BIOMECHANICS - 2024/5

Module code: ENG2097

Module Overview

This is an introductory level course in biomechanics. Topics taught in modules on solid and fluid mechanics are reviewed and then used to analyse certain aspects of the functioning of the human body. The topics covered are:

- Biomechanics of movement and analysis of the musculoskeletal system.
- An introduction to the material behaviour of biological tissues.
- An introduction to the fluid mechanics of the cardiovascular system.

Module provider

Mechanical Engineering Sciences

Module Leader

CIROVIC Srdjan (Mech Eng Sci)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 5

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 75

Lecture Hours: 22

Tutorial Hours: 11

Guided Learning: 20

Captured Content: 22

Module Availability

Semester 1

Prerequisites / Co-requisites

N/A

Module content

- Mechanics of locomotion; walking and running.
- Statics of the musculoskeletal system.
- Kinematics of linkage systems applied to the human body; link-segment models of the human body.
- Dynamics of the musculoskeletal system.
- Synthesis of movement analysis.
- Stress analysis applied to long bones.
- An introduction to the material behaviour of soft tissue.
- An introduction to the fluid mechanics of the cardiovascular system.

Assessment pattern

Assessment type	Unit of assessment	Weighting
Coursework	COURSEWORK	25
Examination Online	ONLINE EXAM (OPEN BOOK) 2 hours within a 4 hour window	75

Alternative Assessment

N/A

Assessment Strategy

The assessment strategy is designed to: provide students with the opportunity to demonstrate that they have developed a good understanding of how the fundamental principles of mechanics can be applied to analyse the human body.

The continual assessment is summative and formative. In the summative assessment students are provided with the opportunity to

go through all the stages of the process of analysing human movement experimental data, thus linking together a number of concepts and skills acquired in lectures and tutorials in a logical sequence. Students are encouraged to write a computer program to perform this analysis. Formative assessment and feedback is provided in form of weekly quizzes and additional quantitative sets of problems based around processing and analysis of large sets of real-life experimental data.

The examination covers all topics delivered in the lectures and it is aimed at assessing both the understanding of theoretical concepts and the ability to apply these in practice.

Thus, the summative assessment for this module consists of:

- Examination [Learning outcomes 1, 2,3,4,5,6]
- Coursework : quantitative analysis of experimental motion-tracking data [Learning outcomes 1,2,3, 5]

Formative assessment and feedback

- Weekly quizzes and sets of formative quantitative assignments
- Formative verbal feedback is given in tutorials.
- Written feedback is given for each of the coursework reports.

Module aims

- An understanding of how the human body can be represented as a mechanical system at various levels of detail depending on the application, and then analysed quantitatively using principles of mechanics.
- An understanding of the way in which muscles and joints act as structures to provide equilibrium or generate movement.
- An understanding of how the principles of statics and dynamics are applied to calculate forces generated in the joints for a range of situations.
- An understanding of the techniques that humans use in locomotion to move with a minimum of energy expenditure.
- An in-depth understanding of all the steps involved in the analysis of human movement and the practical skills needed to conduct that analysis.
- An understanding of how stress analysis can be applied to the long bones to examine their functional behaviour, fracture modes, and resilience.
- An introduction to the material behaviour of soft tissue.
- An introduction to the analysis of the cardiovascular system from the perspective of fluid dynamics

Learning outcomes

		Attributes Developed
001	On successful completion of this module, students will be able to: determine joint forces, joint moments, bone-on-bone forces and muscle forces using the methods of static analysis in which the body is in equilibrium.	KCP
002	Be familiar with simple models for the analysis of running and walking and understand the mechanisms through which energy expenditure in locomotion is minimized.	KC
003	Be able to experimentally determine some anthropometric parameters such as the position of the centre of mass of the whole body.	KP
004	Be able to conduct structural analysis of long bones, understand fracture patterns for different types of loading, understand the concept of resilience to fracture, and understand the role of muscles in preventing bone fracture as well as be familiar with the concepts of viscoelasticity and non-linear elasticity of soft tissue.	KC
005	Analyze experimental data to calculate joint angles, joint moments, and joint reaction forces in motion from marker position data and anthropometric data using engineering principles and computer-based data processing.	CPT
006	Be able to apply the concept of hydraulic resistance to the vascular system, in order to analyse pressure drop in the microcirculation, and understand the concept of capacitance and elastance of arteries and veins and their role in regulating pressure and flow in the cardiovascular system and the concept of pulse speed in the arteries.	KC

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to give student an introduction to the field of biomechanics with a combination of lectures, tutorial sessions, and guided learning via formative assessment.

The purpose of lectures is to familiarise students with fundamental concepts in biomechanics and to enable them to acquire knowledge on selected topics in this field. Furthermore, the students are motivated to synthesize knowledge gained across other engineering modules for the purpose of analysing problems in biomechanics. Lectures are delivered in person. Video recordings of all lectures are available to the students via the SurreyLearn VLE.

Tutorials are used to reinforce the newly acquired knowledge and to further develop understanding through solving quantitative problems. Problem solving skills and techniques are given special attention.

Formative assignments are provided in form of weekly quizzes and quantitate sets of problems. Quizzes are used to test and reinforce the understanding of core concepts introduced in the material delivered in that week. Quantitative problems are based around processing and analysing real-life experimental data computationally. They provide students with the opportunity to link the theory with application.

The learning and teaching methods include:

- Lectures to present fundamental concepts in biomechanics.
- Tutorials to reinforce the fundamental concepts through solving quantitative practical problems.

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: ENG2097

Other information

In this module students develop the capability of identifying and applying various core concepts of mechanics to analyze the functioning of the human body. This requires students to synthesize their knowledge acquired over a range of engineering modules and apply it to a new and unfamiliar situation, thus developing their **resourcefulness and resilience.** Students are introduced to numerical processing techniques of experimental data which builds their **digital capabilities.** This module covers the underpinning theory for clinical movement analysis, rehabilitation engineering, implant technology, and prosthetics which are crucial for **employability** in the medical engineering sector.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Biomedical Engineering BEng (Hons)	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Biomedical Engineering MEng	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module