This Minor in Robotics and Intelligent Systems is offered under BEng(DASE) for 2025-26 cohort and onwards.

Minor in Robotics and Intelligent Systems

The syllabus applies to students admitted in the academic year 2025-26 and thereafter under the four-year curriculum.

The curriculum encompasses key areas of robotics and intelligent systems. Students in the BEng in Data and Systems Engineering (BEng(DASE)) and BEng in Industrial Engineering and Logistics Management (BEng(IELM)) must complete 36 credits of specialised courses, whereas students in other programmes are required to complete 12 credits of foundational courses and 24 credits of specialised courses. Students who have taken a course for their other degree requirements or minor programmes need to take a replacement among the specialised courses.

Candidates who are interested in pursuing minor in Robotics and Intelligent Systems must satisfy the following prerequisite:

- Level 4 or above in Mathematics in the Hong Kong Diploma in Secondary Education (HKDSE) Examination, or equivalent
- MATH1851 Calculus and ordinary differential equations
- MATH1853 Linear algebra, probability & statistics

Candidates are required to complete a total of 36 credits of courses in the following manner:

Course Code	Course	Credits
(i) Foundational courses		
Non-BEng(DASE) and non-BEng(IELM) students should take the two courses below:		
DASE2144	Fundamentals of robotics	6
DASE3139	The internet of things	6
(ii) Specialised courses		
From the following list, non-BEng(DASE) and non-BEng(IELM) students should take 24 credits, while BEng(DASE) and BEng(IELM) students should take 36 credits:		
CIVL3140	Artificial intelligence in civil engineering	6
DASE3103	Advanced robotics and automation	6
DASE3128	Human-machine collaboration	6
DASE3137	Virtual reality for systems engineering	6
DASE3155	Sensors and intelligence for robotic systems	6
DASE3156	Computer vision and applications	6
DASE3158	Data structures and algorithms	6
DASE4136	Intelligent transportation and autonomous driving	6
DASE4140	Machine learning and applications	6
DASE4141	Digital twin and applications	6
DASE4145	Data analytics for human-machine systems	6
DASE4146	Additive manufacturing	6
DASE4147	Mechatronic systems engineering	6
DASE4157	Security of cyber-physical systems	6
DASE4538	Healthcare systems engineering	6
ELEC3249	Pattern recognition and machine intelligence	6
ELEC4252	Robotic control and vision	6

MECH3433	Robotics, drones and autonomous ground vehicles	6
MECH4424	Sensors and actuators for robots	6
MECH4425	Human-robot control interface and wearable robotics	6

Notes:
1. In principle, double counting is not permissible. For students in the BEng in Industrial Engineering and Logistics Management and BEng in Data and Systems Engineering, a completed course within the minor programme curriculum can be counted toward either the graduation requirements of their Professional Core or the requirements of the minor programme, but not both.
2. Course enrollment in elective courses is subject to the approval of the Department of Data and Systems Engineering, in consideration of class quota and other academic issues.
3. The following courses have elements of hands-on experiences and design projects: DASE2144, DASE3139, DASE3103, DASE3137, and DASE3155

CIVL3140. Artificial intelligence in civil engineering (6 credits)

This course is designed to equip students with the knowledge of widely used data analytical skills and artificial intelligence algorithms and their applications in real-world civil engineering problems. This course aims to provide students with a comprehensive exposition of artificial intelligence approaches that are useful for solving real-world data analytic problems in civil engineering, particularly transportation engineering. Topics will include linear regression models, logistic regression models, decision trees, ensemble learning, deep learning approaches and unsupervised learning methods. Software packages such as Python will be used to support the demonstration of practical civil engineering applications in the course.

Assessment: 50% continuous assessment, 50% examination

DASE2144. Fundamentals of robotics (6 credits)

Introduction to robotics and automation, fundamental of robotics; basic components of robotic systems; robot applications including industrial robots, services robots, space robots, and medical robots; robot intelligence, integration of robotics systems for automation, applications of automation in manufacturing, logistics, and smart city; Global trend and development in robotics and systems automation. The course includes lectures and laboratory experiments.

Prerequisite: MATH1851 Calculus and ordinary differential equations;
MATH1853 Linear Algebra, Probability & Statistics
Assessment: 70% continuous assessment, 30% examination

DASE3103. Advanced robotics and automation (6 credits)

Discussing robot kinematics and dynamics modelling; introducing basic robot control and motion planning methods, sensing systems, and applications. The topics also include robot force control, teleoperations and the integration of robots with automation systems. The application examples include manufacturing automation and services. The course includes lectures and laboratory experiments. The course includes lectures and laboratory experiments.

Prerequisite: IMSE/DASE2144 Fundamentals of robotics
Assessment: 70% continuous assessment, 30% examination

DASE3128. Human-machine collaboration (6 credits)

Fundamentals of human-machine collaboration; human-centric theories and methods; design and evaluation of interactive systems through user studies; trust, safety, and health in human-machine collaboration; human sensation, perception, and cognition; information processing; heuristics, biases, and mental models in human decision making; human factors and ergonomics; UX and UI design.

Assessment: 40% continuous assessment, 60% examination

DASE3137. Virtual reality for systems engineering (6 credits)

Fundamental of virtual reality, concepts of virtual, augmented and mixed reality, visualization of and interaction with complex information and systems through virtual reality, applications of virtual reality technology in engineering systems design and analysis, immersive and interactive virtual environments; innovation and consciousness in virtual reality system development and deployment, ethical issues and social impacts of adopting virtual reality in system development, including user data privacy, safety standards and digital ethics. Designing and building virtual systems with immersive virtual reality systems including CAVE-like environment and VR headsets.

Assessment: 60% continuous assessment, 40% examination

DASE3139. The internet of things (6 credits)

Introduction to the Internet-of-Things (IoT); IoT network architecture; sensors and devices; IoT communication techniques; wireless sensor networks; edge computing; embedded systems; cloud computing; data analytics; distributed computing; control and signal processing; integration and interaction between cyber systems and physical systems; design, analysis, optimisation of CPSs; security and privacy techniques for CPSs and IoTs; CPS and IoT applications in smart manufacturing, smart supply chains, and smart healthcare.

Assessment: 50% continuous assessment, 50% examination

DASE3155. Sensors and intelligence for robotic systems (6 credits)

Introducing sensors and sensing system for robotic systems and operations; discussing methodologies for decision making in robotic operations including model-based as well as data-driven approaches; focusing on applications in manufacturing automation, services, and smart constructions. The course is a combination of discussions of theoretical knowledge and application examples. It consists of lectures and laboratory experiments.

Pre-requisite: DASE2144 Fundamentals of robotics
Assessment: 70% continuous assessment, 30% examination

DASE3156. Computer vision and applications (6 credits)

Fundamental principle of computer vision including imaging hardware systems, image processing methods, and pattern recognition; applications of computer vision including image based recognition and visual servo; application examples including industrial inspection, autonomous driving, and robot navigation.

Prerequisite: ENGG1330 Computer programming I or IMSE/DASE2113 Information systems
Assessment: 60% continuous assessment, 40% examination

DASE3158. Data structures and algorithms (6 credits)

This course will introduce the essential components for data structures. Basic concepts, definitions, and examples for data structure are included such as array, string, matrix/grid, stack, queue, hash, tree, and graph. Typical algorithms for data analytics will be covered, including searching and sorting algorithms, divide and conquer algorithms, graph algorithm, geometric algorithms, bitwise algorithms, and randomized algorithms.

Prerequisite: ENGG1330 Computer programming I
Assessment: 50% continuous assessment, 50% examination

DASE4136. Intelligent transportation and autonomous driving (6 credits)

Introduction to the Intelligent Transportation System (ITS) framework and autonomous driving systems; sensor and data collection in ITS; traffic flow theory and mathematical models; traffic control and operation; architecture of connected autonomous vehicles; localization and state estimation; perception in modern autonomous driving, neural network and deep learning; decision making and planning for autonomous driving; kinematic model and vehicle control; safety, reliability and social aspects of ITS and autonomous driving.

Prerequisite: IMSE/DASE2132 Statistical analysis
Assessment: 40% continuous assessment, 60% examination

DASE4140. Machine learning and applications (6 credits)

Introduction to machine learning; Supervised and unsupervised learning; Predictive and classification performance evaluation; Model training, testing, selection, and validation; Regularization and stability; Linear predictors; Boosting; Stochastic gradient descent; Support vector machines; Kernel methods; Decision trees; Neural networks; Dimensionality reduction; Feature selection; Machine learning applications in industry.

Prerequisite: IMSE/DASE2132 Statistical analysis and IMSE/DASE2135 Mathematical optimisation
Assessment: 50% continuous assessment, 50% examination

DASE4141. Digital twin and applications (6 credits)

Introduction to basic concepts and fundaments of digital twin (DT); Building blocks for DT; DT infrastructures and systems; Sensing technologies; Data twining and cloning; DT modelling; DT-enabled system integration, testing, and maintenance; DT for process monitoring; DT applications in manufacturing, robotics, construction, supply chain management, logistics, transportation, and healthcare.

Assessment: 50% continuous assessment, 50% examination

DASE4145. Data analytics for human-machine systems (6 credits)

Fundamentals of human-machine systems; data-driven decision-making and statistical modelling in human-machine interaction; analysis and prediction for human-machine system performance and safety; data visualization for human-machine systems; image processing and analysis for human-machine interaction

Assessment: 40% continuous assessment, 60% examination

DASE4146. Additive manufacturing (6 credits)

Concept, principle, applications, and scope of additive manufacturing (AM); AM fabrication processes: classification, materials, and characteristics; AM workflow: object modelling, material selection, process planning, object fabrication, post-processing, and quality inspection; Design considerations for AM: object geometry, geometry fidelity, surface finish, and mechanical strength; Current limitations and further development of AM.

Prerequisites: IMSE/DASE2109 Fundamentals of engineering design
Assessment: 50% continuous assessment and 50% examination

DASE4147. Mechatronic systems engineering (6 credits)

Principles of mechatronics; System integration and design; Sensors and transducers; Circuits and electronics; Embedded systems and microcontrollers; Actuators and drives; Mechanisms and mechanical components; Control systems and PID controllers; Programmable motion control; Artificial intelligence in mechatronics.

Prerequisites: ENGG1310 Electricity & Electronics and ENGG1330 Computer programming I
Assessment: 40% continuous assessment and 60% examination

DASE4157. Physical AI (6 credits)

Introduction to Physical AI and the coupling of machine intelligence with the physical world; foundations of embodied AI, including robot perception, manipulation, locomotion, vision-language-action models, and sim-to-real transfer; AI for autonomous driving, including multi-sensor perception, prediction, planning, end-to-end driving, and world models; AI for cyber-physical systems (CPS), including edge inference, time-series foundation models, federated learning, and anomaly detection; safety and verification of learning-enabled control; applications in humanoid robotics, intelligent transportation, smart manufacturing, and smart healthcare.

Assessment: 50% continuous assessment, 50% examination

DASE4538. 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.

Assessment: 40% continuous assessment, 60% examination

ELEC3249. Pattern recognition and machine intelligence (6 credits)

This module aims at providing fundamental knowledge on the principles and techniques of pattern recognition and machine learning. Specifically, the module covers the following topics: Estimation theory and Bayes decision theory; parametric and non-parametric methods; linear discriminant functions; design of classifiers, unsupervised learning and clustering; feature extraction; neural networks and deep learning; case studies.
After finish the course, students will be able to

1. Master the basic concept of pattern recognition and techniques for preprocessing and feature extraction.
2. Master the application of statistical techniques to the estimation of probability densities from samples.
3. Master the techniques of designing classifiers for pattern classification.

Pre-requisite: MATH1853 or MATH2101
Assessment: 50% continuous assessment; 50% examination

ELEC4252. Robotic control and vision (6 credits)

The development of robotics has evolved from early programmable industrial arms or manipulators (consisting of a driven mechanical structure) to a diverse range of objects that 44 may generally be referred to as robots. As a result, robotics has become a highly interdisciplinary subject involving different kinds of technologies.

The first part of the course is aimed at providing a general understanding of the fundamental principles of robot manipulators covering robot kinematics, robot dynamics and robot control. The second part of the course will venture into selected topics in robotics (such as robot vision, AI in robotics etc.) and then consider robot applications to different areas (such as humanoid robot, medical and surgical robots, etc.).

At the end of the course, students should have gained an understanding in the principles and mathematical techniques that underlie the traditional manipulator as a basic building block of different kinds of robots, and also an appreciation of how other technologies can be applied to enhance the capabilities and scope of applications of robots.

Pre-requisite: ELEC3241 Signals and linear systems
Assessment: 20% continuous assessment, 80% examination

MECH3433. Robotics, drones and autonomous ground vehicles (6 credits)

This course aims at giving out the “hands-on” techniques from robot design, fabrication and control, which enable students to implement her/his basic engineering principles and knowledge (e.g. basic electronics, and fundamental mechanics) on the robotic software and hardware platforms.

Topics include: 1) identification of robot/drone manipulation, 2) system integration of sensing and actuation units, 3) programming of closed-loop feedback controller, 4) practical use of software/hardware tools for robot developments.

Pre-requisite: ENGG1300 and ENGG1310 or equivalent
Assessment: 60% practical work, 40% continuous assessment

MECH4424. Sensors and actuators for robots (6 credits)

This course introduces sensors and actuators used in modern Robots: visual sensors, ranging sensors (light detection and ranging, radio detection and ranging, ultrasonic), barometric sensors, inertial sensors, encoders, and motors. Developments, principles, data processing, and typical applications of these sensors and actuators will be covered.

Assessment: 15% practical work, 15% continuous assessment, 70% examination

---

MECH4425. Human-robot control interface and wearable robotics (6 credits)

This course offers students an opportunity to explore, not only the conventional robotics knowledge in terms of actuation, sensing and intelligence, but also various key and trendy technologies such as interactive robot mechanisms and their use of materials, compliance joint and soft control, leader-follower control strategy, exoskeleton architecture and mechanism design, body sensor network and wearable electronics. Through such wide-angle coverage on the synergistic use of human motion comments and robotic manipulation, students will be inspired by the numerous ground-breaking technologies which did or will make big impact in our daily life.

Assessment: 15% practical work, 15% continuous assessment, 70% examination

---