3BIO2 **BIOMEDICAL DESIGN PROJECT** [5 Credits]

Lecturer: Prof. Caitríona Lally (lallyca@tcd.ie)

Semester: 2

Module Organisation

The module runs for 12 weeks of the academic year and comprises 3 hours of lectures/labs and 1 tutorial per week. Total contact time is 44 hours.

Start Week	End Week	Lectures/Labs per week	Lectures total	Tutorials per week	Tutorials total
1	12	3	33	1	11

Module Description

This module aims to develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology. It provides the students with theory, methods and practise to create insights necessary to develop safe, effective and efficient medical devices, which are optimised for specific functional requirements.

The theory of different design approaches, relevant to medical device design is reviewed and discussed. Focussing on the CDIO design methodology, students will define the product/technology need and develop the design concept. The student will then focus on creating the design, i.e., the plans, drawings and 3D model which will define what will be implemented. The design will then be transformed into a product prototype using 3D printing or other suitable 3D modelling capability. In the final stage, Operate, the product will be analytically evaluated and mechanically tested to determine if it has met its design objectives.

In the module, students will be provided with the necessary theory and practise to understand and follow the CDIO design process. Students will learn the use of 3D CAD (Solidworks) and use the software to design their prototype product. The students will be presented with a range of suitable methods for evaluation and testing, which can be utilized at different stages of the design process to review and test medical design concepts and prototypes.

The module will provide students with an introduction to multidisciplinary project teams and the opportunity to apply learned knowledge to a real world problem within group project work. The module structure is based on project based learning. Each week students are introduced to new content, which they learn to apply by engaging in activities, practical implementation and discussion. The design project is based on a real world problem.

Learning Outcomes

On successful completion of this module, students will (be able to):

1. Critically evaluate a number of different design processes.
2. Apply an appropriate design method to need find, generate ideas and evaluate design concepts.
3. Implement a suitable design process from beginning to end
4. Apply engineering sciences through learning-by-doing project work
5. Communicate and work effectively in teams
6. Present their work orally through public presentation using posters and slide shows
7. Conceive, design, implement and operate tangible prototypes
8. Propose suitable materials for use in design
9. Estimate product costs
10. Correctly use CAD (Solidworks) to draw and model parts and assemblies.
11. Create a 3D prototype based on a 3D model.
12. Analytically analyse the designed component from a solid mechanics perspective to assess if it is mechanically fit for purpose and inform the optimisation of the product design
13. Mechanically test and/or outline suitable mechanical tests to be carried out on the product to mechanically evaluate the product and inform the optimisation of the product design
14. Be able to work effectively as part of a multidisciplinary project team
15. Demonstrate effective project management skills
16. Write a professional technical report documenting the design process

Module Content

- Introduction to the iterative design process (CDIO)
- Overview of different design approaches
- Overview of the process of needs finding
- Overview of anthropometrics, fundamentals of biomechanics and human factors as they apply to medical devices
- Overview of the role of the user in the design process for medical devices
- Problem analysis, iterative problem shaping and idea synthesis
- Task analysis and project management
- 3D computational modelling of product designs and assemblies using CAD (Solidworks).
- Prototype development and testing
- Theoretical and hands-on mechanical evaluation of design concepts and prototype designs
- Effective evaluation of user device interaction in the context of medical device innovation

Module Notes

Outline notes will be provided on Blackboard

Teaching Strategies

The module structure is based on project based learning, students having the opportunity to immediately apply learned theory in practice in their design project.

The students are asked to do background reading which will be outlined and facilitated by the use of blackboard. Students learn CAD early in the module and then apply it to the design of their own product. Students will also use discussion groups for learning and assessment.

Assessment Modes

(i) Idea/design concept presentation (10%), (ii) Continuous assessment (40%) which includes bimonthly project reviews between the design teams and a design process diary, (iii) Final project report (40%) and (iv) Final project presentation (10%)

Recommended or Core Text

1. **Design of Biomedical Devices and Systems** by Paul H. King, Richar C. Fries nad Arthur C. Johnson, 3rd Edition. CRC Press, 08/2014. VitalBook file.

Supplemental Texts

1. **Biodesign: The Process of Innovating Medical Technologies** by Stefanos Zenios, Josh Makower and Paul Yock.
2. **Engineering Design: A Systematic Approach** by G. Pahl, W. Beitz, J. Feldhusen and K.-H Grote.
3. **Handbook of Human Factors in Medical Device Design** by Matthew Weinger (https://books.google.ie/books?id=jAemLm2zu_oC&printsec=frontcover#v=onepage&q&f=false)

Note:

This module has no exams, it is evaluated fully through continuous assessment. Therefore, there are no associated supplemental exams which can be taken if the subject is failed. Similarly, it is not possible to complete work over the summer individually, as an alternative to exams. This is due to the group work nature of the module.