3B8  Universal Design Innovation

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ECTS Value: 10

Semester: 1&2

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Aims/Objectives
- to develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology
- to provide an experiential learning environment, while applying academic knowledge
- and engineering science
- to provide a framework to encourage creativity and innovation
- to develop team work and communication skills through group based activity
- to foster self-directing learning and critical evaluation
- to instil in students a sense of social responsibility and civic awareness through community engagement and “Service Learning”

Course Description
This course will provide a comprehensive overview of the full engineering design process through learning-by-doing project work complimented with relevant and useful laboratories to provide the students with the technical skills to realise their engineering designs.

Course Organisation
The course runs for both semesters of the academic year and comprises of two formal lectures per week, two moderated hours per week to carry out project work plus significant additional practical laboratory time-see separate timetable.

Course Elements

Project: Universal Design Innovation (Prof. Gareth J. Bennett)
The students participate in a Universal/User Centred Design process project in conjunction with a community group such as the National Disability Authority or the National Council for the Blind of Ireland. Working in groups, the students
identify user needs and define their own project brief from which they develop concept variants through divergent thinking techniques (e.g. Stanford University’s: Design Thinking) before evaluation and definition of a final concept. The student groups now move down the design process iteratively to manufacture a tangible working prototype. Real users are involved in the process from beginning to end which culminates in a competitive public showcase.

**Machine Element Design (Prof. Gareth J. Bennett)**
Standard engineering components are examined and the skills for their analysis are developed to allow for correct component choice/design.

**Computer Aided Drawing/Computer Aided Manufacture (Mr. John Gaynor)**
This module allows the student to use a number of different software packages which facilitate design. Engineering drawings will be created electronically and used to develop machining code to practically illustrate the CAD/CAM process. Laboratories 9 and 10 are part of the 3B8 course, marks achieved in which count exclusively towards the 3B8 final mark. In these labs, the student learns how to use and apply AutoCAD and CREO Parametric for drawing and solid modelling. AlphaCAM is used in the Mechanical Workshop with a CNC milling machine to machine a part. The CAM/machining functionality of CREO is also be explored.
The students use the solid modelling software in this lab for their Universal Design Innovation project.

**LabView & ARDUINO (Mr. Paul Normoyle)**
Virtual prototyping is a cost effective means for industry to reduce the time to design and manufacture. “LabView” is a powerful software platform issued by National Instruments and is fast becoming the industry standard. In this lab the students will gain hands on experience in virtual engineering employing LabView for automation and control. The students participate in a lab where they develop code to acquire information from sensors and then process this data in order to do something useful with an actuator. The ARDUINO data acquisition hardware is used. This experience provides the students with the skills to add technology to their Universal Design Innovation project.

**Internal Combustion Engine Practical (Mr. Gerry Byrne or designate)**
The students gain hands on experience with the disassembly and examination of a number of different i.c. engines and components such as overhead cams, valves, pistons, clutches etc. This lab is highly practical and pragmatic where the students are required to use metrological equipment to calculate performance characteristics.

**Finite Element Analysis (Prof. Tim Persoons)**
The underlying theory and mathematics of Finite Element (FE) systems is covered to the extent that students are able to formulate an element stiffness matrix and solve simple 2D problems. The students apply this theory to real engineering problems using different software packages such as CREO Simulate and ANSYS. Continuity with the CAD Lab is provided as drawings
produced in CREO Parametric are analysed in CREO Simulate. Also, the students are required to analyse part of their Universal Design Innovation project using FEA.

**Workshop Course (Mr. Mick Reilly)**

It is vital that design engineers appreciate the skill and difficulties involved in manufacturing parts and assemblies. In this element, the students will gain hands on experience using typical mechanical workshop equipment. Welding, manual machining, CNC machining and turning are covered.

**Guest Lecture Series**

*(Engineering Managers from Industry)*

Guest speakers from industry will address the students, presenting their company profile and underlining the importance of Design and Innovation to the success of their company. Previous speakers have come from Dyson, Thermoking, INTEL and Forfás

*(TCD)*

A workshop on communication skills is given by the Student Development Services (TCD).

Trinity Research and Innovation have previously given talks on Innovation, Commercialisation and Patenting.

**Teaching Strategies**

The design module lectures are punctuated by short exercises, peer-to-peer discussion and generalized question-and-answer sessions on current topics. The drive is always to foster that aspect of thought – *divergent thinking* - which is so essential to the design engineer and so different from the *convergent* thinking processes used for solving engineering science problems.

**Assessment Modes**

The course marks are derived *fully* from continuous assessment. There will be no exam in the examination period. Formative and summative marks are awarded for both individual and for group work. All work is structured through Blackboard VLE.

**Recommended Texts**

Full notes are given for the Design module and for the CAD/CAM element of the computer aided engineering module

- **Engineering Design: A Systematic Approach**
  G. Pahl, W. Beitz, J. Feldhusen, K. H. Grote
  3rd Ed. 2007
  Springer-Verlag London Limited

- **Creating innovative products using total design : the living legacy of Stuart Pugh**
  Stuart Pugh
  1996
  Addison-Wesley
• **Total design : integrated methods for successful product engineering**  
  Stuart Pugh  
  Addison-Wesley ,1990  
  ISBN: 0201416395 (pbk)

• **The ten faces of innovation : IDEO's strategies for beating the devil's advocate & driving creativity throughout your organization**  
  Tom Kelley, with Jonathan Littman  
  Profile Books, 2008  
  ISBN: 184668031X, 9781846680311

• **Bootcamp Bootleg**  
  Design Thinking Methods from the D-School  
  Stanford University  

• **Shigley's mechanical engineering design**  
  Richard Budynas  
  ISBN: 9780071257633 (pbk.), 0071257632 (pbk.)

• **Creo Parametric 1.0 Tutorial and MultiMedia DVD**  
  Roger Toogood Ph.D., P. Eng., Jack Zecher P.E.  
  Published January 4, 2012  
  400 Pages  
  ISBN (Book + Software on Disk): 978-1-58503-730-8

• **Parametric Modeling with Creo Parametric 1.0**  
  An Introduction to Creo Parametric 1.0  
  By Randy H. Shih  
  Published August 25, 2011  
  432 Pages  

• **Introduction to Finite Element Analysis Using Creo Simulate 1.0**  
  By Randy H. Shih  
  Published September 5, 2011  
  423 Pages  
  ISBN (Book + Software on Disk): 978-1-58503-731-5

Learning Outcomes
On successful completion of this course, students will (be able to):
1. critically evaluate a number of different design processes.
2. apply an appropriate design method to needfind, generate ideas and evaluate design concepts.
3. implement a 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. value the differences in peoples’ abilities through the participation in a Universal Design/User Centred Design project working with community groups.
9. promote social responsibility and civic awareness
10. optimally design machine components for use in design
11. correctly select standard components for use in design
12. propose suitable materials for use in design
13. correctly use AutoCAD and CREO Parametric to draw and to solid-model parts and assemblies.
14. understand the benefits of Computer Aided Manufacture (CAM) and to output code from CAD to a milling machine to machine a part.
15. develop code in LabView to acquire and process data, and to output signals to actuate components for some useful purpose.
16. have insightful hands-on knowledge and understanding of the workings of internal combustion engines.
17. Understand and describe both the advantages and the limitations of FEA as an engineering modelling tool in design, process investigation or defect analysis.
18. Understand the concept of element stiffness and be able to derive the underlying mathematical expressions used in the development of an element stiffness matrix
19. Set up and model simple 2D structural and thermal problems using two commercial software packages and incorporating realistic loading and constraint conditions.
20. Interpret the results of the analysis, e.g. stress/thermal distributions, but more importantly recognise errors in the results arising from incorrect or insufficient input data or the setup of the FEA model.
21. apply and use a commercial FEA software package to an open ended design problem
22. use a selection of mechanical workshop equipment such as: milling machines (manual and CNC); lathes; welding equipment; bench press etc.
23. discuss critically the benefits of different mechanical workshop processes
24. understand industry structures and to interact directly with technical professionals and members of engineering industry
25. write professional technical reports documenting design work

IMPORTANT NOTE:
As the course is evaluated fully through continuous assessment, there are no exams. 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 course. As the course counts for 10ECTS, it therefore is possible that you will have to repeat the year if you fail this subject.