BME3104: ROBOTIC TECHNOLOGY IN HEALTHCARE

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Robotic Technology in Healthcare

Subject Code

BME - Biomedical Engineering

Course Number

3104

Academic Unit

Biomedical Engineering (BME)

College/School

College of Biomedicine (BD)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

BME2105 Introduction to Biomedical Engineering#

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Additional Information

Prerequisites which are not part of the Major Requirement are waived for students admitted with Advanced Standing.

Part II Course Details

Abstract

COVID-19 sheds light on healthcare robots, because they minimize the trauma of patients and permit safe distance between doctors and patients via teleoperation for infection control. This course aims to prepare students to thrive in the modern healthcare paradigm in the peri- and post-pandemic eras. It covers robotic healthcare solutions such as DaVinci platform, AI in medical image processing, robot-assisted laparoscopy, and their corresponding regulations. Particularly, it covers miniature robots that access hard-to-reach regions inside human body and perform diagnostic and therapeutic tasks. Students will learn the state-of-the-art robotic technologies deployed in clinic workspace, and labs sessions are offered for students to obtain hands-on experiences. At the end of the course, students will understand the open challenges, the future directions, and the socioeconomic impacts of healthcare robotic technologies. Performance is evaluated in exams about in-depth analysis of exemplar robotic systems, as well as research projects rooted from real-world healthcare challenges.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the basic concepts and goals of the robotic technologies in modern healthcare.		x	x	
2	Explain the design considerations, working principles and applications of representative robotic systems in diagnostics and therapeutics.		x	x	
3	Discuss the application of AI and machine learning in robotic medical systems. Discuss the cooperation between the software (e.g., AI) and the hardware (e.g., da Vinci).		x	x	
4	Identify the open challenges and evaluate the candidate solutions.		x	x	x
5	Apply the system-level integration and candidate strategies to propose a novel robotic healthcare system to address problems derived from real-world challenges.		x	x	x

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 real-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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Students will develop an understanding of the concepts, working principles, designs, and analytical methods related with the robotic systems for healthcare, as well as representative robotic systems.	1, 2, 3, 4, 5	3 hrs/week
2	Laboratory Work	Students will gain hands-on experiences with an exemplar robotic platform for healthcare.	1, 2	2 hrs for 2 weeks
3	Group-based Problem-solving Projects	Students will apply the principles taught in lectures through case studies.	4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignment	1, 2, 3	10	-	No
2	In-lecture interaction	1, 2, 3, 4	5	-	Yes
3	Quiz	1, 2, 3	10	-	No
4	Group projects	4, 5	10	Promote teamwork	Yes
5	Lab Reports	5	5	-	Yes

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Assessment Rubrics (AR)

Assessment Task

1. Assignments

Criterion

Ability to calculate the design parameters within given boundary conditions for exemplar healthcare robotic systems introduced in the lectures.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
2. Quiz

Criterion
Capability of applying the concepts introduced in lectures for analysis of results from healthcare technology.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
3. Group Projects

Criterion
Capability of identifying healthcare problems, such as chronic diseases, and providing feasible robotic solutions to it.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
4. Lab Reports

Criterion
Ability to perform tests and analyse data on healthcare robotic systems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
5. Examination

Criterion
Capability of applying the concepts introduced in lectures for analysis of results from healthcare robotic technology.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

General keywords:

- Medical robotics
- Robotic surgery and telesurgery
- AI in healthcare

Applications

- Targeted drug delivery
- Endoscopy
- Minimally invasive healthcare

Exemplary systems

- da Vinci surgical systems
- AI and machine learning
- Swallowable capsules
- Robotic catheters
- Micro/nano robotics

Reading List

Compulsory Readings

	Title
1	M. Sitti, et al., Biomedical applications of untethered mobile milli/microrobots. Proc. IEEE 103, 205–224 (2015).
2	J. W. Martin, et al., Enabling the future of colonoscopy with intelligent and autonomous magnetic manipulation. Nat. Mach. Intell. 2, 595–606 (2020).
3	K. H. Yu, A. L. Beam, I. S. Kohane, Artificial intelligence in healthcare. Nat. Biomed. Eng. 2, 719–731 (2018).

Additional Readings

	Title
1	L. Sliker, G. Ciuti, M. Rentschler, A. Menciassi, Magnetically driven medical devices: a review. Expert Rev. Med. Devices 12, 737–752 (2015).
2	S. J. Park, et al., New paradigm for tumor theranostic methodology using bacteria-based microrobot. Sci. Rep. 3, 3394 (2013).
3	S. Martel, Microrobotics in the vascular network: present status and next challenges. J. Micro-Bio Robot. 8, 41–52 (2013).
4	N. G. Hockstein, J. P. Nolan, B. W. O’Malley, Y. J. Woo, Robotic microlaryngeal surgery: A technical feasibility study using the daVinci Surgical Robot and an airway mannequin. Laryngoscope 115, 780–785 (2005).
5	Y. Wei, et al., A Review of Algorithm & Hardware Design for AI-Based Biomedical Applications. IEEE Trans. Biomed. Circuits Syst. 14, 145–163 (2020).
6	Y. H. Bae, K. Park, Targeted drug delivery to tumors: Myths, reality and possibility. J. Control. Release 153, 198–205 (2011).
7	A. Esteva, et al., Dermatologist-level classification of skin cancer with deep neural networks. Nature 542, 115–118 (2017).
8	Rebecca Richards-Kortum (2010), “Biomedical Engineering for Global Health”, Cambridge University Press.