Course Code	Course Title	Unit	Course Description	Learning Outcomes	Pre-requisites	Co-requisites	Preclusions	Syllabus	Assessment	Illustrative Reading List
RB3201	Sensors and Actuators for Robots	4	This course introduces the sensors and actuators commonly used in robotics. It covers the fundamentals of the technologies involved, their working principles, and the mathematical relations that govern them. Students will gain insights into the key physical quantities at play and the properties by which sensors and actuators are chosen for a given robot design. This will be achieved through the introduction of relevant mechanical design tools, modeling and analysis techniques, and testing procedures.	1 Understand what sensors and actuators are available and used on robots 2 Select the most suitable sensors and actuators for a new robot design, based on their working principles and related mathematical models 3 Integrate sensors and actuators into a robotic system, based on their characteristic and mechanical/electrical/software interfaces 4 Apply mechanical design tools, modeling and analysis software, and testing equipment	-	-	-	1 Robot Sensors Position Sensors (e.g. encoders, potentiometers), Force Sensors (e.g. strain gauge and force/torque sensors, load cells), Tactile Sensors (e.g. resistive, capacitive), Proximity and Distance Sensors (e.g. ultrasound sensors, infrared sensors, laser scanners), Inertial Sensors, Cameras 2 Robot Actuators Electric Motors, Pneumatic Actuators (McKibben actuators and others), Hydraulic Actuators 3 Design Tools CAD Tools, FEM Software, Mechanical Testing Equipment	Project/Group Project Mid-term Test Final Exam	
RB4107	Robotic System Design Project	4	This technical elective course is part of the Robotics and Machine Intelligence (RMI) programme. It involves a group-based project centered on designing a comprehensive robotic system, often inspired by collaborations with industry partners and research initiatives. The course emphasises the entire design process, including analysis and prototyping. To build familiarity and experience, the major project may be preceded by smaller projects. Students are expected to submit a detailed report, drawings, analyses and simulations, as well as deliver a presentation to showcase their project outcomes.	1 Translate customer requirements or research challenges into effective robotic designs, utilising the knowledge acquired from the Robotics and Machine Intelligence (RMI) programme 2 Understand and critically weigh the pros and cons of a design 3 Be an effective member of a team on an engineering design project 4 Fabricate designs and integrate sensors and actuators, culminating in the creation of a functional physical prototype	-	-	-	This course focuses on student collaboration to design and prototype solutions for industrial or research projects related to robotic system design and control. Students work in groups, guided by faculty tutors, to develop practical solutions tailored to client needs. Week 1: Introduction and Group Formation Instructor will introduce the course objectives and expectations, as well as assign student groups and project topics based on availability and interest. Each group will have a tutor allocated to it for guidance of the project. Week 2 to 4: Establishing Criteria and Objectives Tutors will guide students to conduct user/client interviews to gather requirements and insights and develop criteria and specific objectives for the project. Week 5 to 6: Ideation and Design Students will brainstorm to generate initial designs using sketches, diagrams, and preliminary models, and optimise their design based on tutor's feedback. Week 7 to 10: Prototyping and Evaluation Students will prototype their design, conduct evaluation tests and iteratively optimise their design based on the results and tutor's feedback. Week 11 to 12: Continued Prototype Development Students will refine prototypes based on tutor's feedback and prepare for final presentation and report. Week 13: Deliverables and Evaluation Students will prepare and submit group deliverables, including a report, CAD files, physical demonstrations, and experimental videos. Students will do an oral presentation to summarise project objectives, process, and outcomes.	Project/Group Project	
RB4301	Robot Learning	4	This course provides a comprehensive introduction to both the theoretical foundations and practical applications of learning-based methods in robotics. Students will explore fundamental techniques underlying robot control, planning, and decision-making processes enhanced by machine learning. It covers key concepts such as Markov Decision Processes and reinforcement learning formulations specific to robotic systems. Additionally, the course examines the latest advancements and trends in robotic learning techniques. To enrich their learning experience, students will implement these methods via hands-on coding projects in simulation environments.	1 Explain fundamental machine learning concepts applicable to robotics 2 Model robotic tasks using Markov Decision Processes (MDPs) 3 Formulate reinforcement learning problems in robotics 4 Understand theoretical foundations of modern reinforcement learning techniques (such as DP, Q-learning, PG, DQN, SAC, TRPO, and PPO) 5 Understand imitation learning and learning-based model predictive control 6 Implement learning algorithms in simulated environment through hands-on coding projects	EE2211	-	-	The course will cover the following topics: Fundamental machine learning concepts applicable to robotics (3 hours) Markov Decision Processes and exact solutions for reinforcement learning (6 hours) Approximate solutions, Deep Q-network and policy gradient method (9 hours) On-policy and off-policy actor-critic methods (SAC, TRPO, PPO) (3 hours) Imitation learning and learning from demonstrations (9 hours) Learning-based model predictive control (6 hours) Hands-on coding projects for implementing reinforcement learning algorithms in a simulated environment	Project/Group Project Quizzes/Tests	Reinforcement Learning, second edition Richard S. Sutton; Andrew G. Barto Learning for Adaptive and Reactive Robot Control Aude Billard; Sina Mirrazavi; Nadia Figueroa Model Predictive Control James Blake Rawlings; David Q. Mayne; Moritz Diehl Reinforcement Learning and Optimal Control Dimitri Bertsekas Takayuki Osa, Joni Pajarinen, Gerhard Neumann, J. Andrew Bagnell, Pieter Abbeel and Jan Peters (2018), "An Algorithmic Perspective on Imitation Learning", Foundations and Trends in Robotics: Vol. 7: No. 1-2, pp 1-179.