City University of Hong Kong
Course Syllabus

offered by
Department of Mechanical Engineering
with effect from Semester B 2019 / 2020

Part I Course Overview

Course Title:	Sensors for Robotics, AI, and Control Systems
Course Code:	MNE6126
Course Duration:	1 semester
Credit Units:	3 credits
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites : *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	MNE8110 Sensors for Robotics, AI, and Control Systems
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course is intended for students with interests in learning about the applications of advanced sensing devices and techniques in *robotics*, *artificial intelligence* (AI), and *control systems*. The objective of this course is to introduce the fundamental operational principles for sensors that are ubiquitous in modern robots, cyber-physical systems ("internet of things"), and control systems. The sensing devices and techniques discussed in this course include microelectromechanical systems (MEMS) based inertial measurement units, soft tactile and pressure sensors, bio/chemical sensors, acoustic sensors, optical sensors, proximity sensing, collision avoidance, light detection and ranging (LIDAR), and simultaneous localization and mapping (SLAM). The course will also discuss how these sensors and techniques are used in robotics, control systems, and AI applications. Fundamental concepts in these application areas, including robot navigation, sensory feedback control, and wireless sensing networks will also be discussed.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	to **give** scientific explanations of the operating principles of various sensors, including motion sensors, optical sensors, acoustic sensors, and bio-sensors.		✓	✓	
2.	to **analyze** and characterize different sensors and sensing methodologies in terms of resolution, sensitivity, precision, and accuracy.		✓	✓	
3.	to **design** and integrate sensing and control technologies for robotics, cyber-physical systems, and AI applications.			✓	✓
4.	to **apply** and implement different sensors and actuators for advanced scanning technologies such as LIDAR and SLAM.			✓	✓
5.	to **adapt** different sensing and tracking methods in system design for applications in robots, cyber-physical systems, and control systems.			✓	✓
		N.A.			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lecture	The main teaching activities will be in the form of lectures but the lectures are sometimes implemented with small group discussions where students work with their team-members before feeding back their results to the class.	✓	✓	✓	✓		2 hrs/week
Tutorial	Tutorials are problem-solving sessions and are sometimes broken up into small group discussions.	✓	✓	✓	✓		1 hr/week

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.					Weighting	Remarks
	1	2	3	4	5		
Continuous Assessment: 40%							
Mini-project			✓	✓	✓	20%	
Assignment/ Homework	✓	✓	✓			20%	
Examination: 60% (duration: 2.5 hours)							
Mid-term and In-class Quiz	✓	✓	✓			25%	
Final Examination	✓	✓	✓		✓	35%	
						100%	

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Written exam at the end of the semester.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Mid-term and In-class Quiz	To test students' understanding of the topics discussed during the course of the lecture.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Assignment/ Homework	To assess students' learning attitudes and ability in understanding the principles of the various signal transduction principles and analysing the performance of the sensors.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4.Mini-project	To assess students' ability to work in a team to design, apply, and adapt state-of-the-art sensing and tracking methods for applications in robots, cyber-physical systems, and control systems.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

Motion sensors, tactile sensors, proximity sensors, vision-based tracking, light detection and ranging (LIDAR), simultaneous localization and mapping (SLAM), artificial intelligence (AI), feedback control, discrete-time systems, control system implementation, robot control.

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

N.A.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	H.R. Everett, *Sensors for Mobile Robots*, Kindle Edition, 1995.
2.	Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, *Feedback Control of Dynamic Systems*, 7th Edition, Kindle Edition, 2015.