

**DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING**  
**UNIVERSITY OF DUBLIN, TRINITY COLLEGE**

**BAI UNDERGRADUATE COURSE**

**SENIOR SOPHISTER (4<sup>TH</sup> YEAR)**

**2011/2012**



## **Mission Statement**

The Department's main objective is the pursuit of excellence in teaching and research in Mechanical & Manufacturing Engineering with the central aim of producing graduate engineers with a capacity for independent thought in problem solving and creative analysis & design.

To achieve this, we must:

- instil in students an enthusiasm for the art and practice of Engineering;
- teach the engineering science and mathematics which underpin the subject areas of Mechanical & Manufacturing Engineering;
- demonstrate the application of these principles to the analysis, synthesis and design of engineering components and systems;
- foster the development of team working skills;
- encourage students to exercise critical judgement and develop the communication skills necessary to make written and oral presentations of their work.

These objectives are underpinned by :

- undertaking both basic and applied research
- provision of advanced facilities for students to undertake graduate research degrees
- the development of academic staff in teaching and research by ensuring that adequate resources are available to assist them
- ensuring that the research work is of the highest international standard by participation in international conferences and publication in learned journals

In addition, we must consider :

- the requirements of the relevant professional institutions
- the needs of Irish and European industry in the undergraduate curriculum

## I. INTRODUCTION

Welcome back to the Department for your final year of study in College. This is an extremely important year for you all and it will be a busy one. Outlined below is what we feel will be the minimum required for you to keep up to date with your work in the Department. We hope you enjoy your year and wish you all success in your exams and in the future.

It is extremely important that you organise and use your time responsibly and effectively. What follows are some rough guidelines to help you to do this. For your project, you should get started immediately and spend at least 8-10 hours/week in the first semester ensuring that you can achieve a reasonable level of success. This does not mean that you neglect your lecture courses and laboratory/assignment work. In general, you should aim to work for about 40 hours/week. With about 24 hours timetabled, this means a minimum of 16 hours of private study. Otherwise, continue the other well serving techniques that you will have perfected in your JS year ...

## II. SENIOR SOPHISTER COURSES

A detailed syllabus for each of the courses taken by students in the Department is given in this booklet together with a timetable for the current year. Courses undertaken by Senior Sophister students in the Department in 2010/2011 are:

4E1	Management for Engineers	(5 credits)
4E2	Engineering Project	(15 credits)
4B1	Mechanics of Solids	(5 credits)
4B2	Materials	(5 credits)
4B3	Thermodynamics	(5 credits)
4B4	Heat Transfer	(5 credits)
4B5	Manufacturing Technology	(5 credits)
4B6	Manufacturing Systems & Project Management	(5 credits)
4B9	Mechatronics & Systems	(5 credits)
4B11	Engineering Vibrations	(5 credits)
4B12	Acoustics	(5 credits)
4B13	Fluid Mechanics 2A	(5 credits)
4B15	Introduction to Bioengineering	(5 credits)
4B16	Biomechanics of Tissues and Implants	(5 credits)

In final year (Senior Sophister), all students are required to take 4E1 Management for Engineers, and 4E2 The Project. Students may then choose eight of the other courses, provided that their choice adds up to 40 credits (60 including 4E1 and 4E2).

The SS courses offered reflect the very wide research and technological interests of the academic staff. There will be small group tutorials for all subjects organised by staff and teaching assistants. Each course has at least one laboratory session, and assignments are used to ensure students have the capacity to apply the theoretical knowledge gained in coursework to practical systems. In addition, the project (4E2), undertaken under the direct supervision of a member of staff, represents a significant element of the work load. A preliminary presentation of the project is made in November. A full presentation of projects is made during the second semester and prizes are given for

the best performances. Professor Dermot Geraghty is the Final Year Project Co-ordinator.

### **III. FACILITIES**

The Department is located in the Parsons Building. All courses in the Sophister years are supplemented by a full programme of laboratory work. The laboratories are well equipped for undergraduate work and, in addition, we have extensive research facilities, which are available for final year projects. The Department has its own well-equipped workshops. Final year students are encouraged, where possible, to make various components which may be required for their project. It is critical that you develop good lines of communication with the Chief Technician, Mr. Mick Reilly, in order to have your workshop requests serviced in a timely and professional manner. The two Computer Applications Laboratories are administered by Mr. John Gaynor and house state of the art workstations, which are used extensively both in the design course in third year and for the project work in fourth year. In general, students are encouraged to make use of these facilities at all times but particularly for final year projects (4E2).

### **IV. INDUSTRIAL VISITS**

Industrial visits are arranged throughout the SS year. Companies are selected to give the students exposure to a range of manufacturing environments. Dr. Ciaran Simms is the Industry Liaison contact and co-ordinates these visits.

### **V. STAFF/STUDENT COMMITTEE**

Mr. Dermot Geraghty meets with each class representative once a semester to discuss matters of interest and concern to students and staff.

### **VI. EXAMINATIONS AND ASSESSMENT**

Examinations in all subjects are held at the end of the academic year. See individual courses for percentages awarded for written exam and labwork or coursework.

For the Project (4E2) a thesis is submitted and examined by two members of staff. In addition, students are required to make two oral presentations of their project work, one in each semester. The first presentation will take place early in the first semester when students can describe their early work and their plans for completion of the project. The final presentation takes place **after** the thesis has been submitted. All project work, including the thesis, must be completed by the end of week 8 in semester 2. The breakdown of marks for the project is as follows:

- Initial presentation (5%)
- Final presentation (15%)
- Thesis (80%)

Students must achieve a pass mark in the project.

All marks for labs/assignments are provisional until after the court of examiners meet.

## B.A.I. EXAMINATION RULES 2011/2012

### Senior Sophister

Candidates undertake 60 credits during the Senior Sophister year of the degree programme. Each module has an individual rating of 5, 10 or 15 credits, the amount being dependent on the level of effort involved. It is the responsibility of each student to ensure that they are taking courses with ratings amounting to 60 credits. The weighted average mark achieved for the Senior Sophister year is calculated using these credit ratings.

Degrees in all streams are awarded based on an overall average mark calculated by combining the average mark achieved in the ANNUAL Junior Sophister examinations (20% towards overall average) and the ANNUAL Senior Sophister examinations (80% towards overall average).

Students who are deemed to have passed the year are awarded 60 credits and an Honors Degree with the grade based on the overall average mark achieved. In order to pass, students must:

- have achieved marks of at least 40% in individual Senior Sophister courses worth at least 50 ECTS credits **AND**
- have an overall average mark of at least 40%.

A pass degree is awarded in the case of students who fail the B.A.I. degree examinations at the first sitting but pass when they present themselves for re-examination. Students presenting for a Pass degree are assessed on their performance in the Senior Sophister year only.

The full set of overall grades is set out below;

<i>Description</i>	<i>Grade</i>	<i>Criterion</i>
First Class Honors	<b>I</b>	mark greater than or equal to 70%
Second Class Honors, First Division	<b>II.1</b>	mark greater than or equal to 60% and less than 70%
Second Class Honors, Second Division	<b>II.2</b>	mark greater than or equal to 50% and less than 60%
Third Class Honors	<b>III</b>	mark greater than or equal to 40% and less than 50%
Fail	<b>F</b>	the candidate has failed to satisfy the criteria listed above
Exclude	<b>EX</b>	the candidate has not made a serious attempt at the examinations <u>or</u> the candidate has not passed the year within eighteen months from that date on which they first became eligible <u>or</u> the candidate has at least one unexplained absence
Deferred	<b>D</b>	the candidate was absent with permission due to medical or other grounds and the

ERASMUS Awaiting Result	<b>ER</b>	result is incomplete Applies to International Exchange students, (eg. Unitech / CLUSTER)
Result Withheld	<b>RW</b>	it may be necessary for academic or administrative reasons to withhold a result (e.g. unpaid fees or fines)
Withdrawn	<b>WD</b>	the candidate has withdrawn from the course

For students entering College before the 2008/2009 academic year, a Pass degree may be awarded.

### Individual module results

All individual module results are published anonymously by student number on the College notice boards, on the local School of Engineering website - <http://www.tcd.ie/Engineering/Results/> (students will need their College username and password) and on the College's Examinations Office website - <http://www.tcd.ie/Examinations/Results/> Class rankings are also published on the Engineering notice boards.

Where a mark is not reported for a subject the following codes apply:

<b>f</b>	=	<b>mark is less than 25%;</b>
<b>a</b>	=	<b>absent with permission – may take a SUPPLEMENTAL examination;</b>
<b>A</b>	=	absent without permission or explanation – automatic exclusion;
<b>mc</b>	=	medical certificate supplied to and accepted by the Senior Lecturer;
<b>cr</b>	=	credit for subject;
<b>gw</b>	=	grade withheld (e.g. unpaid fees or fines).

### **DESCRIPTION OF THE EUROPEAN CREDIT TRANSFER SYSTEM (ECTS)**

**The European Credit Transfer and Accumulation System (ECTS)** is an academic credit system based on the estimated student workload required to achieve the objectives of a module or programme of study. It is designed to enable academic recognition for periods of study, to facilitate student mobility and credit accumulation and transfer. The ECTS is the recommended credit system for higher education in Ireland and across the European Higher Education Area.

The ECTS weighting for a module is a **measure of the student input or workload** required for that module, based on factors such as the number of contact hours, the number and length of written or verbally presented assessment exercises, class preparation and private study time, laboratory classes, examinations, clinical attendance, professional training placements, and so on as appropriate. There is no intrinsic relationship between the credit volume of a module and its level of difficulty.

The European **norm for full-time study over one academic year is 60 credits.**

**ECTS credits are awarded to a student only upon successful completion of the course year.** Progression from one year to the next is determined by the course regulations. Students who fail a year of their course will not obtain credit for that year even if they have passed certain component courses. Exceptions to this rule are one-year and part-year visiting students, who are awarded credit for individual modules successfully completed.

## **VII. ATTENDANCE, NON-SATISFACTORY ATTENDANCE, COURSE WORK**

Please note the following extract from the University Calendar: *“For professional reasons, lecture and tutorial attendance in all years is compulsory in the School of Engineering.”* Attendance at practical classes is also compulsory

All students must fulfil the requirements of the School with regard to attendance and course work. Students whose attendance or work is unsatisfactory in any year may be refused permission to take all or part of the annual examinations for that year. Where specific attendance requirements are not stated, students are non-satisfactory if they miss more than a third of a required course in any semester

At the end of the teaching semester, students who have not satisfied the department or school requirements may be returned to the Senior Lecturer's Office as non-satisfactory for that term. In accordance with the regulations laid down by the University Council, non-satisfactory students may be refused permission to take their annual examinations and may be required by the Senior Lecturer to repeat their year. See also the sections dealing with College and engineering examination regulations.

Further details on the academic regulations concerning attendance, non-satisfactory attendance and course work are given in the University Calendar.

***Please note that you must attend the particular tutorial and laboratory sessions to which you have been assigned. Students cannot swap sessions because of the complexity of the timetable, the large numbers in the year and the limited accommodation available.***

## **VIII. KEY DATES**

### **Semester 1 (Michaelmas Term)**

12 weeks

Monday, 26 September to Friday 16 December 2011.

### **Semester 2 (Hilary Term)**

12 weeks

Monday, 16 January to Friday 05 April 2012.

### **Revision/Examinations/Results (Trinity Term)**

Annual Examinations commence Monday, 30 April 2012 and finish at the latest on Friday 25 May 2012.

## IX. SENIOR SOPHISTER (4<sup>th</sup> YEAR) COURSE OPTIONS

### 4B1 MECHANICS OF SOLIDS

**Lecturer:** Professor Conor Buckley ([conor.buckley@tcd.ie](mailto:conor.buckley@tcd.ie))

**Semester:** 2

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#### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week. Total contact time is 44 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
13	24	3	33	1	11

#### Course Description

Mechanics of Solids expands upon fundamental topics of beam bending developed in the third year course 3B3, extending these to cover specialized topics which are important in beam design, such as the analysis of composite and non-symmetric beams, inclined loads, shear stresses in thin walled beams and shear centres. Next a more fundamental view is taken of the theory of elasticity. The use of stress functions is developed and applied to problems such as thick-walled pressure vessels and holes in plates. Finally the theory of the finite element method and its use in solving problems in mechanics is introduced.

#### Learning Outcomes

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

- Calculate the distribution of stress in composite beams and build-up beams. Determine the influence of an inclined load on the stress distribution within a beam.
- Calculate the shear stresses in beams of thin-walled open cross-section..
- Calculate the shear centre of a beam. Design a beam to meet certain requirements.
- Demonstrate a fundamental knowledge of the theory of elasticity, including equilibrium equations, compatibility equations, boundary conditions, stress functions etc.
- Use stress functions to determine the stress distribution in a number of engineering structures, given the appropriate boundary conditions. Understand the importance of the theory of elasticity in the design of engineering components.
- Demonstrate a basic understanding of the finite element method.
- Use strain gauges in a laboratory assignment to investigate composite beams.

## Course Content

- Stresses in beams
  - Composite Beams
  - Inclined Loads
  - Shear Stresses in beams of thin-walled open cross-section
  - Calculating the shear centre
  - Built-up beams
- Theory of Elasticity
  - Equilibrium and compatibility equations in Cartesian and polar coordinates
  - Stress functions
  - Beams
  - Thick-walled pressure vessels
  - Concentrated load at a point
  - Hole in a plate
  - Introduction to plates and shells
- Finite element method
  - Linear interpolation models
  - Derivation of element matrices
  - Assembly of element matrices

## Course Notes

### Teaching Strategies

This part of the course is taught using a combination of lectures, laboratories and tutorials. During the tutorials and laboratories the students work in groups thereby encouraging teamwork and cooperation.

### Assessment Modes

Written Exam (85%) and laboratory experiment (15%).

### Recommended Texts

- Theory of Elasticity, Timoshenko (McGraw-Hill)
- Mechanics of Materials, Gere, 5th Ed (Nelson Thornes)

### Further Information

Web Page

### Laboratory

Analysis of a Composite Beam

## 4B2 MATERIALS

**Lecturers:** Professor David Taylor ([dtaylor@tcd.ie](mailto:dtaylor@tcd.ie))

**Semester:** 1

### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures and one tutorial per week (except the study week). Total contact time is 44 hours.

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

### Course Description

This course aims to advance the student's knowledge of the mechanical properties of materials, especially in respect of the principal modes of failure of engineering components. These failure modes are introduced through a series of real-life case studies, giving the student experience of failure analysis and of the related methods of design and material selection. Legal and ethical aspects of component failure are also discussed.

### Learning Outcomes

On successful completion of this course, students will be able to:

- List and describe the various types of mechanical failure which occur in components, explaining the appearance of fracture surfaces and other relevant evidence which allows the mechanism to be diagnosed
- List the various common causes of failure in engineering components and explain how components are designed so as to prevent failure
- Conduct a failure investigation to determine the mechanism and cause of a failure; write an appropriate report with recommendations
- Determine the stress intensity of a cracked body under load and use this information to predict brittle fracture and fatigue. Estimate the fatigue strength of a structure given results from stress analysis (such as finite element or photoelastic analysis) and other relevant information. Use damage mechanics to predict failure under creep and creep/fatigue situations.
- Understand the importance of legal and ethical aspects of engineering failures, the need for safe working practices and the responsibilities of the forensic engineer.

## Course Content

- Mechanisms of failure
- Causes of failure
- Examination of fracture surfaces
- Case 1: failure of a freight container
- Case 2: failure of a pressure vessel
- Case 3: the Markham Colliery disaster
- Case 4: failure of plastic piping
- Stress analysis, finite element methods
- Brittle fracture; fracture mechanics; stress intensity
- Brittle fracture, fracture mechanics, stress intensity
- Fatigue from stress concentrations, notch factors, stress and stress-intensity approaches
- Creep, damage mechanics
- Ethical and legal issues

## Course Notes

Web pages

## Teaching Strategies

This part of the course is taught through a series of four case studies presented via the internet, each of which describes an industrial failure. The students are given a description of the failure and appropriate background information, including data on this particular case and background theory. They are asked to put themselves in the position of the engineer assigned to the failure analysis. There are no formal lectures, instead the lecturer meets with the class, either as a whole or in small groups, to monitor progress and give hints. Necessary theory is covered in an on-line textbook and via tutorial classes. Students write up one of the case studies as a report.

## Assessment Modes

Written Exam (85%), assignment (7.5%) and lab report (7.5%).

## Recommended Texts

- How Components Fail, Wulpi (ASM)
- Deformation and Fracture Mechanics of Engineering Materials, Hertzberg (Wiley)

## Laboratory

Strength and toughness

## 4B3 THERMODYNAMICS

**Lecturers:** Professor Darina Murray ([dmurray@tcd.ie](mailto:dmurray@tcd.ie))

**Semester:** 1

### Course Organisation:

The course runs for 12 weeks of the academic year and comprises three lectures per week (with the exception of week 7). A tutorial is given every week. Total contact time is 44 hours.

Start week	End week	Lectures per week	Lectures Total	Tutorials per week	Tutorials Total
1	12	3	33	1	11

### Course Description:

This course aims to enhance the students' understanding of thermodynamic principles by applying them to advanced vapour and combined power cycles and combustion processes. The aim is to instil within the students and awareness of the environmental and social implications of engineering technology, especially with regard to energy efficiency and safety. Students also gain experience of the use of practical measurement techniques and modern computer-based presentation and analysis. Lifelong learning is fostered by providing a diverse and interactive learning environment.

### Learning Outcomes:

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

- Analyse combustion processes and generate mathematical models from conservation principles
- Recognise, classify and describe the operating functions and thermodynamic principles of the devices and components that comprise vapour (with reheat and regeneration) and gas-vapour power plants and combined heat and power plants.
- Estimate the Thermal Efficiency (vapour or combined gas-vapour power plant) or Utilisation Factor (Cogeneration plant)
- Recognise the environmental and socio-economic implications associated with desired system output (power/ process heat) versus required 'cost' input (fuel/energy source).
- Evaluate thermodynamic processes and cycles from an exergy and second law efficiency perspective
- Describe a broad range of renewable energy sources and assess their current and potential contribution to meeting Ireland's energy requirements
- Utilise internet resources for general course material, individual research assignment and lab report preparation.

## **Course Content**

- Vapour and Combined Power Cycles: Rankine cycle with reheat, Rankine cycle with feed heating, exergy and second law efficiency, cogeneration, gas and combined cycles.
- Combustion of Fuels and Dissociation: theoretical combustion, air-fuel ratio, products of combustion, dew point temperature, 1<sup>st</sup> law analysis of combustion, adiabatic flame temperature, dissociation.
- Energy Sources and Renewable Energy Technologies: energy market, nuclear energy, solar energy collectors, wind power, wave and tidal power, bioenergy

## **Teaching Strategies**

The course encompasses a diverse range of teaching and learning strategies. This is accomplished by coordinating formal lectures with problem solving tutorial sessions supplemented by technical report writing and an individual research assignment. The course is delivered in a technologically up-to-date fashion by providing access to computerised course notes and by exposing the students to digital control and data acquisition whilst encouraging the use of modern software packages.

## **Assessment**

Written examination 80%, written assignment 20%.

## **Recommended Texts**

- Thermodynamics: an Engineering Approach, A.Y. Çengel and M.A. Boles (McGraw Hill)
- Thermodynamics and Transport Properties of Fluids, SI Units, G.F.C. Rogers and Y.R. Mayhew (Blackwell)
- Renewable Energy, Godfrey Boyle, Oxford University Press

## **Assignment**

Renewable Energy

## 4B4 HEAT TRANSFER

**Lecturers:** Professor Darina Murray ([dmurray@tcd.ie](mailto:dmurray@tcd.ie))

**Semester** 2

### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures per week (with the exception of week 7). A tutorial is given every week. Total contact time is 44 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
13	24	3	33	1	11

### Course Description

This course aims to enhance the students' understanding of heat transfer principles by applying them to a range of thermal systems and processes. Concepts in radiative and convective heat transfer are introduced; various techniques are explained for the solution of heat transfer problems, emphasizing real life problems such as practical heat exchangers. We also aim to instil within the students an awareness of the environmental and social implications of engineering technology, especially with regard to energy efficiency and safety. Students also gain experience of the use of practical measurement techniques and modern computer-based presentation and analysis. Lifelong learning is fostered by providing a diverse and interactive learning environment.

### Learning Outcomes

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

- Analyse, generate mathematical models, solve problems, and communicate the solutions to practical conductive heat transfer problems in rectilinear, cylindrical and spherical coordinates
- Classify and explain the parameters affecting radiative heat exchange between two surfaces and solve practical heat transfer problems involving radiation.
- Explain the fundamental scientific principles underlying the governing equations (continuity, momentum, energy) for convective heat transfer and normalise the equations to determine key dimensionless numbers for convection.
- Analyse and solve practical problems related to forced convection (internal and external flows), natural convection and convection with phase change.
- Analyse the thermal performance of heat exchangers and recognise and evaluate the conflicting requirements of heat transfer optimisation and pressure drop minimisation.
- Design or select a heat exchanger to perform a predetermined task.
- Recognise basic laboratory procedures and safety and conduct laboratory experiments as a group
- Acquire, tabulate and analyse useful data in the laboratory

- Communicate information and provide physical interpretation of measurements in technical laboratory reports.
- Utilise internet resources for general course material and lab report preparation.

## **Course Content**

- Conduction: Fourier's law, conduction equation, thermal resistance, contact resistance, critical radius of insulation, lumped thermal capacitance
- Radiation: introduction to heat transfer, fundamental concepts and definitions, radiation exchange between surfaces, practical examples and approximations.
- Forced Convection Fundamentals: velocity and thermal boundary layers and governing equations, dimensional analysis for convection, Reynolds analogy, laminar and turbulent flows.
- Forced Convection for External Flows: laminar, turbulent and separated flows; flat plates, cylinders in cross flow, tube arrays.
- Forced Convection for Internal Flows: entrance region and fully developed flow, laminar and turbulent flows in pipes and ducts.
- Free Convection: principles, governing equations, dimensional analysis, correlations.
- Boiling and Condensation: dimensional analysis, modes of boiling, mechanisms of condensation, correlations.
- Heat Exchanger Performance and Design: heat exchanger types, overall heat transfer coefficient, log mean temperature difference, effectiveness, methodology for design.
- Experimental Methods: Isothermal and uniform wall flux boundary conditions, local surface temperature measurement, local heat flux measurement

## **Teaching Strategies**

The course encompasses a diverse range of teaching and learning strategies. This is accomplished by coordinating formal lectures with problem solving tutorial sessions supplemented by 'hands-on' laboratory experimentation, technical report writing. The course is delivered in a technologically up-to-date fashion by providing access to computerised course notes and by exposing the students to digital control and data acquisition whilst encouraging the use of modern software packages.

## **Assessment Modes**

Written examination 85%; laboratory experiment (with formal written report) 15%.

**Recommended Texts**

- Introduction to Heat Transfer - Incropera, F.P. & De Witt, D.P. (Wiley)

**Other Relevant Texts**

- Heat Transfer: A Practical Approach - Cengel, Y.A. (McGraw Hill)
- Heat Transfer - Bejan, A. (Wiley)

**Further Information**

Web page

**Laboratory**

Exchanger Testing

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## 4B5 MANUFACTURING TECHNOLOGY

**Lecturers:** Professor John Monaghan ([Jmonghan@tcd.ie](mailto:Jmonghan@tcd.ie))  
Professor Kevin Kelly ([Kevin.Kelly@tcd.ie](mailto:Kevin.Kelly@tcd.ie))

**Semester:** 2

**Prerequisite Course(s):** 3B7

### Course Organisation

The course runs for 9 weeks of the academic year and comprises three lectures per week. A tutorial is given every two weeks. Total contact time is 36 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
13	24	3	33	1	11

### Course Description

Manufacturing Technology, aims to develop in students the capability to understand, analyse, design and/or select the tooling, forming machinery and processes necessary for the production of metallic and polymer components. The focus will be on enabling students to understand the underlying material science and mathematical theories that underpin the production of components with particular emphasis on: the identification of product defects; the safe design of forming tooling and the selection of forming equipment; the optimum and efficient use of materials and energy and the selection of appropriate manufacturing processes with particular emphasis on safety, both personal and environmental.

### Learning Outcomes

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

- identify the main material properties required of the workpiece and the tooling and the forming process parameters influencing the manufacture of defect free components made of strainrate sensitive and non-strainrate sensitive materials.
- use appropriate yield criteria, material properties and realistic friction and boundary conditions to derive suitable mathematical expression for the evaluation of workpiece and tool stresses and the forming loads required to ensure the manufacture of safe, defect free components under safe working conditions and in an environmental friendly manner
- design forming sequences that optimise production rates yet minimises the use/waste of expensive or scarce materials and the energy required to manufacture a component.
- use the material covered in this course in conjunction with a laboratory exercise (Extrusion or Forging) to obtain appropriate data, analyse and discuss that data, and present it in a professional engineering format.

- critically assess the suitability of using EDM and ECM for the production of complex geometries in difficult to machine materials, to understand the safety and environmental issues associated with such processes and the particular factors that affect the quality and safety of the finished component.

### **Course Content**

- Factors affecting the selection of appropriate tooling, equipment and the processes required for the manufacture of metal and polymer components, with particular emphasis on the influence of material properties on tool design and press selection and product quality.
- Derivation of the underlying mathematical expressions associated with an analysis of the bulk and sheet metal forming processes, including Extrusion, Forging, Strip/Wire drawing and the Deep Drawing of sheet components.
- The operating principals and main applications of thermo-electrical processes such as Electro Discharge Machining (EDM) Electro-Chemical Machining (ECM) for the machining high strength materials and the production of complex geometries.
- An analysis of the mechanics of polymer processing with an emphasis on extrusion, sheet forming and injection moulding.

### **Course Notes**

#### **Teaching Strategies**

The course is taught through a combination of lectures and tutorial sessions. During tutorials, although guided by a teaching assistant, the students work alone and develop their capacity for independent thought which contributes to the process of lifelong learning. Small group working is also an aspect of tutorials and laboratory work and is encouraged in the preliminary stages of assignments, this builds the ability to cooperate and work as a team member.

#### **Assessment**

An annual written examination (85%), laboratory experiment & assignments (15%).

#### **Recommended Texts**

- *Principles of Industrial Metalworking Processes*, Rowe (Arnold: ISBN – 0-7131-3381-3)
- *Manufacturing Science*, A. Ghosh & A.K.Mallik (Ellis Horwood: ISBN -0-470-20312-9)
- *Fundamentals of Modern Manufacturing*, M. P. Groover (Prentice Hall: ISBN – 0-471-40051-3)

#### **Other Relevant Texts**

- *Manufacturing Engineering and Technology*, S. Kalpakjian & S.R.Schmid, (Pearson/Prentice Hall, ISBN 0-13-148965-8)
- *Applied Elasto-Plasticity of Solids*, T.Z.Blazynski, (Macmillian Press London – ISBN 0-333-34545-2)

#### **Further Information**

Web Page

## 4B6 MANUFACTURING SYSTEMS AND PROJECT MANAGEMENT

**Lecturers:** Professor Kevin O’Kelly ([okellyk@tcd.ie](mailto:okellyk@tcd.ie))

**Semester:** 1

### Course Organisation:

The course runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week. Total contact time is 36 hours.

Start week	End week	Lectures per week	Lectures Total	Tutorials per week	Tutorials Total
1	12	3	33	1	11

### Course Description:

This course provides a general introduction to operations management of manufacturing systems. It will explore strategies for operating and optimising the production of products in different varieties and volumes with limited resources and in competitive environments. The impacts of design decisions on manufacturing performance and the physical organisation of plants are explored through various DFM and plant layout strategies.

Formal project management methods will be introduced reflecting the growing use of continuous improvement through project management.

### Learning Outcomes:

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

#### *Learning outcome for Operations Management*

- describe manufacturing planning & control strategies (e.g. MRP, MRP II, JIT)
- construct a materials requirement plan from a bill of materials and master schedule using finite and infinite capacity
- assess the influence of costs on a plan
- link DFM and layout strategies with production planning and control
- identify the key differences between product and process layouts
- identify and quantify key metrics for creating manufacturing cells
- apply contemporary techniques to layout design
- understand the role of purchasing in a manufacturing company

#### *Learning outcomes for Project Management*

- define objectives and deliverables in a project environment
- understand the role of project management in contemporary business practice
- write a project proposal including preliminary budgets and project controls
- apply planning methods including resource, time and cost planning
- understand the importance of risk assessment in developing alternate plans and emergency procedures
- be able to use graphical methods for presenting project schedules and plans

- be able to utilize contemporary techniques and technology for project management.
- apply course material to a project using MS Project software

### **Course Content**

- Materials Requirements Planning
- Just in Time Manufacturing
- Capacity Planning
- Production Activity Control and the Master Production Schedule
- Purchasing
- Introduction to Costing
- Management by project
- Project Life Cycle
- Elements of Project Management – phase structure
- Project Assessment
- Project Planning
- Project Control
- Completion & handover
- Applied project management: factory layouts
- Process based layouts
- Product based layouts
- Case study

### **Teaching Strategies**

The course encompasses a diverse range of teaching and learning strategies. This is The course is taught using a combination of lectures, assignments, and tutorials. The bulk of the course material (notes, tutorials) are provided as handouts. There is a group based tutorial project developing skills in computer-based Project Management.

### **Assessment**

Written Exam (80%), Practical work (20%)

### **Recommended Texts**

- Slack, Chambers, Harland and Johnston *Operations Management*, 3rd Ed., Pitman, 2003.
- Heizer and Render. *Production and Operations Management*, 3rd or later Edition, Allyn and Bacon, 2002.
- Vollman, Berry and Whybark, *Manufacturing Planning and Control Systems*, 4<sup>th</sup> Edition, McGraw Hill, 1997

The core text is an important base, but most topics will be supplemented with specialist readings which are listed under the headings. I have sometimes distinguished between ‘post-session readings’, which you are recommended to consult in order to provide more in depth coverage of lecture material, and ‘background reading’ which provides additional material for widening your knowledge.

## 4B9 MECHATRONICS AND SYSTEMS

**Lecturers:** Prof. Dermot Geraghty ([tgergthy@tcd.ie](mailto:tgergthy@tcd.ie)) (Course Co-ordinator)  
Prof. Frank Boland (Dept. of Electronic & Electrical Eng.)

**Semester:** 2

**Prerequisite Course(s):** 3B6

### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week. Total contact time is 44 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
13	24	3	33	1	11

### Course Description

This course introduces the technology of control systems and their applications in power electronic control devices to control motors, such as AC, DC and Stepping Motors, etc. The aim is to equip the student with the ability to select and design suitable control systems. Aspects of the course include: Programmable Logic Controllers, PID and Fuzzy control systems, Real Time control and Digital Control.

### Learning Outcomes

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

- Understand the operation of AC and DC power control systems as commonly employed in motor control systems e.g. controlled and uncontrolled rectifier bridges
- Understand the control strategies for AC, DC and Stepping Motors and the types of controllers commonly used with these motors i.e. motor drives
- Understand the operation of Programmable Logic Controllers (PLCs), ladder logic and state machine design
- Understand the principles of fuzzy logic and how it compares with PID control
- To describe the dynamical behaviour of controlled processes through use of time and transform domain descriptors
- To explain the role and function of sampling and quantization in digital control loops
- To explain criteria for stability and dynamic response constraints as applied to closed-loop control systems
- To translate a word description of a controller specification into a formal description
- To design compensators for closed loop control using industrial controllers
- To carry out modeling and design of a digital controller using state-space methods

### Course Content

- Rectifiers and Rectifying Circuits
- D.C. Line Commutation

- Motor Control – DC, AC and Stepping
- Programmable Logic Controllers & State Machines
- Fuzzy Controllers and PID Controllers
- Process Modelling: Input-output models based on transfer functions and state-space models derived from engineering analysis
- System Analysis: basic behaviour of systems in open and closed loop in terms of stability, transient and steady-state responses
- Control System Design - specification of the performance of controlled systems and the design of appropriate algorithms. These topics will be illustrated by examples such as speed/position controllers as used in elevators, liquid-level control systems and robotic systems.

## **Course Notes**

### **Teaching Strategies**

The course is taught using a combination of lectures, laboratories and tutorials. The laboratory session introduces students to the apparatus of control systems including controlled rectifiers, such as the fully controlled full wave rectifying bridge. They are also introduced to speed control of a DC motor and implement P, PI and PID speed control of a DC motor. The transient behaviour of the control system is also investigated.

For the digital control section of the course the strategy is a mixture of lectures, problem solving tutorials and group based project work. During tutorials, students work on written analysis problems with the aid of the lecturer. The intention is to cover problems relating to the material covered in lectures during each week. The lecturer supervises each student as they work through problems, giving advice and assistance as required. During the tutorial, the lecturer illustrates the essence of the solution to each problem once the class has made a realistic attempt. The project work is undertaken in groups of 3-4 students. The objective of the project is defined in descriptive terms and the group must decide on an appropriate approach and use Matlab as a tool for obtaining a practical solution. The project work is assessed through a joint presentation and a short individual report.

### **Assessment Modes**

An annual written examination and laboratory experiments.

### **Recommended Texts**

- Lander, Cyril W., Power Electronics, 3<sup>rd</sup> edition
- Franklin, G.F., J.D. Powell, and M.L. Workman, Feedback Control of Dynamic Systems, 4<sup>th</sup> Edition, Addison-Wesley, Chapter 8.
- Franklin, G.F., J.D. Powell, and M.L. Workman, Digital Control of Dynamic Systems, 3<sup>rd</sup> Edition, Addison-Wesley

### **Further Information**

#### **Laboratory**

DC Motor Control

## 4B11 ENGINEERING VIBRATION

**Lecturer:** Professor Henry Rice ([hrice@tcd.ie](mailto:hrice@tcd.ie))

**Semester:** 1

### **Course organisation**

This course runs for the first semester of the academic year and comprises of three lectures per week plus a one-hour weekly tutorial. There is also a detailed laboratory session which must be formally written up. Total contact time is 36 hours per student.

Start week	End week	Lectures per week	Lectures Total	Tutorials per week	Tutorials Total	Practicals per semester	Total
1	12	3	33	1	11	1	6

### **Course description, aims and contribution to programme**

Vibration analysis allows for the prediction of the potential for vibration and noise in a given system and to design structures to withstand these vibrations. This course builds on analysis techniques developed in previous years by applying them to engineering problems and introduces the latest methods for vibration analysis.

### **Learning outcomes**

Upon completion of this course, students will be able to:

- understand the principles of vibration isolation and assess designs for solutions of one of the most common problems faced by noise and vibration engineers in practice;
- analyse and recognize multi-degree of freedom systems and apply modal methods to their solution;
- apply eigenvalue analysis to the solution of vibration problems;
- understand the concept of modal analysis and how it is implemented in practice;
- model and analyse continuous systems;
- predict vibration properties of systems using finite elements;
- perform vibration measurements and compare the results with those obtained by the analytical and numerical methods developed in the course.

### **Course content**

1. Vibration measurement and isolation  
Forced vibration of single degree-of-freedom systems; vibration isolation; vibration measurement; vibration absorbers.
2. Multi degree of freedom systems  
Generalised equations of motion; Newton's equations of motion for discrete systems; matrix formulation; Lagrangian formulations.
3. Modal analysis  
Stiffness and flexibility matrices; mode shapes and natural frequencies; orthogonality; analysis of dynamic response; mode superposition; modal analysis; generalised dynamic response.

4. Continuous Systems

String vibration; longitudinal and torsional vibration; transverse vibration; applications.

5. Vibration Testing

Measurement hardware; digital signal processing; random vibration analysis; modal data extraction.

6. Numerical Methods

Vibrating rod and beam finite elements; FE method in vibration; Matlab Modelling.

**Experiment**

- *Vibration analysis of a wing structure*

**Course notes**

[http://www.tcd.ie/Engineering/Courses/BAI/SS\\_Subjects/4B11/](http://www.tcd.ie/Engineering/Courses/BAI/SS_Subjects/4B11/)

**Teaching strategies**

This course is taught principally through a lecture programme. This is supplemented by a detailed laboratory for which a comprehensive report must be submitted. A series of tutorials are run each with its own problem sheet. Matlab simulations will be used to assist learning.

**Assessment**

Assessment is by means of formal written examination (75% of overall mark) and a laboratory experiment & assignment (25% of overall mark).

**Recommended texts**

*Engineering Vibration*, DJ Inman, Prentice Hall

**Other Relevant Texts**

*Elements of Vibration Analysis*, L Meirovitch, McGraw Hill

*Mechanical Vibrations*, SS Rao, Pearson/Prentice-Hall

*Theory of Vibration with Applications*, W Thompson, Chapman & Hall

## 4B12 ACOUSTICS

**Lecturer:** Prof. Henry Rice ([hrice@tcd.ie](mailto:hrice@tcd.ie)) Dr. Eoin King ([kingea@tcd.ie](mailto:kingea@tcd.ie))

**Semester:** 2

### Course organisation

This course runs for the second semester of the academic year and comprises of three lectures per week plus a one hour weekly tutorial. There is also a detailed laboratory session which must be formally written up. Total contact time is 44 hours per student.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total	Practicals per term
12	24	3	33	1	11	1

### Course description, aims and contribution to programme

Acoustic analysis allows for the prediction of the potential for vibration and noise in a given system and to acoustically optimise our environment. This course builds on analysis techniques developed in previous years by applying them to engineering problems and introduces the latest analysis methods for acoustics.

### Learning outcomes

Upon completion of this course, students will be able to:

- perform acoustic measurements and be familiar with standard procedures; in addition, the reasoning behind these standard procedures will be understood;
- understand the principles of physical acoustics;
- formulate numerical models for acoustic systems;
- apply wave-based analysis to applied acoustics problems;
- analyse and solve some commonly occurring environmental noise problems;
- understand and interpret key elements of noise legislation and standards.

### Course content

- *Fundamentals of acoustics*  
Nature of sound; measurement and perception of sound
- *Sound waves*  
Wave equation; plane waves; spherical waves; sources of sound; acoustic impedance; transmission problems; acoustic energy
- *Environmental noise*  
Noise measurements and standards; noise in living and working spaces; noise control; architectural acoustics.
- Acoustic Impedance Measurement (laboratory session)

**Teaching strategies**

This course is taught principally through a lecture programme in the second term. This is supplemented by a detailed laboratory for which a comprehensive report must be submitted. A series of tutorials are run, each of which has its own problem sheet. This activity is managed directly by the lecturers.

**Assessment**

Assessment is by means of formal written examination (85% of overall mark) and laboratory experiments (15% of overall mark).

**Recommended texts**

- Fundamentals of Acoustics, Kinsler et al, Wiley

**Other Relevant Texts**

- Basic Acoustics, Donald Hall, Wiley

**Laboratory**

Impedance tube measurement

## 4B13 FLUID MECHANICS 2A

**Lecturer:** Professor Craig Meskell (cmeskell@tcd.ie)

**Semester:** 1

**Prerequisite Course(s):** 3B2 (or equivalent)

### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given each week. Total contact time is 40 hours.

Semester	Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
1	1	12	3	33	1	7

### Course Description

Fluid Mechanics 2A is an optional course currently offered to Senior Sophister B Stream students. The course can be divided into two sections: inviscid flow and introduction to turbulence modelling. Although both parts of the course are quite mathematical, real world examples and anecdotes, particularly from the aerospace and power generation industries, drawn from the lecturer's research expertise, are used to illustrate the technical content. This helps the student to contextualize the details of the course in an engineering light.

*Inviscid flow.* This section of the course introduces the student to important concepts in flow analysis such as vorticity and circulation. Attached flow around wings and wing sections (i.e. aerofoils) is used to demonstrate the significance of the inviscid assumption and vorticity. The performance of aerofoils and wings is analyzed using various methods. The need for, and affect of, high lift devices on aircraft is also dealt with. By the end of this section, the student should realize that without viscosity and hence vorticity flight would not be possible, but that it also causes problems such as drag and separation.

*Turbulent flow:* In this part of the course, the student is introduced to issues relating to the numerical solution of the full (i.e. viscous) Navier-Stokes equations. The need for turbulence modelling is discussed, and various turbulence models are presented.

### Learning Outcomes

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

- define and describe various approaches to describe and visualize fluid motion e.g. 4b6 exam 2006 Q1(a,b) ;
- define and describe various methods of measuring flow velocity e.g. 4b6 exam 2006 Q7(a) ;
- formulate relationships between derived variables (e.g. vorticity) and the primitive variables (velocity and pressure) describing fluid flow e.g. 4b6 exam 2005 Q1(a,b) ;
- discuss the significance of vorticity in flows of engineering interest e.g. 4b6 exam 2005 Q1(c) ;

- state the limitations of various methods to analyze flow around aerofoils e.g. 4b6 exam 2004 Q4(a) ;
- explain the differences between irrotational and rotational flows and describe the physical significance e.g. 4b6 exam 2006 Q1(c) ;
- calculate the effect of wing aspect ratio on drag and hence evaluate the impact on aircraft performance e.g. 4b6 exam 2005 Q4(c) ;
- analyze aerofoils with arbitrary camber e.g. 4b6 exam 2005 Q3(c);
- evaluate the effect of high lift devices on aerofoil performance e.g. 4b6 exam 2006 Q3(c) ;
- assess whether the numerical results of methods used to analyze an aerofoil are physically reasonable e.g. 4b6 exam 2004 Q3;
- assess the appropriateness of a computational mesh e.g. assignment
- discuss the relative merits/demerits of various turbulence models e.g. assignment

### Course Content

- Classical hydrodynamics:
  - Governing equations for inviscid fluid flow - Laplace and Poisson Equations;
  - Development of concepts and equations for stream function, velocity potential, vorticity and circulation;
  - Definition of basic inviscid flows: uniform flow, source/sink flow, point vortex, rigid body rotation, corner flow, doublet flow;
  - Potential flow around a circular cylinder and comparison with real viscous flow;
  - Potential flow around a rotating cylinder and comparison with real viscous flow.
- Analysis of flow around aerofoils:
  - Terminology associated with definition of aerofoil geometry and performance;
  - Kutta-Joukowski condition;
  - Joukowski aerofoil analysis;
  - Thin aerofoil theory;
- Analysis of flow around finite wings:
  - Helmholtz' vortex theorems;
  - Prandtl's lifting line theory - wing tip vortices and starting vortex;
  - Effect of aspect ratio on wing performance.
- Introduction to Turbulence Modelling
  - Physical description and origins of turbulence
  - Reynolds equations and turbulent shear stress
  - Eddy viscosity and mixing length hypotheses
  - Law of the wall for turbulent boundary layers
  - 2 equation turbulence models
  - 5 equation turbulence models

### Teaching Strategies

This course is taught using a combination of lectures, assignment and tutorial sessions. The tutorial sessions are overseen by a Teaching Assistant: during these sessions students are encouraged to work in groups to develop their communication and

teamwork skills. As a significant proportion of the course is highly mathematical, the majority of lecture overheads for the first part of the course are available in the VLE. It is emphasized to students that these files are simply a convenience to avoid errors in transcription of mathematical formulae. They do not replace taking notes in class, as many of the anecdotes and practical examples illustrating the technical content are not detailed in the electronic files.

### **Assessment Modes**

Written exam and assignment. Examination questions are designed to test the students' ability to use the knowledge gained in lectures to solve practical problems, bringing together different aspects of the course and of other courses, such as mathematics. The written exam counts for 80% (4 questions from 6); the turbulence modelling assignment counts for 20%.

### **Recommended Texts**

- *Foundations of Aerodynamics 5th Ed.*, Arnold M. Kuethe & Chuen, Yen Chow  
(The textbook is followed closely throughout the course.)

### **Other Relevant Texts**

- *Fundamentals of aerodynamics*, J.D. Anderson
- *An introduction to computational fluid dynamics: the finite volume method (2<sup>nd</sup> Ed.)*, Versteeg, Malalaseekera
- *Fundamentals of fluid mechanics 6e (SI Version)* Munson, Young, Okiishi, Huebsch.

## 4B15 INTRODUCTION TO BIOENGINEERING AND MEDICAL DEVICE DESIGN

**Lecturers:** Prof. Bruce Murphy ([bruce.murphy@tcd.ie](mailto:bruce.murphy@tcd.ie)),  
Prof. Patrick Prendergast ([pprender@tcd.ie](mailto:pprender@tcd.ie)),  
Prof. Clive Lee ([tclee@rcsi.ie](mailto:tclee@rcsi.ie))  
Prof. Richard Reilly ([richard.reilly@tcd.ie](mailto:richard.reilly@tcd.ie))  
Prof. Conor Buckley ([conor.buckley@tcd.ie](mailto:conor.buckley@tcd.ie))  
Prof. Garry Duffy ([garryduffy@rcsi.ie](mailto:garryduffy@rcsi.ie))

**Semester:** 1

### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week. Total contact time is 44 hours.

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

### Course Description

The objective of this course is to apply the principles of engineering mechanics and dynamics taught in the junior sophomore year to investigate the mechanical behaviour of body systems such as the musculo-skeletal and cardiovascular systems. A basic introduction to human anatomy and physiology will be provided. The course will also investigate engineering materials which can be implanted into the body. The process of medical device design from concept through to production will be discussed and standard device related problems analysed. Finally the student will be introduced to biomedical sensors and biosignal processing. The course aims to promote independent critical thinking and lifelong learning through the use of group assignments.

### Learning Outcomes

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

- Describe the basics of human anatomy and physiology.
- Calculate joint reaction forces.
- Appreciate the importance of biocompatibility for devices that are implanted into the body.
- Describe the engineering properties of ceramic, metallic and polymer biomaterials, and how they would respond after implantation into the body.
- Use Bernoulli's equation and Poiseuille law to analyze blood flow in the circulatory system.
- Describe the mechanics of the human heart.
- Describe how biomedical sensors work and describe some of their uses.
- Explain how the Fourier Transform can be used to help process signals from biomedical sensors.
- Have completed a group assignment and an independent learning assignment unique to them. This requires researching a specific bioengineering problem and producing an electronic report.

- Understand the process of medical device design from concept to the clinic.

### **Course Content**

- Statics
- Metallic, ceramic and polymeric biomaterials
- Introduction to cell biology and stem cell biology
- Biocompatibility
- Biofluid mechanics
- Biomedical sensors
- Biosignal processing
- Medical device innovation and intellectual property
- Medical device regulation and quality control
- Methods for manufacturing medical devices

### **Course Notes**

Web Page

### **Recommended Texts**

Introduction to Biomedical Engineering, J. Enderle, S. Blanchard, J. Bronzino (Elsevier).  
Basic Orthopaedic Biomechanics, V.C. Mow & W.C. Hayes (Lippencot-Raven)  
Essentials of Anatomy & Physiology, F.H.Martini, E.F. Bartholomew, (Prentice-Hall, 1997).  
Biodesign, Zenios, Makower, Yock (Cambridge 2009).

### **Other Relevant Texts**

Biomechanics: Circulation, Y.C.Fung (Springer 2<sup>nd</sup> Ed. 1996)

### **Teaching Strategies**

The course is taught using a combination of lectures, assignments and tutorials. During the tutorials the students work in groups thereby encouraging teamwork and cooperation. Each student is given a group assignment and an independent learning assignment which introduces the student to research skills necessary for life-long learning and critical analysis.

### **Assessment Modes**

Written exam (70%) , group assignment (30%).

### **Further Information**

## 4B16 BIOMECHANICS OF TISSUES AND IMPLANTS

**Lecturers:** Prof. Conor Buckley (conor.buckley@tcd.ie)  
Prof. Ciaran Simms (csimms@tcd.ie)  
Prof. Clive Lee ([tclee@rcsi.ie](mailto:tclee@rcsi.ie))  
Prof. Patrick Prendergast ([pprender@tcd.ie](mailto:pprender@tcd.ie))

**Semester 2**

### Course Organisation

The course runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week. Total contact time is 44 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
13	24	3	33	1	11

### Course Description

This course studies the biomechanics of human tissues and joints, and implants that are used to replace or repair damaged tissues and joints. It begins with an introduction to human anatomy and physiology and the biology of cells and tissues and goes on to discuss the mechanical behaviour of human tissues and joints. Concepts of tissue remodelling and repair are explored. Finally the student is introduced to the use of implants and medical devices for reconstruction and repair of human tissues and systems. The course aims to promote independent and lifelong learning through the use of individualised assignments.

### Learning Outcomes

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

- Describe the basics of human anatomy and physiology.
- Explain how tissues such as bone and cartilage grow, develop, adapt and repair.
- Develop mathematical frameworks to describe biological events such as bone remodeling.
- Explain how the structure and components of tissues determine their mechanical properties (structure-function relationships). This will be facilitated by laboratory assignment where students will determine the aggregate modulus of articular cartilage using a stress relaxation test.
- Use constitutive equations to describe the visco-elastic response of a tissue.
- Describe the biomechanics of human joints (the knee, hip, shoulder, elbow and spine).
- Understand the basics of the human gait cycle.
- Explain the design principles behind orthopaedic implants used for joint replacement and bone fracture repair. The students will also gain an understanding of the consequences of a poorly designed implant, as well as the benefits of well designed implant.
- Use mechanics of solids theory to analyze different orthopaedic implants.

- Appreciate how medical devices designed by engineers are used by clinicians (the customer).
- Develop constitutive equations to model large deformations of soft tissues.
- Have completed an independent learning assignment unique to them. This requires researching a specific bioengineering problem and producing an electronic report.

### **Course Content**

- Cell physiology
- Tissue differentiation, growth, adaptation and repair
- Mechanical properties of bone and soft tissues;
- Musculoskeletal biomechanics, design of joint replacements and orthopaedic
- Constitutive modelling of tissues
- Gait analysis
- Biomechanics of man-machine interaction

### **Course Notes**

Provided in lectures

### **Teaching Strategies**

The course is taught using a combination of lectures, laboratories and tutorials. Each student is given an independent learning assignment which introduces the student to research skills necessary for life-long learning.

### **Assessment Modes**

Written Exam (70%), laboratory experiment and individual learning assignment (30%).

### **Recommended Texts**

- Basic Orthopaedic Biomechanics, V.C. Mow & W.C. Hayes (Lippencot-Raven)
- Bone Mechanics Handbook, S.C. Cowin, Ed., CRC Press, Boca Raton, 2001
- Essentials of Anatomy & Physiology, F.H.Martini, E.F. Bartholomew, (Prentice-Hall, 1997)
- Biomechanics: Mechanical Properties of Living Tissues, Y.C. Fung (Springer 1991)

## 4E1 MANAGEMENT FOR ENGINEERS

**Lecturer(s)** Prof. Gerard Lacey ([gerard.lacey@tcd.ie](mailto:gerard.lacey@tcd.ie))  
Prof. Bartley McElroy ([bartley.mcelroy@tcd.ie](mailto:bartley.mcelroy@tcd.ie))

**Semester:** 1

### Course Organisation

This subject is delivered in two parts: Project Management and Financial Management.  
Total contact hours 33.

Semester	Start week	End week	Lectures Per week	Total Lectures	Tutorials Per week	Total Tutorials
1	1	12	3	33	0	0

### Weeks 1 to 6 – Project Management

**Lecturer:** Dr. Gerard Lacey, School of Computer Science and Statistics

### Course Description and Aims

This course aims to introduce students to the concepts and tools of project management. We will use a project management simulation SimProject [www.fissure.com](http://www.fissure.com) to develop the practical skills of project management.

### Course Outline

Week	Lecture Learning Outcomes
1	Course Outline and introduction to Project management concepts Project definition and organization
2	Project Planning tools
3	Project Feasibility and Evaluation
4	Risk , Resources and Costs
5	Team Dynamics and Organizational behavior
6	Alternative Models of Project Management: IT, Innovation, New Product Development
<b>Coursework</b>	
<u>End week 6</u>	Team Report on SimProject showing performance reports – submit via Turnitin Individual reflective Diary on SimProject – submit via Turnitin
End week 7 (reading week)	Individual Case Study on project Management – submit via Turnitin

### Assessment

The course will be assessed entirely by coursework. Plagiarism will be taken extremely seriously and all assessments must be submitted via the Turnitin plagiarism detection system.

Project Management Case Study	60%
Group Report on SimProject	20% - each team member gets the same mark.
Individual Reflective diary on SimProject	20%

## References

### Primary Texts

1. [Project Management](#) - Clifford F. Gray & Erik W. Larson; McGraw-Hill, 4<sup>th</sup> Edition, ISBN 978-0-07-128751-7

### Supplementary Texts

1. [Software Project Survival Guide \(Pro -- Best Practices\)](#)- Steve McConnell  
MICROSOFT PRESS (1 Oct 1997)
2. [The Innovators Dilemma](#) – Clayton M Christensen; Collins Business Essentials 2003
3. [Winning at New Products: Accelerating the Process from Idea to Launch](#), by Robert G. Cooper

## Weeks 8 to 12 Financial Management

**Lecturer:** Mr. Bartley McElroy, Department of Mechanical & Manufacturing Engineering

The second part, Financial Management, deals with a number of business areas. In particular, students are taught to assess business decisions, especially from the financial, legal and marketing aspects, including the different types of business ownership and the concept of a business plan.

This course provides students with important insights into business and management issues in Engineering. Most engineers will work on projects at some stage in their careers; many will spend their entire careers working on projects and some will eventually become project managers. A knowledge of project management is, therefore, of critical importance to graduates. This course is taught using examples from real life and from all branches of engineering and ranging from large civil projects to internal mechanical or electrical projects concerned with, say, the development of a new component or product. This course also exposes student to some of the 'messy' practical realities of working in the real world of people and organisations.

### Learning outcomes

Upon completion of this part of the course, students will be able to:

- articulate the assumed primary objective of a commercial organisation;
- apply a number of techniques to assist with business decision making, including net present value; internal rate of return; payback; accounting rate of return; decision trees and breakeven analysis;
- draft the contents of a business case;
- read and interpret some key items from financial statements, including profit and loss account; balance sheet and cash flow, including some ratio analysis;
- articulate the role of marketing in a business, including marketing mix, market segmentation and the role of channels to market;

- articulate the key elements required for a contract and the remedies for a breach of contract;
- explain the common forms of business ownership and their advantages and disadvantages;
- draft the contents of a business plan;
- interpret a broad range of commercial terminology.

### **Course content**

- financial decision making;
- business cases;
- understanding financial statements;
- marketing and sales;
- business plans;
- law of contract;
- common forms of business ownership;
- business and commercial terminology;
- human resources;
- taxation.

### **Course notes**

#### **Teaching strategies**

*Financial Management*, is taught using a combination of lectures and tutorial sessions.

#### **Assessment**

*Financial Management*, is assessed through written examination, assignments and assessments.

#### **Recommended texts**

The following books are referenced for specific topics:

- Business Blunders, Geoff Tiballs (1999), Robinson
- A Handbook of Practical Business Finance, Ray Fitzgerald (1990), Kogan Page
- Investment Appraisal and Financial Decisions, Steve Lumby (1999), Chapman Hall
- Costing - An Introduction, C Drury (1998), Chapman Hall
- Introduction to Management Science (any edition), Bernard Taylor (1986), Prentice Hall
- Judgment in Managerial Decision Making, M Bazerman (2002), Wiley

***See page 3 of this handbook***

The final year project is designed to assess a student's ability to undertake development, design or research work using his own initiative. Students are required to make an oral presentation of their work and to submit a written report describing their achievements. Marks for the project are awarded on the basis of both communication skills and technical competence.

**GUIDELINES ON EXAMINATIONS**

The following pages set out some guidelines on examinations, including extracts from the University Calendar on plagiarism and anonymous marking procedures

***Plagiarism***

53 Plagiarism is interpreted by the University as the act of presenting the work of others as one's own work, without acknowledgement.

Plagiarism is considered as academically fraudulent, and an offence against University discipline. The University considers plagiarism to be a major offence, and subject to the disciplinary procedures of the University.

54 Plagiarism can arise from deliberate actions and also through careless thinking and/or methodology. The offence lies not in the attitude or intention of the perpetrator, but in the action and in its consequences.

Plagiarism can arise from actions such as:

- (a) copying another student's work;
- (b) enlisting another person or persons to complete an assignment on the student's behalf.
- (c) quoting directly, without acknowledgement, from books, articles or other sources,
- (d) either in printed, recorded or electronic format;
- (d) paraphrasing, without acknowledgement, the writings of other authors;

Examples (c) and (d) in particular can arise through careless thinking and/or methodology where students:

- (i) fail to distinguish between their own ideas and those of others.
- (ii) fail to take proper notes during preliminary research and therefore lose track of the sources from which the notes were drawn;
- (iii) fail to distinguish between information which needs no acknowledgement because it is firmly in the public domain, and information which might be widely known, but which nevertheless requires some sort of acknowledgement;
- (iv) come across a distinctive methodology or idea and fail to record its source;

All the above serve only as examples and are not exhaustive.

Students should submit work done in co-operation with other students only when it is done with the full knowledge and permission of the lecturer concerned. Without this, work submitted which is the product of collusion with other students may be considered to be plagiarism.

55 It is clearly understood that all members of the academic community use and build on the work of others. It is commonly accepted also, however, that we build on the work of others in an open and explicit manner, and with due acknowledgement. Many cases of plagiarism that arise could be avoided by following some simple guidelines:

- (i) Any material used in a piece of work, of any form, that is not the original thought of the author should be fully referenced in the work and attributed to its source. The material should either be quoted directly or paraphrased. Either way, an explicit citation of the work referred to should be provided, in the text, in a footnote, or both. Not to do so is to commit plagiarism.
- (ii) When taking notes from any source it is very important to record the precise words or ideas that are being used and their precise sources.
- (iii) While the Internet often offers a wider range of possibilities for researching particular themes, it also requires particular attention to be paid to the distinction between one's own work and the work of others. Particular care should be taken to keep track of the source of the electronic information obtained from the Internet or other electronic sources and ensure that it is explicitly and correctly acknowledged.

56 It is the responsibility of the author of any work to ensure that he/she does not commit plagiarism.

57 Students should ensure the integrity of their work by seeking advice from their lecturers, tutor or supervisor on avoiding plagiarism. All departments should include, in their handbooks or other literature given to students, advice on the appropriate methodology for the kind of work that students will be expected to undertake.

58 If plagiarism as referred to in §34 above is suspected, the Head of Department will arrange an informal meeting with the student, the student's tutor<sup>1</sup>, and the lecturer concerned, to put their suspicions to the student and give the student the opportunity to respond.

59 If the Head of Department forms the view that plagiarism has taken place, he/she must notify the Senior Lecturer in writing of the facts of the case and suggested remedies, who will then advise the Junior Dean. The Junior Dean will interview the student if the facts of the case are in dispute. Whether or not the facts of the case are in dispute, the Junior Dean may implement the procedures set out in CONDUCT AND COLLEGE REGULATIONS §2.

*Note 1: As an alternative students may nominate a representative from the Students' Union to accompany them to the meeting*

*pp. G12-G13 Calendar 2000-2001*

### ***Anonymous Marking***

Candidates will have their new examination number forwarded to their home address, by letter, from the Examinations Office before the end of the first semester. Examination option information (XIDs) will not be included in these letters. Students will be able to access their own examination information on the new Student Information System in late February/early March, following completion of XID and option maintenance by Faculty Offices and the Examinations Office. An email will be sent to students asking them to check their examination subjects on the Student Information System and contact the appropriate Department or Faculty Office if there are any corrections.

## **Safety in the Department.**

Dear Student,

The Department of Mechanical & Manufacturing Engineering operates a 'safe working environment' policy and we take all practical precautions to ensure that hazards or accidents do not occur. We maintain safety whilst giving you the student very open access to the departmental facilities. Thus safety is also your personal responsibility and it is your duty to work in a safe manner when within the department. By adopting safe practices you ensure both your own safety and the safety of others.

Please read the Safety Document on the Departmental website: <http://www.mme.tcd.ie/> and comply with the instructions given within. Failure to behave in a safe manner may result in your being refused the use of departmental facilities.

Professor Biqiong Chen  
Dept Safety Officer

## **Student Disability Services**

If you have a disability or a specific learning disability (such as dyslexia) you may want to register with Student Disability Services.

Do you know what supports are available to you in College if you have a disability or a specific learning disability? Further information on our services can be found at [www.tcd.ie/disability](http://www.tcd.ie/disability)

**Declan Reilly and Alison Doyle** are the Disability Officers in College. You can make an appointment to see them by phoning 8963111, or emailing them at: [disab@tcd.ie](mailto:disab@tcd.ie).