# BME6143: BIOLOGICAL THERMOFLUIDICS

**Effective Term**
Summer Term 2026

## Part I Course Overview

**Course Title**
Biological Thermofluidics

**Subject Code**
BME - Biomedical Engineering
**Course Number**
6143

**Academic Unit**
Biomedical Engineering (BME)

**College/School**
College of Biomedicine (BD)

**Course Duration**
One Semester

**Credit Units**
3

**Level**
P5, P6 - Postgraduate Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
Nil

**Precursors**
Nil

**Equivalent Courses**
Nil

**Exclusive Courses**
Nil

## Part II Course Details

**Abstract**
Have you ever wondered how cells generate energy or how heat flows effect to a biosystem? By blending thermodynamics, heat transfer, and fluid mechanics with biomedical science, this course reveals the invisible forces powering life itself.

Students explore how energy moves, transforms, and drives biological systems -from microscopic thermal fluctuations to large-scale fluid flows in the human body. Core topics include 1. energy conservation, 2. heat transfer direction, 3. thermal process kinetics, and 4. fluid dynamics in biological systems. Through real-world examples like photosynthesis, metabolic reactions, and ATP synthesis, students uncover how physical principles govern life's essential processes. The course equips students with the tools to evaluate bio-reactions, understand cellular energetics, and apply thermofluidic principles to biomedical innovation. Whether aiming to design medical devices for rapid diagnostics to investigate cellular mechanics, students gain a powerful foundation for advancing biomedicine.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | Explain thermofluidics principles. | | | x | |
| 2 | Apply thermofluidic principles for solving problems in biological applications and rapid diagnostics. | | | x | x |
| 3 | Describe how microscopic states give rise to macroscopic phenomena using thermal statistical principles to explain biological processes. | | | x | |
| 4 | Analyse the direction of biological reactions using thermofluidic principles. | | | 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 their understanding on biological thermofluidics. | 1, 2, 3, 4 | 2 hrs/ week |
| 2 | Tutorial | Students will discuss selected problems through case studies. Students will engage in answering, with guidance, the selected 'problem-solving' questions. | 1, 2, 3, 4 | 1 hr/week |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks ("-" for nil entry) | Allow Use of GenAI? |
|---|---|---|---|---|---|
| 1 | Project | 1, 2, 3, 4 | 20 | - | No |
| 2 | Test | 1, 2, 3 | 30 | Duration: 2 hours | No |

**Continuous Assessment (%)**
50

**Examination (%)**
50

**Examination Duration (Hours)**
2

**Minimum Continuous Assessment Passing Requirement (%)**
30

**Minimum Examination Passing Requirement (%)**
30

**Assessment Rubrics (AR)**

**Assessment Task**
Assignments

**Criterion**
Ability to remember and to use the principles in thermofluidic engineering for biomedical applications.

Ability to cooperate with team members for a project in biological thermofluidics.

Ability to perform the experiments and to make reports for thermofluidic engineering.

**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**
Test

**Criterion**
Ability to solve questions in thermofluidic engineering.

**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**
Examination

**Criterion**
Ability to analyse and to resolve the questions in biological thermofluidics.

**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**
First law of thermodynamics (Enthalpy), Second law of thermodynamics (Entropy), Gibbs free energy to analyse bio-processed (Free energy), Energy transfer kinetics (Enzymes), Statistical mechanics (Boltzmann relation), Bio-reaction equilibrium constant, Thermo-transfer, Microfluidics (Reynold number, Diffusion principle)

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | N.A. |

**Additional Readings**

| | Title |
|---|---|
| 1 | Thermodynamics and kinetics for the biological science, Wiley-Interscience, 2000, Gordon G. Hammes |
| 2 | Thermodynamics An Engineering Approach 7th edition, McGrawHill, 2011, Yunus A. Cengel, Michael A. Boles |
| 3 | Fundamental of Fluid Mechanics, Young et al |
| 4 | An Introduction of Thermal Physics, Daniel V. Schroeder |