Engineering</td>
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<tr>
<td>Diagnostic, Therapeutic &amp; Laboratory Equipment</td>
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<tr>
<td>Medical Imaging Technology</td>
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<td>Project ID: Connecting the Dots ^</td>
<td>4</td>
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<tr>
<td><strong>Level 3.2 (22 hours per week)</strong></td>
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<tr>
<td>6-Month Internship / Final-year Project</td>
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</tbody>
</table>

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