BME3101: MICRO AND NANOTECHNOLOGY FOR BIOMEDICAL ENGINEERING

Effective Term
Semester B 2022/23

Part I Course Overview

Course Title
Micro and Nanotechnology for Biomedical Engineering

Subject Code
BME - Biomedical Engineering
Course Number
3101

Academic Unit
Biomedical Engineering (BME)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
MBE3101 Micro and Nanotechnology for Biomedical Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

Micro and nanotechnology offers particular advantages to the biomedical field in many ways such as better uniformity, reliability, reproducibility, miniaturized implants, precise control, quick response, micro-texturing, less invasive and lower power requirements, etc. More than $1 trillion/year by 2020 in new technologies and products and 2 million jobs have been projected by such technology. The convergence of nanotechnology and biomedical sciences opens the possibility for a wide variety of biological research topics and medical uses at the molecular and cellular level. This course aims to introduce the modern multidisciplinary micro and nanotechnology for biomedical engineering to the students and get them prepared for the new industrial revolution led by rapid progress in these fields. It covers important topics in biomedical engineering-related micro and nanotechnology such as applications of micro and nanotechnology, fabrication procedures, nanotechnology-based drug delivery, implantable nanomaterials, micro and nanotechnology-based implantable medical devices, nanotechnology for bio-imaging, etc.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the fundamentals of micro and nanotechnology, especially those related to biomedical engineering.			x	
2	Explain the main biomedical engineering-related techniques and processes of micro and nanotechnology.		x	x	
3	Apply micro and nanotechnology principles to design PDMS-based micro-bio-devices for biomedical applications.		x	x	x
4	Apply techniques for the characterizations of micro-bio-devices used for biomedical applications.			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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Classroom lectures on the topics of the keyword syllabus.	1, 2, 3, 4	3 hrs/week
2	Laboratory	Lab experiment projects.	1, 2, 3, 4	2 Laboratory sessions (3 hrs/week)

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Project/Presentation	1, 2	10	Students will design a new device based on their understanding of micro- and nanotechnology principles.
2	Test	1, 2	10	
3	Lab Reports	3, 4	20	Students will carry out research on the new device design and generate 2 lab reports.

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

1. Project/Presentation

Criterion

Ability to identify the principles of fabrication for existing devices or to design a device based on these principles.

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. Test

Criterion
Ability to describe the fundamentals of micro/nano 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. Lab Reports

Criterion
Ability to apply micro/nanotechnology to fabricate micro devices for biomedical applications and to apply techniques for characterizations of micro devices used for biomedical applications.

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. Examination

Criterion
Ability to describe the fundamentals and processes of micro and nanotechnology and to explain the main biomedical engineering-related techniques.

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

- Introduction to microtechnology, including applications, bioMEMS for synthetic organs, silicon microfabrication, "soft" fabrication (PDMS-based soft lithography, microcontact printing, etc.) and polymers, microfluidic principles, microactuators and drug delivery, DNA and protein microarrays, etc.
- Introduction to nanotechnology, nanomaterials and nanodevices, top-down approach, bottom-up approach, combined top-down and bottom-up approaches, nanotechnology based drug delivery, implantable nanomaterials, nanotechnology-based implantable medical devices, nanotechnology for bio-imaging, etc.

Reading List

Compulsory Readings

	Title
1	Steven S. Saliterman, "Fundamentals of BioMEMS and Medical Microdevices", SPIE Press, 2006, ISBN: 978-0-819-45977-0.
2	Arlen D. Meyers et al, "Nanotechnology for the Life Sciences: Fundamentals and Applications", CRC Press Inc., 2012, ISBN: 978-1-439-81122-1.

Additional Readings

	Title
1	Marc J. Madou, "Fundamentals of Microfabrication: The Science of Miniaturization", Second Edition, CRC Press, 2002, ISBN: 978-0-849-30826-0.
2	Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd rev. and extended ed., 2007, ISBN: 978-3-540-29857-1.