City University of Hong Kong
Course Syllabus

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

Part I Course Overview

Course Title:	Biorobotics
Course Code:	BME6115
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/MNE6115 Bio-Inspired Robots/BME8129 Biorobotics
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to expose students to (i) robotic systems developed by applying concepts from nature and biology to engineered systems; and (ii) biomedical robots. The objective is for students to learn the principles behind the bio-inspired robots from biological counterparts, to learn how robotics are applied in biological engineering from molecular to macro levels, and to translate extracted biological solutions into robotic systems. The course intends to enhance students' knowledge in dynamics, physics of scaling, sensing, biomechanics, and locomotion, taking inspiration and examples from nature and biomedical devices.

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 bio-inspired robots and biomedical robots.		✓	✓	
2.	To **derive** the dynamics and governing laws for flying, walking, and different locomotion seen in creatures and robots.			✓	
3.	To **master** the working principles underpinning biorobotics (control, sensing, kinematics, dynamics, biomechanics).			✓	
4.	To **analyse**, **identify** novel underlying principles of biological or biorobotics 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.	√	√	√		3 hrs/week for 10 weeks
Discussion	Seminar-style interactive activities with virtual experiments.				√	3 hrs/week for three weeks (Week 8, 9, and 10)

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: 50%						
Mid-term test	√	√	√		10%	
Tutorial				√	15%	Three tutorials, 5% for each report submission.
Group presentation				√	25%	Maximum group size of five students.
Examination: 50%						
Examination	√	√	√		50%	Duration: 2 hours
					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.	High	Significant	Basic	Not even reaching marginal levels
Tutorials	1. ABILITY to LEARN and APPLY robotic technologies in simulated scenarios 2. ABILITY to technically SUMMARIZE and ELABORATE the implemented methodology and outcomes effectively.	High	Significant	Basic	Not even reaching marginal levels
Group 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	Basic	Not even reaching marginal levels
Examination	ABILITY to understand working principles, design methods and related to bio-inspired robots and biomedical devices.	High	Significant	Basic	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.	High	Significant	Moderate	Basic	Not even reaching marginal levels
Tutorials	1. ABILITY to LEARN and APPLY robotic technologies in simulated scenarios 2. ABILITY to technically SUMMARIZE and ELABORATE the implemented methodology and outcomes effectively.	High	Significant	Moderate	Basic	Not even reaching marginal levels
Group 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
Examination	ABILITY to understand working principles, design methods and related to bio-inspired robots and biomedical devices.	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-inspiration, Biomimetics, Flying, Aerial robots, Walking, Dynamics, Stability, Physics of scaling, Sensing, Biomechanics, Rehabilitation, Medical robots, Micro/nano robots.

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.	Achim S, Floris E, Medical robotics, Springer, 2015
5.	Fukuda T, Arai F, Nakajima M. Micro-nanorobotic manipulation systems and their applications. Springer Science & Business Media, 2013.
6.	Yi G, Selected topics in micro/nano-robotics for biomedical applications. Springer, 2013.