BME2122: BIOLOGICAL THERMOFLUIDS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Biological Thermofluids

Subject Code
BME - Biomedical Engineering
Course Number
2122

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
PHY1201 General Physics I#

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 or for students with A/AS-level Physics, HKDSE Physics with Level 3 or above, or equivalent admitted with Advanced Standing.

Part II Course Details

Abstract

Biological thermofluidics as a science began its development during 19th century and was used to understand the operation of work producing devices, such as steam engines. Biological thermofluidics contains the concepts of thermodynamics and fluidic dynamics. In board term, this subject is concerned with relationships between different types of energies and transportation phenomena in biological systems. In this course, we are mainly focused on fundamental principle introduction and the applications in biomedical engineering. In the first part, we will introduce thermal principles (First las, Second law and Entropy) and will conduct them to determine bio-reaction processes. In the second part, we will discuss fluidic dynamics in biological systems. At the end of the course, the students will not only be able to do calculations and solve problems on separate subjects, but also understand in full detail how the subjects interrelate.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the fundamental principles of thermodynamics, fluid mechanics, and heat transfer.			x	
2	Justify relevant principles to obtain solutions of thermodynamics and fluid mechanics problems.			x	
3	Apply the integrative principles of thermodynamics and fluid mechanics to the applications in biomedical engineering.			x	
4	Demonstrate reflective practice in a biomedical 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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture and Tutorial	Student will develop an understanding of key concepts, principles, theories, and their applications related to thermodynamics and fluid mechanics.	1, 2, 3	3 hrs/week

2	Laboratory Work	Students will engage in laboratory work to apply the principles of thermodynamics and fluid mechanics in practical applications by performing experiments such as immunoassay, ligand binding, diffusion in micro-channel, and low Reynolds number-fluidic flow.	1, 2, 3, 4	3 hrs/week for 2 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2, 3	20	1 quiz in the midterm
2	Reports on Laboratory Works	1, 2, 4	20	2 lab reports
3	Projects	1, 2, 3, 4	20	1 final project report and presentation

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2.5

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. Test

Criterion

Capacity to understand the key concepts, principles and theories related to thermodynamics, fluid mechanics and heat transfer, and to analyse and solve related engineering 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

Assessment Task
2. Reports on Laboratory Works

Criterion
Capacity to conduct experiments, obtain and analyse the data, and have discussions and conclusions based on the concepts, principles and theories learned from the lectures, as evident from the reports.

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. Projects

Criterion
Capacity to apply fundamental theories to biomedical applications. In the projects, students would have the opportunity to work together as a team to solve current challenges in biomedical industry.

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

Capacity to understand the key concepts, principles and theories related to thermodynamics, fluid mechanics and heat transfer, and to analyse and solve related engineering 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

Part III Other Information

Keyword Syllabus

- Thermofluid properties;
- Properties of pure substances;
- Energy, energy transfer and general energy analysis;
- First law of thermodynamics
- Second laws of thermodynamics;
- Entropy;
- Free energy;
- Hydrostatics;
- Bernoulli equation
- Fluidic Kinetics
- Diffusion and transfer phenomena
- Biological process
- Bioreactions

Reading List

Compulsory Readings

	Title
1	Bruce Munson, Donald Young, Theodore Okiishi, Wade Huebsch, Fundamental of Fluid Mechanics (6th edition).
2	Yunus A. Çengel, Michael A. Boles, Thermodynamics: An Engineering Approach (7th edition).
3	Gordon G. Hammes, Thermodynamics and kinetics for the biological science, Wiley-Interscience, 2000.

Additional Readings

	Title
1	Donald T. Haynie, Biological Thermodynamics (2nd Edition).
2	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Fundamentals of Heat and Mass Transfer (7th Edition).