Annex II

MASTER OF SCIENCE IN ENGINEERING IN ROBOTICS AND INTELLIGENT SYSTEMS
(Applicable to students admitted to the curriculum in the academic year 2025-26 and thereafter)

Definition and Terminology

Discipline course – any course offered by the curriculum of the Master of Science in Engineering in Robotics and Intelligent Systems (MSc(Eng)(RIS)).

Fundamental course – a specific number of discipline courses in the curriculum that a student must pass.

Elective course – any course offered at taught postgraduate level by the Departments of the Faculty of Engineering, and selected courses in the subject areas of COMP, ECOM, FITE, ICOM offered by the School of Computing and Data Science, for the fulfilment of the curriculum requirements of the degree of MSc(Eng)(RIS) that are not classified as discipline courses.

Capstone Experience – a dissertation or a project which is a compulsory and integral part of the curriculum.

Curriculum Structure

Candidates are required to complete 72 credits of courses, as set out below.

	Enrolment Mode	
Course Category	**8 Courses + Dissertation**	**10 Courses + Project**
Discipline Courses (including 3 Fundamental Courses)	Not less than 36 credits	Not less than 48 credits
Elective Courses	Not more than 12 credits	
Capstone	Dissertation (24 credits)	Project (12 credits)
Total	72 credits	

Candidates are permitted to select courses in accordance with Regulations MSc4, MSc5 and MSc6. The curriculum provides two enrolment modes for candidates to choose from either (i) 8 courses plus a dissertation, or (ii) 10 courses plus a project. In choosing the enrolment mode (i), candidates must complete a 24-credit dissertation and at least 6 discipline courses (including 3 fundamental courses); for enrolment mode (ii), candidates must complete a 12-credit project and at least 8 discipline courses (including 3 fundamental courses).

Candidates choosing any enrolment mode can take no more than 2 elective courses out of Taught Postgraduate level courses offered by other curricula in the Faculty of Engineering, and selected courses in the subject areas of COMP, ECOM, FITE, ICOM offered by the School of Computing and Data Science. All selection will be subjected to approval by the Course Coordinator.

The curriculum is offered in both part-time and full-time modes. For the part-time mode of study, the curriculum shall extend over not less than two and not more than three academic years of study. For the full-time mode of study, the curriculum shall extend over not less than one and not more than two academic years of study.

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The curriculum provides advanced education and training in the philosophy, methods and techniques of robotics and artificial intelligence, which are essential for developing and deploying advanced robots and intelligent systems in many fields from manufacturing and logistics to healthcare and education.

All courses are assessed through examination and / or coursework assessment, the weightings of which are subject to approval by the Board of Examiners.

The following is a list of discipline courses offered by the Department of Data and Systems Engineering. It should be noted that not all of the courses listed below are offered every year:

List of Discipline Courses (All courses are 6 credits, unless otherwise specified.)

Fundamental Courses (compulsory):
DASE7501 Robot modelling, planning and control
DASE7502 Advanced Robot sensing and intelligence
DASE7503 Robotic systems integration

Capstone Course (compulsory):
DASE7098 Project (12 credits) or
DASE7099 Dissertation (24 credits)

Other Discipline Courses:
ELEC6008 Pattern recognition and machine learning
ELEC6026 Digital signal processing
ELEC6099 Wireless communications and networking
ELEC6100 Digital communications

DASE7113 Optimization methods for intelligent systems
DASE7128 Human factors engineering
DASE7137 Virtual reality and applications
DASE7138 Healthcare systems engineering
DASE7139 Cyber-physical systems
DASE7140 Machine learning and applications
DASE7141 Advanced digital twin and applications
DASE7142 Advanced computational methods
DASE7143 The internet of things
DASE7154 Intelligent technologies for systems engineering A
DASE7155 Intelligent technologies for systems engineering B
DASE7504 Human-robot collaboration
DASE7505 Intelligent unmanned systems
DASE7507 Frontiers in robotics and intelligent systems
MECH7010 Contemporary robotics
MECH7017 Robotic control
MECH7020 Autonomous drones
MECH7021 Field and services robotics

Elective Courses
Please consult courses offered for other taught postgraduate curricula in the Faculty of Engineering.

<u>Calendar entries for discipline courses included in the MSc(Eng)(RIS) curriculum</u>

ELEC6008. Pattern recognition and machine learning (6 credits)

This course aims at providing fundamental knowledge on the principles and techniques of pattern recognition and machine learning.

Specifically, the course covers the following topics: Bayes decision theory; parametric and non- parametric methods; linear discriminant functions; unsupervised learning and clustering; feature extraction; neural networks; context-dependent classification; case studies.

Pre-requisite: A good background in linear algebra, programming experience.

Mutually exclusive with: COMP7504 Pattern recognition and applications

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ELEC6026. Digital signal processing (6 credits)

This course provides an introduction to the fundamental concepts of digital signal processing (DSP) including a wide variety of topics such as discrete-time linear-time invariant systems, sampling theorem, z-transform, discrete-time/discrete Fourier transform, and digital filter design. Furthermore, the course will also discuss in detail about other advanced topics in digital signal processing such as multidimensional signals and systems, random processes and applications, and adaptive signal processing.

ELEC6099. Wireless communications and networking (6 credits)

5G refers to the fifth generation wireless technologies for digital cellular networks that began wide deployment in 2019. This course aims at introducing the core principles and technologies for 5G communications and networking. The first half focuses on basic concepts and techniques including radio propagation, digital modulation, Orthogonal Frequency Division Multiplexing (OFDM), Multiple-Input-Multiple-Output (MIMO) Communication. The second half provides a comprehensive introduction to 5G covering physical layer (PHY) technologies, millimetre wave (mmWave) communications, network virtualization and slicing, provides an introduction to different types of networks including cellular networks, satellite communication networks, narrow-band Internet-of-Things (NB-IoT).

Mutually exclusive with: ELEC6040, ELEC6071 and ELEC6087

ELEC6100. Digital communications (6 credits)

This course aims at enabling the fundamental understanding of the digital communication systems. After an overview on basic probability and random processes, the course will cover the modulation and demodulation. Then, performance analyses under additive white Gaussian noise channel and fading channel are examined. This is followed by topics on spatial diversity and channel equalization.

Mutually exclusive with: ELEC6014 and ELEC6045

DASE7098. Project (12 credits)

A group of students will work on a supervised project that relates to major research and/or industrial projects and initiatives that supervisors have recently carried out. Groups are expected to generate project deliverables of a variety of forms including patents, software copyrights, research papers, proof-of-the-concept solutions and products, consultancy reports / whitepapers, etc. This course will provide students with a range of opportunities to engage in academic research, industrial innovation and entrepreneurship development.

DASE7099. Dissertation (24 credits)

Student individuals will undertake a supervised project which will be assessed. The dissertation module must relate to the subject matter and be agreed by the Department of Industrial and Manufacturing Systems Engineering. The Dissertation can be related to research projects within the department or industry-related projects.

DASE7113. Optimization methods for intelligent systems (6 credits)

Overview of optimization theory; linear and nonlinear programming; integer programming; simplex method; steepest descent method; Newton's method; Frank-Wolfe algorithm; branch-and-bound algorithm; emerging topics in optimization; applications in data science; applications in real-world engineering systems (e.g., energy, transportation, logistics, service)

DASE7128. Human factors engineering (6 credits)

Ergonomics and systems design. Physical ergonomics, anthropometry, biomechanics. Human information processing, person-machine interface design, displays and controls. The visual environment and visual performance. Thermal environment and effects on performance, indices of comfort. Noise; noise measurement, effects of noise, control of noise. Vibration and acceleration; human tolerance.

DASE7137. Virtual reality and applications (6 credits)

Fundamental concept of virtual reality, augmented and mixed reality; human perception and virtual reality; system components of modern virtual reality systems; applications of virtual reality technology in engineering systems design and analysis, immersive and interactive virtual environments; innovation and consciousness with virtual reality system development and deployment, ethical issues and social impacts of adopting virtual reality in system development. Designing and building virtual systems with immersive virtual reality systems including CAVE-like environment and VR headsets.

DASE7138. Healthcare systems engineering (6 credits)

Introduction to healthcare delivery systems; healthcare technology-human integration; human factors in healthcare; crew resource management; quality of care; economic analysis in healthcare; healthcare logistics; healthcare system test and evaluation; analysis and design for patient safety.

DASE7139. Cyber-physical systems (6 credits)

This course mainly consists of lectures and projects. The topics include introduction to cyber-physical systems (CPS), sensors and sensor networks, robotics and automation, communications for CPS, data analytics in CPS, digital twins, cloud computing for CPS, and system integrations. By completion of the projects, the topics will be discussed in the related lectures and hands-on experiments. The outcomes of the individual projects will be integrated at the end to address CPS from system point of view as well in applications related settings.

DASE7140. Machine learning and applications (6 credits)

Overall view of machine learning methods. Supervised learning, unsupervised learning, reinforcement learning. Support-vector machines, linear regression, decision trees, k-nearest neighbor algorithm, neural networks. Active learning, classification and regression. Model training, testing, selection, and validation. Performance evaluation. Industrial applications in forecasting, ranking, recommendation systems, information extraction, object recognition in computer vision, and pattern recognition.

DASE7141. Advanced digital twin and applications (6 credits)

This course teaches fundamental technologies of digital twin. Overall view of basic concepts related to digital twin. How to build blocks of digital twin. The setup of sensor systems and digital twin infrastructures. The integration, testing, monitoring and maintenance of digital twin. Data collection, processing, storage, transmission, and synchronization. Simulation and decision-making support in industrial engineering and logistics management.

DASE7142. Advanced computational methods (6 credits)

This course teaches fundamental computational methods and the applications to engineering problems in the context of industrial engineering. Analytical models, algorithms, and simulation methods will be discussed. Variability and uncertainty in engineering problems. Foundations of probability, sampling distributions, confidence intervals. Interpolation and regression. Numerical solution of linear and non-linear equations, numerical differentiation and integration, boundary value problems, initial value problems and partial differential equations. Monte Carlo method.

DASE7143. The internet of things (6 credits)

Theory and fundamentals of internet of things (IoT). Methods to create abstractions, formalisms and semantics at IoT layer. Artificial intelligence of things, machine learning for IoT, edge computing. IoT challenges in security, reliability and privacy. Device software development, IoT in cloud-to-thing-continuum. IoT software development, test beds and quality assurance. Sensors and actuators, remote operations and control. IoT applications in manufacturing, construction, healthcare, logistics and supply chain management.

DASE7154. Intelligent technologies for systems engineering A (6 credits)

This course is part of the series "Intelligent technologies for systems engineering". This series of courses are designed to introduce students to critical technologies with applications in intelligent engineering systems. The course will cover essential topics about the intelligent technologies with an emphasis on their augmentation in data engineering and analytics. Students will learn the fundamental theories and knowledge related to the technologies, and how to leverage such technologies to enhance various aspects of industrial engineering. This course mainly consists of lectures and projects.

DASE7155. Intelligent technologies for systems engineering B (6 credits)

This course is part of the series "Intelligent technologies for systems engineering". This series of courses are designed to introduce students to critical technologies with applications in intelligent engineering systems. The course will cover essential topics about the intelligent technologies with an emphasis on their integration into complex industrial systems. Students will learn the fundamental theories and knowledge related to the technologies; and gain hands-on experience in implementing these technologies to improve efficiency, productivity and performance of the industrial systems. This course mainly consists of lectures and projects.

DASE7501. Robot modelling, planning and control (6 credits)

This course focuses on the fundamental concepts and techniques in robotics modelling, planning, and control. Topics covered will include forward and inverse kinematics, Jacobian matrix; Lagrangian mechanics, Euler-Lagrange equations; Linear and nonlinear interpolation, path planning and trajectory planning; motion and force control; intelligent robot control; Robot operating system (ROS); programming.

DASE7502. Advanced robot sensing and intelligence (6 credits)

This course focuses on the theories and algorithms in image processing and computer vision. Topics include image acquisition; image representation; image enhancement; image segmentation; image feature extraction; image restoration; mathematical morphology; image compression; scene understanding and motion analysis. Students will gain practical experience in implementing algorithms for image processing using Python or MATLAB.

DASE7503. Robotic systems integration (6 credits)

This course provides students with hands-on experience in designing, building, and programming robotic systems. It will enable the student to understand and work with robot hardware and software. Topics include electronic circuit design and implementation, embedded system development and programming, computer-aided-design, 3D printing, Robot Operating System (ROS), program advanced robotic systems (both industrial and mobile). Throughout the course, students will work in teams.

DASE7504. Human-robot collaboration (6 credits)

Human–robot interaction is a multidisciplinary field with contributions from artificial intelligence, robotics, natural language processing, design, and psychology. This course will focus on the emerging field of human-robot interaction technologies and systems. Topics include wearable sensors; brain computer interface; human-robot physical interaction; human-robot collaboration; wearable robots; tele-robotics.

DASE7505. Intelligent unmanned systems (6 credits)

This course will introduce students to the field of autonomous mobile robotics. Topics will focus on definition and applications of mobile robots; mobile robot components and architecture; kinematics and dynamics of mobile robots; sensors for mobile robots; planning and navigation for mobile robot; simultaneous localization and mapping; mobile manipulators; applications. The assignments of this course will involve building and testing autonomous mobile robots using simulation software and physical robots.

DASE7507. Frontiers in robotics and intelligent systems (6 credits)

The aim of this series is to provide students with a deeper understanding of the advance topics under the five areas of focus of this programme. This course focuses on the fundamental theories and advanced engineering technologies related to robotics and intelligent systems. Through this course, students are expected to have a holistic view of the fundamental theories and technologies for robotics and intelligent systems. This course mainly consists of lectures and projects.

MECH7010. Contemporary robotics (6 credits)

This course aims to explore the major technologies related to modern robotic systems, including the components and working principle of robots, automatic and computer-aided control, kinematics and control of mobile robots including drones and driverless cars, soft robots, etc.

The specific course objectives are: (1) to have a comprehensive understanding of robotic systems in terms of their system configurations, working principles, historical evolutions, and applications; (2) to understand the mathematical foundations, designs, data processing, and real-time control of various sensing and actuation units which comprise a robotic system; (3) to study the robot kinematics modelling, sensing, estimation, and control; (4) to explore the challenges and trends in contemporary robotic research, and the future directions for application of robotic components.

MECH7017. Robotic control (6 credits)

This course focuses on the fundamental principles of modeling, analysis, and control applied to robotics, utilizing both conventional and modern approaches. The course objectives are: (1) to equip students with the skills to employ various modeling methods for characterizing different types of robots; and (2) to foster a comprehensive understanding of control schemes for robotic systems. Topics include: Frequency domain analysis; Nyquist stability criterion; linear control system design; state-space analysis of multivariable linear system; controllability and observability; stability analysis; control of robotic systems.

MECH7020. Autonomous drones (6 credits)

This course aims to explore the key techniques of a small-scale, unmanned aerial vehicle (UAV), including sensor calibration, navigation systems, and advanced control techniques. The specific course objectives are as follows: 1) To have an overall understanding of UAVs: system configurations and applications. 2) To study the modelling, motion planning and nonlinear control techniques for small-scale UAVs, such as nonlinear dynamic inversion and optimal control. 3) To understand the common navigation techniques in modern small-scale UAVs, such as GPS / IMU navigation, visual-inertial navigation, and light detection and ranging (lidar) navigation. 4) To conduct experiments on state-of-the-art navigation and control techniques for actual UAVs.

This course covers the following topics: UAV configuration; UAV materials; innovative design methodology; dynamics and modeling; motion planning; path planning and obstacle avoidance; classic UAV control; modern UAV control; optimal and nonlinear control; navigation; state estimation; sensor fusion; visual odometry and lidar odometry; Simultaneous localization and Mapping (SLAM).

MECH7021. Field and services robotics (6 credits)

This course covers the following topics: localization; map representation; 3D sensing, path planning and navigation; wheeled and legged robotic design and locomotion, gait planning and balance; hand and arm movement; grasping and manipulation; teleoperation; safety and robustness. Case studies on robots for agriculture, mining, search and rescue will be provided.

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Notes: The examination-coursework assessment ratio: 40% to 100% for continuous assessment and 0% to 60% for examination