# BME3103: BIO-SENSORS AND BIO-DEVICES

**Effective Term**
Semester B 2023/24

## Part I Course Overview

**Course Title**
Bio-sensors and Bio-devices

**Subject Code**
BME - Biomedical Engineering
**Course Number**
3103

**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**
MBE3103 Bio-sensors and Bio-devices

**Exclusive Courses**
Nil

## Part II Course Details

**Abstract**
This course provides an overview of the available and advanced technologies related to sensing techniques with practical biomedical applications. The course starts with an introduction of electronic circuit design and fabrication. Advanced

biomedical related sensing principles and devices will also be introduced in this course, including MEMS/Nano-based immunosensors, medical diagnostics biosensors, and biochips for detecting pathogens and drug compounds. It also covers conventional biomedical imaging, sensing, and analyses techniques, including X-ray imaging, computed X-ray tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and ultrasound imaging.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | Describe the basic principles of biomedical imaging and sensing. | | | x | |
| 2 | Identify relevant knowledge and technologies to obtain solutions for bio-detection problems. | | | x | |
| 3 | Apply the principles of biomedical imaging and sensing to analyse selected real life problems. | | | x | x |
| 4 | Demonstrate reflective practice in an engineering context. | | | | 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 | Mainly include lectures from experts in the fields of bio-sensors and bio-devices. | 1, 2, 3, 4 | 3 hrs/week |
| 2 | Laboratory Works | Students are required to form teams to complete 4 weeks of laboratory sessions. | 2, 3, 4 | 3 hrs/week for 2 weeks |
| 3 | Group-based Problem Solving Project | Students are required to form teams to perform literature survey and engineering design and analysis to address a real-life bio-engineering problem. | 1, 2, 3, 4 | |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks (e.g. Parameter for GenAI use) |
|---|---|---|---|---|
| 1 | Project | 1, 2, 3, 4 | 20 | Draft and final project reports |
| 2 | Assignment | 1, 2, 3 | 10 | One or two assignments on the basic principles of bio-devices and the devise modelling. |
| 3 | Laboratory Report (In-Class) | 2, 3, 4 | 20 | Two labs on practical experience of bio-sensing techniques and data analyses. |

**Continuous Assessment (%)**

50

**Examination (%)**

50

**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**

Project

**Criterion**

Ability to work in a team environment and perform the following:
1) provide an up-to-date literature survey of a given topic in bio-engineering;
2) execute engineering design and analysis of the given problem;
3) give a professional presentation on the team’ s findings.

**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

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**Assessment Task**

Assignment

**Criterion**
Ability to use the fundamental scientific and engineering principles learned in class to solve bio-sensing and bio-imaging related problems.

**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

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**Assessment Task**
Laboratory Report (In-class)

**Criterion**
Ability to work with team members to perform lab procedures provided by the course instructor(s) and collect/analyse experimental results.

**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

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**Assessment Task**
Examination

**Criterion**
Ability to apply the concepts and principles learned in class to solve engineering problems related to bio-sensing and bio-devices.

**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

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# Part III Other Information

**Keyword Syllabus**

- Sensor transducer, biosensor
- Electronic circuit resistor, diode, transistor, operational amplifier, Wheatstone bridge
- Temperature sensor thermocouple, thermistor, Zener diode
- Piezoelectric sensor piezoelectricity, quartz crystal, pressure sensing,
- Light sensor photoresistor, photodiode, phototransistor, light emitting diode, spectrophotometry, pulse oximeter, fluorescence
- Micro/nano-sensor Lap on a Chip, soft lithography, paper based sensor, nanoparticle, quantum dots
- Bioimaging X-ray, ultrasound, magnetic resonance imaging

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | Nil |

**Additional Readings**

| | Title |
|---|---|
| 1 | Gabor Harsanyi, Sensors in Biomedical Applications: Fundamentals, Technology and Applications, CRC Press, 2000 (ISBN 9781566768856). |
| 2 | Jeong-Yeol Yoon. Introduction to Biosensors: from Electric Circuits to Immunosensors. (2nd Edition) Springer, 2016. (ISBN 978-3-319-27411-9) |