MEDICAL IMPLANTS AND BIOMATERIAL APPLICATIONS - 2024/5

Module code: ENGM261

Module Overview

This module covers the principles of the design and use of medical implants, orthopaedic implants in particular, related prosthetic technology and biomaterials such as metals, ceramics and polymers and composites with specific reference to biomedical applications.

Module provider

Mechanical Engineering Sciences

Module Leader

XU Wei (Mech Eng Sci)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 7

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

Overall student workload

Workshop Hours: 6

Independent Learning Hours: 81

Lecture Hours: 24

Tutorial Hours: 4

Guided Learning: 11

Captured Content: 24

Module Availability

Semester 2

Prerequisites / Co-requisites

N/A

Module content

Introduction to medical implants

- Review of medical implants

Design of implants

- An introduction to the design of implants from the biomechanics viewpoint with a discussion of implants' mechanical properties and testing in the product development, the attachment methods for mechanical implants, basic skills of stress analysis for the design of a mechanical implant and selection of materials for hip, knee, dental and percutaneous trans-femoral osseointegration implant.

Trans-femoral Osseointegration and dental implants

- Introduction to trans-femoral osseointegration and dental implant
- Engineering solutions to the issues of osseointegration
- Improvement of mechanical and surface properties of implants

Articular Implants

- Assessments, arthroscopy, minimally invasive methods.
- Current joint replacement methods in upper and lower limbs.
- Elbow, shoulder, hip and knee joint implants, design requirements and available solutions.

Materials for medical applications

- Introduction to human tissue properties - viscoelastic materials
- Smart materials for implant: Introduction to the mechanical and physical properties of shape memory alloys; their current clinical use and their clinical potential.
- Bonding, structure etc. with comparisons of major groups of materials such as metal ceramics, polymers and composites. The importance of the surface – tribology and attachment. Replacing bone – scaffolds etc. The total hip replacement. Stents, valves, lens etc. Drug delivery, Apparatus (scalpels/filters for dialysis/X-ray tables etc.).

Biological techniques and tissue engineering

The basics of two broad ranging techniques used in the investigation of the reaction between biomaterials and host (recipient) tissues. Histological/cytological preparation. Discussion of the difficulties of interpretation, use and artifact that can arise with these methods. The use of living cells and biodegradable polymers in joint and organ replacement; current research and future prospects.

Assessment pattern

Assessment type	Unit of assessment	Weighting
Examination Online	2 hours online (open book) exam within a 4 hours period	100

Alternative Assessment

N/A

Assessment Strategy

The assessment strategy is designed to provide students with the opportunity to demonstrate understanding of scientific principles, methodologies, mathematics methods, ability to describe particular systems and processes and to interpret a problem and present a solution clearly and accurately in an open book examination.

The summative assessment for this module consists of::

- 2 hours online (open book) exam within a 4 hours period [Learning outcomes 1, 4, 5,]

Formative assessment and feedback:

- Verbal feedback is given in the tutorials.

Module aims

- An up-to-date knowledge base on the biomechanical and clinical requirements relevant to mechanical implants and on the associated surgical procedures.
- An understanding of biocompatibility, physiology and biological responses of human tissue to biomaterials.

Learning outcomes

Ref		Attributes Developed	
001	Demonstrate a systemic understanding of current methods for medical implants including advanced materials and tissue engineering techniques for implant technology.	K	M1
002	Critically evaluate current approaches of implementing engineering solutions, with particular reference to the development of mechanical implants.	KCP	M1, M5
003	Continue to independently advance their knowledge in the field of medical implants and relevant areas in clinic.	T	M4, M5

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:

Introduce implant design and development technologies, industry standards, regulations and clinical practice, prosthetic design and development method and clinical practice and biomaterial applications. This is delivered principally through lectures and tutorial classes.

The learning and teaching methods include a mix of lectures, tutorials, pre-recorded talk, workshop and industry visit.

Indicated lecture hours are approximate. The arrangement of industry/clinical visit will usually be finalised after the initial publication of the teaching timetable for the relevant semester.

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: ENGM261

Other information

The School of Mechanical Engineering Sciences is committed to developing graduates with strengths in Employability, Digital Capabilities, Global and Cultural Capabilities, Sustainability and Resourcefulness and Resilience. This module is designed to allow students to develop knowledge, skills and capabilities in the following areas;

Employability: This module provides students with knowledge about the fundamental processes that occur during a variety of medical implant design and application of bio-materials. The module builds on this to develop the student's understanding of the interrelationship between patients and product developers. Students will become familiar with open discussion methods and supportive collaborative environments.

Digital capabilities: Students will learn how computer simulation is used to support the medical implant design and product development.

Global and Cultural Capabilities: A sustainability analysis requires students to demonstrate an appreciation of the societal impacts of the whole cradle-to-grave lifecycle of the medical implant and biomaterial productions. By its very nature this will require students to demonstrate global culture awareness due to the global nature of any engineered product.

Sustainability: The ultimate learning outcome of this module is for the students to demonstrate their ability to complete a sustainability assessment for a medical implant product making use of an industry-standard assessment framework.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Biomedical Engineering MEng	2	Optional	A weighted aggregate mark of 50% is required to pass the module