City University of Hong Kong
Course Syllabus

offered by
Department of Mechanical Engineering
with effect from Semester A 2022 / 23

Part I Course Overview

Course Title:	Bio-Inspired Robots
Course Code:	MNE6115
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)*	MBE6115 Bio-Inspired Robots / BME6115 Biorobotics
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to expose students to the robotic systems developed by applying concepts from nature to the design of real world engineered systems. The objective is for students to learn the principles behind the bio-inspired robots from biological examples and how they are implemented in robotic systems. Dynamics and locomotion will be discussed. The course intends to enhance students' skills for understanding of dynamics, physics of scaling, and locomotion, taking inspiration from nature.

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 **compare** and **give** account of the engineering, bio-inspired, and biomimetic systems.		✓	✓	
2.	To **derive** the dynamics and governing laws for flying, walking, and different locomotion seen in creatures and robots.			✓	
3.	To **examine** the basics of multi-agent and decentralised systems in biology and **demonstrate** their applications and potential in robotic systems.			✓	
4.	To **analyse** and **identify** additional underlying principles of biological systems of interest and **illustrate** how to critically **apply** them to engineering 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	
Lecture	The main teaching activity.	√	√	√		2 hrs/week
Discussion	Seminar-style interactive discussion between students themselves and the instructor based on given topics and readings.				√	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		
Continuous Assessment: 100%						
Mid-term test	√	√	√		60%	
Group report and presentation				√	40%	Maximum group size of four students. 10% for the presentation and 30% for the written report.
					100%	

5. Assessment Rubrics

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

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
Mid-term exam	1. ABILITY to IDENTITY/CONTRAST similarities and differences between engineering, bio-inspired, and bio-mimetic systems. 2. ABILITY to EMPLOY robotic principles to ANALYSE different locomotion seen in creatures and robots. 3. ABILITY to EXPLAIN and INTEPRETE the significance of decentralised systems.	High	Significant	Moderate	Not even reaching marginal levels
Group report and presentation	1. CAPACITY for SELF-DIRECTED LEARNING to study biological and robotic systems. 2. ABILITY to COMMUNICATE and PRESENT the finding in robotic framework. 3. ABILITY to critically APPLY biological and physic principles to engineering systems.	High	Significant	Moderate	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
Mid-term exam	1. ABILITY to IDENTITY/CONTRAST similarities and differences between engineering, bio-inspired, and bio-mimetic systems. 2. ABILITY to EMPLOY robotic principles to ANALYSE different locomotion seen in creatures and robots. 3. ABILITY to EXPLAIN and INTEPRETE the significance of decentralised systems.	High	Significant	Moderate	Basic	Not even reaching marginal levels
Group report and presentation	1. CAPACITY for SELF-DIRECTED LEARNING to study biological and robotic systems. 2. ABILITY to COMMUNICATE and PRESENT the finding in robotic framework. 3. ABILITY to critically APPLY biological and physic principles to engineering 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.)

Bio-inspired and bio-mimetic, Flying, Aerial robots, Flapping-wing robots, Terrestrial robots, Walking, Limit cycle, Dynamics, Stability, Physics of scaling, Decentralised systems, Multi-agent systems. Synchronisation.

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.	Tennekes, Hendrik. The simple science of flight: from insects to jumbo jets. MIT press, 2009.
2.	Russ Tedrake. Underactuated Robotics: Algorithms for Walking, Running, Swimming, Flying, and Manipulation (Course Notes for MIT 6.832). Downloaded on June 2016 from http://underactuated.mit.edu/
3.	Haberland, M., and S. Kim. "On extracting design principles from biology: I. Method? General answers to high-level design questions for bioinspired robots." Bioinspiration & biomimetics 10.1 (2015): 016010.
4.	Ma, Kevin Y., et al. "Controlled flight of a biologically inspired, insect-scale robot." Science 340.6132 (2013): 603-607.
5.	Werfel, Justin, Kirstin Petersen, and Radhika Nagpal. "Designing collective behavior in a termite-inspired robot construction team." Science 343.6172 (2014): 754-758.
6.	Koh, Je-Sung, et al. "Jumping on water: Surface tension–dominated jumping of water striders and robotic insects." Science 349.6247 (2015): 517-521.
7.	Cully, Antoine, et al. "Robots that can adapt like animals." Nature 521.7553 (2015): 503-507.