

# DIPLOMA PLUS PROGRAMME ELECTIVE MODULES

## AEROSPACE DESIGN CLUSTER

This cluster develops students' technical competency in computer-aided engineering design and simulation, enhancing their capability for a design career, particularly in the field aerospace engineering.

### Aerospace Mechanism Design

The mechanism design module equips students with computer-aided engineering skills to articulate and perform kinematics analyses of mechanisms. The students will be able to design, assemble and model behaviour of motion generating machine elements. Animated results and data obtainable from the analyses will be used for design optimisation.

### Aerospace Component Design

This module focuses on the basic engineering methods and tools for the design and development of aerospace components. The objective is to equip students with a good understanding of the fundamental engineering principles of aerospace component design, and a knowledgeable appreciation of the elemental aspects of computational stress analysis using finite element methods.

### Aerospace Design Simulation

This practice-oriented module enables students to perform basic computational fluid dynamic analyses of aerospace component design through the appropriate use of numerical methods and computer applications. In the process, students will hone their engineering analytical skills and apply knowledge acquired from the previous modules to work on the various interesting aerospace design projects.

## AEROSPACE ELECTRONICS CLUSTER

This cluster is designed for students interested in the aerospace industry. It provides an appreciation of aviation and the electronics systems in a modern aircraft. The three aerospace fundamental modules are Human Factors, Fundamentals of Aerospace Technology, and Avionics Systems.

### Human Factors

This module introduces students to human factors, which refer to the study of human capabilities and limitations and how they affect performance at work. Topics include social psychology, physical environment, types of tasks, and communication and human errors, with special reference to the aerospace industry.

### Fundamentals of Aerospace Technology

This activity-based module aims to provide students with an appreciation on the basics of aerodynamics and principles of flight, basic aircraft structures, components and systems, basic aircraft design features and airworthiness legislations requirement for the aerospace industry. It traces the historical development of aerospace technology and examines issues which have an impact on the Singapore aerospace industry.

### Avionics Systems

This module provides students with an appreciation of aircraft electronics systems. It includes topics such as cockpit flight instruments, navigation, communication, surveillance and flight control systems, as well as other essential electrical and electronics systems found in a modern commercial airliner.

## APPLIED PHYSICS CLUSTER

Designed in collaboration with the Department of Electrical and Computer Engineering, National University of Singapore (NUS), this cluster helps to prepare students for university-level physics modules. The three modules in the cluster enhance the students' knowledge and bridge the gaps to university physics modules.

### Foundational Physics

This module covers the fundamental knowledge in units

and measurement, mechanics, thermodynamics and oscillation.

### Classical Physics

This module covers the remaining topics of classical physics at the undergraduate level. The topics are dynamics, gravitation, thermodynamics and electromagnetism. For the last topic, the focus is more on the theoretical fundamentals, as opposed to the applied aspect found in the typical diploma-level module.

### Modern Physics

This module covers modern physical concepts that include topics such as atomic structure, quantum concept, wave-particle duality, nuclear physics and radioactivity. Additionally, the study of the applications of modern physics lets the student realise its practical usefulness.

## AVIATION FUNDAMENTALS CLUSTER

Based on the ground school examinations curriculum of the Private Pilot Licence (PPL) as specified in the Singapore Air Safety Publication published by the Civil Aviation Authority of Singapore, the Aviation Fundamentals cluster is designed for students who are interested in flying as a co-curriculum activity or as a future profession. The syllabus is based on the five basic modules offered in the ground school examinations for the PPL. It provides a foundation in aircraft systems and operations with an emphasis on the basic principles of air navigation and aviation technology. The cluster consists of three integrated modules:

### Aircraft Rating

This module provides a foundation in aircraft systems and the basic principles of flight with an emphasis on general aviation aircraft. It covers the systems of fixed wing and rotary wing aircraft as well as the operating environment, airworthiness requirements, structural limitations and basic aircraft maintenance.

### Meteorology, Human Performance & Limitations

This module consists of two components: Meteorology

as well as Human Performance and Limitations. The meteorology component provides a foundation in the study of weather and its effect on flight operations. The component on human performance and limitations covers the factors and interactions between man and machine, and their impact on aviation safety with an emphasis on air crew performance in the flight environment.

#### Aviation Law, Flight Rules & Procedures, and Navigation

This module consists of two components: Aviation Law, Flight Rules and Procedures as well as Navigation. The first component provides a foundation in aviation laws and regulations, rules of the air and flight procedures. The second component covers the use of aeronautical charts and basic air navigation including the determination of track, heading, air speed and ground speed. This module provides training in the essential skills and knowledge required for a basic pilot licence.

### BIOMEDICAL ENGINEERING CLUSTER

This cluster prepares students for the exciting field of biomedical engineering. The Foundational Chemistry and Further Engineering Mathematics modules aim to bridge the gap with university science and mathematics modules in the engineering and science courses. The Biomedical Signal Processing and Medical Imaging Technology modules seek to introduce students to the exciting and promising field of Biomedical Engineering.

#### Foundational Chemistry

Students are introduced to the concepts of physical, inorganic and organic chemistry. Students will gain a working knowledge of the atomic nature of matter, periodic table and law, chemical bonding between particles, mole concept, the balancing of chemical equations, different types of chemical reactions, spontaneous and non-spontaneous processes, the role of catalysts, as well as the structure and properties of various organic compounds.

#### Further Engineering Mathematics

Students are introduced to the various types of differential equations and their solutions, as well as their applications in science and engineering. Students will

gain a working knowledge of using differential equations in modelling physical and engineering systems. They will develop important skills to obtain the solution of a differential equation by applying analytic, numerical, or graphical techniques.

#### Biomedical Signal Processing

This module gives an introduction to biomedical signal processing and analysis. Students are introduced to fundamental signal processing techniques to analyse and process signals that originate from biological sources such as ECGs, EMGs, EEGs, and blood pressure signals, and integrate the information with physiological knowledge, useful for physiologic investigation and medical diagnosis and processing.

#### Medical Imaging Technology

This module aims to expose students to the field of Biomedical Engineering through an understanding and appreciation of medical imaging technology and equipment. 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 including topics such as ultrasound imaging, X-ray and Magnetic Resonance Imaging are taught.

### COMPUTER-AIDED DESIGN SKILLS CLUSTER

This cluster is specially designed to strengthen and deepen the technical knowledge and skills of students in applying design software skill to solve challenging engineering design problems. Talented students will be invited to join the programme. The programme will equip students with strong engineering problem solving skills and prepare them to participate in World Skill Singapore (WSS) Competition and related events.

#### Fundamental Mechanical CAD

This module is a practice-oriented module designed to give students strong fundamentals in using AutoDesk Inventor as Computer Aided Design tool in solving engineering design problems. This module covers drafting concepts and techniques.

#### Advanced Mechanical CAD

This is a practice-oriented module designed to equip students with strong advanced software skills in solving engineering design problems. This module covers advanced CAD commands and engineering design principles. Topics include geometric dimensioning and tolerancing, assembly techniques and designs.

#### Mechanical CAD Project

This module is a project-based module designed to hone students' knowledge and skill in solving complex engineering design problems. This module covers advanced engineering design concepts and techniques on a wide range of case studies and design projects.

### COMPUTER & COMMUNICATION SYSTEMS CLUSTER

The modules in this cluster are designed to strengthen students' knowledge in computer and communication systems. Students will acquire knowledge in computer networking, Linux Systems administration, web technologies and tools. In addition, they will also study the latest developments in various modern communication systems, in particular the Digital Audio and Video broadcast systems.

#### Operating Systems & Networking

This module covers fundamental operating system principles and networking concepts. UNIX/Linux are used as the primary operating system reference model for this module. Network Management and UNIX/Linux networking are included, together with an emphasis on writing basic application programs. This module will prepare students with a suitable background for working in system administration, Local Area Network (LAN) and the internetworking environments.

#### Internet Technology

The module aims to provide the concept of Web operations and the tools used for developing Webbased applications. Students will learn the basics of HTML, Java language, JSP, JDBC and JavaScript so that they are able to develop multiple-tier Web-based database applications.

### Digital Audio & Video Technology

This module introduces students to digital audio and video fundamentals and compression standards, together with their applications in multimedia services and broadcasting technology. It also covers the basics of Digital Audio Broadcasting (DAB) and Digital Video Broadcasting (DVB) standards and their capabilities as compared to the current analogue broadcasting systems.

### Communication Systems & Applications

This module provides the opportunity for students to explore and recognise the developments that are currently used in communication systems. Students will acquire an understanding of wireless technology and be able to apply key concepts and processes associated with transmission fundamentals, high frequency transmission media and wave propagation. They will then be able to appreciate the application of RF technology to radar systems, satellite and mobile communication systems, fibre optical communication and the increasingly popular RFID and Bluetooth technology.

## COMPUTING METHODOLOGY CLUSTER

This cluster is designed for engineering students who wish to strengthen their computer science and programming foundation for university studies. The syllabus is based on the first-year computer science curricula for engineering degrees of NUS and NTU. The cluster consists of three sequential modules.

### Advanced C Programming and Techniques

Topics included are fundamentals of C, Arrays, String, Pointers, File Processing, Bitwise Operations and Serial Communication.

### Programming and Data Structures

Topics included are fundamentals of Data Structures, Unions, Advanced Pointers, Stacks and Queues, Linked Lists, Binary Trees and Hashing.

### Algorithms and Applications

Topics included are fundamentals of Algorithms, Recursion, Sorting and Searching, Management Sciences and Engineering Applications.

## ELECTRICAL CONTROL & MEASUREMENT CLUSTER

This cluster aims to provide students with relevant knowledge and skills in the areas of precision electrical measurement, calibration and electrical system control. It also aims to provide students with a basic understanding of power quality.

### Electrical Calibration & Measurement

Students are introduced to the theories and practices in metrology and calibrations. This includes precision electrical measurements and the process of selecting and setting up instruments as well as precautionary measures to obtain the best possible measurement results. Students will also learn about the characteristics of instruments, such as the digital multimeter, counter and oscilloscope.

### Lighting Technology & Control

This module provides a broad knowledge of lighting in commercial, industrial, residential and theatrical productions. Students will gain a comprehensive overview of the science of lighting design as well as the technical knowledge of lighting in different environments.

### Fundamentals of Power Quality

This module introduces the various technical and economic issues of power quality. Topics covered include power interruptions, voltage sags, transient over-voltage, voltage regulation, harmonics, filtering and common grounding problems. Students will also learn about the impact of power quality on sensitive equipment, international standards on power quality, power quality monitoring, and the methods used to mitigate power quality problems.

### Sensors & Instrumentation (For CEM students)

The module equips students with graphical programming skills using LabVIEW and the knowledge to develop virtual instrumentation systems. Students learn the concept of virtual instrumentation, sensor technologies, data acquisition devices, and computer interfaces such as RS232, GPIB and USB.

## ENVIRONMENTAL INNOVATIONS CLUSTER

This cluster will help EWT and SDE students develop specialised skills for process design and operation, and research techniques. These skills will complement their domain knowledge for further studies or prepare them for work in the environmental and water technology field. Students will work alongside research engineers and scientists at EWTCOI in R&D projects in emerging areas of environmental and water technology.

### Membrane Technology 1, 2 & 3

Students will learn how the industry applies membrane technology to treat polluted waters and air. Experiential learning will include the technique of preparing and designing membranes, performance testing of membranes for relevant applications, understanding and managing membrane fouling, and membrane cleaning methods.

### Water Technology 1, 2 & 3

Students will be involved in novel water technologies which can be applied in water quality monitoring, non-conventional methods of water treatment and improvements to current water treatment methods. Students will be directly involved in the design and test-bedding of these technologies using prototype systems. They will understand how to optimise the operating parameters, develop testing protocols to test the performance of the systems, refine design considerations and techniques of troubleshooting and control and monitoring.

### Waste to Resource 1, 2 & 3

Students will be involved in the exciting field of using science and engineering to convert waste into new resources. Some examples of such technologies include the conversion of glass to building materials, food waste to energy or compost, and algae to energy or nutrient supplements. Students will also learn how the fundamentals of material science and engineering, chemistry, microbiology and civil engineering can be used to transform different wastes into new materials or resources.

### Green Building Technology 1, 2 & 3

This module aims to provide students with insight into the Building Construction Authority's Green Mark Scheme. Understanding the scheme will provide a clear picture of the concept of actions and technologies that can be implemented to achieve the greening of the building. Students will learn to use the latest computer software tools such as building information modelling, building performance and energy analysis software. These tools are designed to predict building energy performance so that green building professionals can effectively develop creative sustainable solutions. Other areas of research will expose students to the latest technologies on sustainable and renewable products that would help to reduce the detrimental effect on the global environment.

### INDUSTRIAL CONTROL CLUSTER

This cluster equips students with knowledge and practical training in the areas of electrical control wiring systems. Students will also acquire skills in programming and designing Programmable Logic Controllers for industrial applications. It aims to train students to compete in the World Skills Singapore Competition (Industrial Control Category).

#### Electrical Control and Wiring

This module aims to provide students with knowledge and practical training in electrical control wiring system. Students will learn to read and interpret the circuit diagrams and wiring of control panels. The training will include mounting and wiring of control panels, PVC conduits, flexible conduits, connectors, junction boxes, PLC and other electrical components, and termination and numbering of cables according to layout diagrams.

#### Control Circuit Design & Troubleshooting

Students will learn the IEC Standards and symbols for Power Control and Protection components including relays, contactors, alarm and signal indicators, timers, limit switches, proximity sensors, photosensors, thermostats, protective devices, and motors. Students will also learn how to troubleshoot and locate faults on test panel within an allocated time.

### Advanced Programming for Programmable Logic Controller

Students will learn to program and design Programmable Logic Controllers (PLC) and learn about their industrial applications. Programming of PLC on projects involves digital I/O, analogue I/O, timers, counters, and internal registers. Students will also learn how to simulate, test the PLC program, and interface of the PLC with inverter, touch screen, sensors, switches, indicating lights, motors starters and other I/O devices.

### LEISURE AND RETAIL MANAGEMENT CLUSTER

This cluster is aimed at helping students develop the relevant knowledge and skills for managing a variety of service, business and specialised facilities.

#### Retail Management

This module is designed for students who have a strong foundation and interest in Property Management. It delves further into the strategies that will improve the positioning of a shopping mall, leasing issues and its day-to-day management. Case studies will be used extensively for illustration.

#### Hospitality Management

In this module, students will learn how the effective management of real estate in the hospitality industry will contribute to the growth of Singapore's economy and property investments. They will also learn how operating effectiveness and preventive maintenance programmes for the various departments and functions in hotels, serviced apartments, lofts and resorts can save operating costs and increase the values of these real estate assets.

#### Space Modelling

Students will learn to develop digital 3D building models, and carry out interior space design and layout, as well as create attractive perspective views and walk-throughs by using current Building Information Modelling software such as Revit Architecture.

#### Hotel & Recreation Facilities

This module will provide students with an overview of

major specialised facilities in hospitality and recreational facilities. It will cover facilities in theme parks, hotels and resorts. Topics include rides and simulators, laser shows, musical fountains, air conditioning for hotel guest rooms and function rooms, kitchen equipment and kitchen exhaust system, filtration system for swimming pools, hot water system and steam generation.

#### Healthcare & Business Park Facilities

This module will provide students with an overview of major specialised facilities in healthcare and business parks that house microelectronic, IT, pharmaceutical and biotechnology companies. Topics include the cleanroom environment, biosafety laboratory, uninterruptible power supply, ultra-clean water supply, and management of hazardous waste.

#### Ecotourism

Ecotourism is considered the fastest growing market in the tourism industry. This module will help students to formulate and develop ecotourism programmes in order to enable people to enjoy and learn about the natural, historical and cultural characteristics of unique environments while preserving the integrity of the sites, as well as meeting tougher environmental requirements.

### MECHANICAL TECHNOLOGY CLUSTER

This cluster equips students with a strong foundation in mechanics modules, preparing them for further study in engineering programmes, particularly benefiting Product Design & Innovation students who wish to gain exemption in degree programmes in mechanical engineering.

#### Applied Engineering Mechanics

This module aims to equip students with the necessary skills to analyse problems of rigid bodies at rest and in motion. Topics include Trusses, Friction, and Work energy and Impulse momentum methods. Students will develop skills to solve engineering problems.

#### Applied Mechanics of Materials

This module studies the effects of external forces and

temperature changes on solids in the form of stresses and deformations. Students apply concepts of stresses, stress-strain diagrams, and Hooke's Law in analysing and solving engineering problems. Topics include stresses and strains, torsion, shear forces and bending moments, beam stresses, combined stresses and experimental stress analysis.

#### Applied Thermofluids

This module covers the fundamental concepts of thermodynamics and fluid mechanics, and their applications in products and systems. Topics include thermodynamic system concepts, the laws of thermodynamics, properties of working fluids, non-flow and steady flow processes with steam and perfect gas, basic heat transfer, principles of fluid mechanics, hydrostatic forces and buoyancy, energies of liquids in motion, and losses of energy in pipelines.

#### MECHATRONICS APPLICATION SKILLS CLUSTER

This cluster is specially designed to strengthen the technical knowledge and practical skills of students in the applications of Mechatronic systems. Potential and talented students will be invited to join the programme, which will also equip students with strong engineering problem solving skills and prepare them for the World Skill Singapore (WSS) Competition and related events.

#### Fundamental Mechatronics & Control

This practice-oriented module is designed to give students strong fundamentals in electrical control systems and principles, characteristics, selection and application of sensors and actuators in typical Mechatronic systems. This module also introduces them to programmable logic controllers, control devices and the relevant Window-based programming software. Students will learn to design ladder diagrams with Programmable Logic Controller (PLC) using CX programmer and perform exercises relevant to industrial applications.

#### Advanced Mechatronics & Control

This module is a practice-oriented module that is designed to equip students with strong advanced software skills particularly into various industrial

scenarios like testing, distribution and sorting with Mechatronic systems. This module covers assembly skills for various Mechatronic systems and commissioning the individual or combined stations. Student will also practice on actual workstations used in the World Skills Competition.

#### Mechatronics Control Project

This is a project-based module designed to hone students' knowledge and skills in resolving engineering problems in various scenarios. This module covers concepts and techniques on a wide range of case studies and design projects.

#### MICROELECTRONICS CLUSTER

This cluster comprises of modules which will provide exposure to the principles of microelectronics design, manufacturing and assembly. Students will gain an appreciation of the range of activities and disciplines that are employed in the creation of integrated circuits. Students will obtain a basic foundation in this exciting area of technology that will enable them to pursue employment opportunities in the industry.

#### Microchip Technology

This module introduces students to various Integrated Circuit (IC) technologies. It provides students with basic concepts of Metal-Oxide-Semiconductor (MOS) digital integrated circuit design. At the end of the module, students will be able to design and layout simple MOS digital ICs both in theory and in practice.

#### IC Layout

The aim of this module is to equip students with basic analogue and digital Integrated Circuit (IC) Layout Design skills. The students will learn how to use computer-aided design tools for layout editing and verification. Students will also learn about the methodology and techniques employed in IC Layout Design.

#### Microelectronic Manufacturing & Assembly

This module aims to provide students with knowledge of the planning and control aspects of process technology to prepare them for careers in the

manufacturing industry. The course also covers basic Integrated Circuit (IC) and surface-mounted board assembly processes, sensor technology and maintenance engineering.

#### NETWORK SYSTEMS & SECURITY CLUSTER

This cluster offers modules for students who are interested to work in the networking industry. Students will be equipped with knowledge in remote access technologies and apply their knowledge acquired in designing a network. They will also learn how to optimise a converged network comprising of voice, wireless and security applications.

#### Workstation Hardware & Software

This module focuses on the functionality of hardware and software components. Through hands-on sessions, students learn how to assemble and configure a computer, install operating systems and application software, and troubleshoot hardware and software problems. They will also be introduced to basic networking concepts, including how to set up a home office network.

#### Internetworking Project Design

This module builds on students' knowledge acquired in the fundamental modules Internetworking 1, Internetworking 2 and Internetworking 3. In this module, students work in teams on three case studies where they will apply their knowledge acquired in the foundational modules to design an internetwork that fulfils the requirements stated in the case studies.

#### Remote Access Networks

This module introduces techniques and technologies to secure and expand the reach of an enterprise network to tele-workers and remote users with focus on securing remote access and virtual private network (VPN) client configurations.

#### Optimising Converged Networks

This module describes the converged network requirements within conceptual network models. It provides the student with important knowledge and advanced hands-on skills in optimising and providing

effective quality of service techniques for converged networks that support voice, wireless and security applications.

## ROBOTICS CLUSTER

The modules in this cluster aim to equip students with the knowledge of robotics and intelligent systems, sensors and imaging systems with microcontroller and decision-making using crisp & fuzzy logic.

### Robotics & Intelligent Systems

This module gives an overview of important types of intelligent robot systems available and their applications. The essential features of an intelligent robot, such as reasoning, parsing and planning, are discussed. It also covers analogue and digital circuits commonly used in robotic systems. It also highlights the tradeoffs between the wheel-driven and tread-driven types of mobile robots and selection of motors for robot manipulators.

### Sensors & Vision Systems

This module equips students with knowledge and skills in using sensors and imaging systems with a microcontroller embedded system. The applications include distance measurement and object recognition.

### Artificial Intelligence & Control

This module provides the solutions on decision-making using crisp & fuzzy logic, decision trees, and path planning algorithm. The discussion includes the sensor data logging process and the application of numerical methods in target solution evaluation and search. The feedback control algorithms for the two-wheel differential drive are also included. The study will be focused on the mobile robot control in an unknown enclosed environment.

## STAGE MANAGEMENT AND TECHNOLOGY CLUSTER

This cluster is aimed at providing students with knowledge related to Technical Theatre: stage technology, which includes lighting, props, theatre settings and layout; and management issues related to show/drama/concert productions. It also seeks to

equip students with basic knowledge in managing supporting technology in shows such as sound, light and video controls. In addition, students can have practical sessions on creating, editing and mixing music to produce sound effects such as surround, spatial and other special effects.

### Introduction to Technical Theatre

The module will provide students with brief knowledge in the topics of lighting, makeup, production, scene setting, sound for stage, theatrical property and costume. Students will study the effect of lighting for theatre productions including the size, intensity, shape, and colour of light for a given scene, which help to accentuate an actor's features. The production process will be discussed briefly. Scenery, which includes set construction, scenic painting, soft goods (drapes and stage curtains) is described, as well as special effects and sound, such as musical underscoring, vocal and instrument mixing and theatrical sound effects. Finally, the module will briefly study theatrical property, or props, which includes furnishings, set dressings, hand props, and an actor's costume props.

### Introduction to Live Performing Arts

The performing arts include theatre, motion pictures, drama, comedy, music, dance, opera, magic and the marching arts. In this module, students will learn to identify, analyse and appreciate the different types of performing arts. Studies include staging, ambience, audio reinforcement, genre of music, costumes, background and storyline.

### Stage Management

In this workshop-based module students learn the roles and responsibilities of the stage manager. Students learn the techniques of successfully managing the numerous aspects of a production, both on stage and backstage, in the pre-rehearsal, rehearsal, performance, and post-performance phases. This includes: the planning of a master calendar and prompt script; aspects of coordination with production designers; using light, sound and costume plots effectively; coordinating the efforts of the cast to stay on scripts; performing checks on safety, legal issues, lighting and

sets; and the smooth coordination of technical and dress rehearsals.

## WORKPLACE SAFETY & HEALTH CLUSTER

This cluster equips students with knowledge and understanding of workplace hazards as well as control measures for minimising, preventing and managing safety and health risks in workplaces of diverse industrial sectors. The programme develops their capabilities in managing Workplace Safety & Health (WSH) issues related to engineering practices, and prepares them for a career as industrial safety coordinators or officers.

### Workplace Safety

This module equips students with the fundamental knowledge of workplace safety. Topics include spotting workplace hazards and various techniques used to control these hazards. In addition, students will learn the various methods that are deployed in the industry to ensure compliance with MOM legal requirements.

### Workplace Health

This module equips students with knowledge in occupational health. Topics include identification of industrial health hazards and their prevention, implications of industrial noise, chemical hazards, lighting, thermal environment, radiation, confined space, general ventilation, occupational diseases and occupational health management.

### Workplace Safety Management & Risk Control

This module introduces students to workplace safety management and risk control. Topics include managing WSH hazards and control measures, risk analysis, WSH policy, behavioural safety programmes, WSH legal issues and work injury compensation act, WSH incident investigation, WSH performance analysis and safety audit, safety education, training and communication.