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Welcome Message from Course Director

As students of the MSc. in Bioengineering, you are among the select few who have joined the biomedical engineering community at Trinity College Dublin for an education that will enable you to become the next leaders in the field of biomedical engineering. Some of the most exciting work in engineering today takes place at the intersection of various disciplines. Research in biomedical engineering is an example of where the biological, physical and digital worlds intersect and where you have the opportunity to have a profound impact on society.

Engineering is not just about crunching numbers or solving problems; it is identifying how problems affect society and how society actually changes because of the solutions you provide. You have an opportunity here as students in biomedical engineering to become involved in that community, so that, as you move into your professional life, you will become a leader who has an impact on the human condition.

You are part of a discipline that offers great opportunities for learning and advancement within Ireland’s premier university. You are now part of the Trinity Centre for Bioengineering. The Centre has over 20 academics from all School of Engineering, School of Medicine, School of Dental Science, School of Natural Sciences and over 100 Postdoctoral, PhD and MSc researchers. All of these researchers are involved in exciting new developments in biomedical engineering ranging from developing new materials for use in cardiac care, analysing minute electrical signal changes in the brain for neurological diagnosis to artificially growing new tissue to replace organ transplantation. The Trinity Centre for Bioengineering has extensive clinical research in five teaching hospitals around Dublin. As a member of this biomedical community, I encourage you to use the opportunity to learn from activities in the Trinity Centre for Bioengineering, so that you can relate your course material to the real clinical challenges that are being researched and the solutions being generated.

The Trinity Centre for Bioengineering is primarily based in the Trinity Biomedical Sciences Centre and many of its laboratories are located here. You will be notified of seminars, news and other of existing developments throughout the year. This handbook contains important information regarding modules, course regulations, faculty members and contact details.

On behalf of all the lecturers and staff, I would like to wish you every success for the coming year. We look forward to you becoming part of the Trinity College Biomedical Engineering family as you embark on making your mark on society at large. If you have any questions or comments, please do not hesitate to contact us.

___________________________
Asst. Prof. Conor Buckley
Director M.Sc. in Bioengineering
Overview

The MSc in Bioengineering consists of taught modules and an individual project focusing on either, neural engineering, biomaterials, biomechanics, medical devices or tissue engineering and carries 90 ECTS to be completed in one academic year.

The programme consists of four streams as illustrated in the Module Dashboard:
1. MSc Bioengineering General Stream
2. MSc Bioengineering with specialisation in Neural Engineering
3. MSc Bioengineering with specialisation in Tissue Engineering
4. MSc Bioengineering with specialisation in Medical Device Design

Students must follow one stream as agreed with the course director.

Assessment
The overall pass mark is 50%. The overall mark for the course is the credit-weighted average of the mark awarded for each module. Taught modules are assessed by examination papers at the end of Michaelmas and Hilary Terms together with in-course assessments and are non-compensatable. To qualify for the award of the M.Sc. in Bioengineering, students are required to pass all modules of the course including the research dissertation. Candidates who do not proceed to the dissertation, or who have failed their dissertation but have passed all required modules, may, on the recommendation of the Examiners, be awarded a Postgraduate Diploma in Bioengineering, provided that they have passed individual modules amounting to 60 ECTS. Both the examinations and the dissertation are subject to external moderation.

Lecture and Tutorial Timetable
**Attendance at lectures, laboratories and tutorials is compulsory**

The timetable for lectures is provided to you in advance of the start of semester. The tutorial Schedules will be announced at the start of each semester. Please note that you must attend the particular tutorial 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.
## MSc Module Dashboard

<table>
<thead>
<tr>
<th><strong>General Stream Modules</strong></th>
<th><strong>ECTS</strong></th>
<th><strong>Code</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomechanics</td>
<td>5</td>
<td>ME5M19</td>
</tr>
<tr>
<td>Biomaterials</td>
<td>5</td>
<td>ME5M20</td>
</tr>
<tr>
<td>Medical Device Design</td>
<td>10</td>
<td>ME5BIO1</td>
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<tr>
<td>Tissue Engineering</td>
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<td>ME5BIO3</td>
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<tr>
<td>Basic Medical Sciences</td>
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<td>ME7B04</td>
</tr>
<tr>
<td>Research Methods</td>
<td>15</td>
<td>ME7B07</td>
</tr>
<tr>
<td>Research Project</td>
<td>30</td>
<td>ME7B08</td>
</tr>
<tr>
<td>Neural Engineering</td>
<td>5</td>
<td>EE7B09</td>
</tr>
<tr>
<td>Design/Innovation</td>
<td>10</td>
<td>ME7B18</td>
</tr>
<tr>
<td><strong>Total ECTS</strong></td>
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<thead>
<tr>
<th><strong>Neural Stream Modules</strong></th>
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<td>Form and Function of the Nervous System</td>
<td>5</td>
<td>PG7901</td>
</tr>
<tr>
<td>Neuroimaging Technology</td>
<td>5</td>
<td>PR7908</td>
</tr>
<tr>
<td>Research Methods</td>
<td>15</td>
<td>ME7B07</td>
</tr>
<tr>
<td>Research Project</td>
<td>30</td>
<td>ME7B08</td>
</tr>
<tr>
<td>Implantable Neural Systems</td>
<td>5</td>
<td>EE7B10</td>
</tr>
<tr>
<td>Neural Signal Analysis</td>
<td>10</td>
<td>EE7M11</td>
</tr>
<tr>
<td>Current Research Topics and Techniques in Neural Engineering</td>
<td>10</td>
<td>EE7B12</td>
</tr>
<tr>
<td>Design/Innovation</td>
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<td><strong>Total ECTS</strong></td>
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<thead>
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<th><strong>Tissue Engineering Stream Modules</strong></th>
<th><strong>ECTS</strong></th>
<th><strong>Code</strong></th>
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<tr>
<td>Biomaterials</td>
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<td>ME5M20</td>
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<tr>
<td>Research Methods</td>
<td>15</td>
<td>ME7B07</td>
</tr>
<tr>
<td>Research Project</td>
<td>30</td>
<td>ME7B08</td>
</tr>
<tr>
<td>Current Topics in Cell and Tissue Engineering</td>
<td>10</td>
<td>ME7B09</td>
</tr>
<tr>
<td>Advanced Cell &amp; Tissue Engineering</td>
<td>10</td>
<td>ME7B13</td>
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<tr>
<td>Laboratory Techniques in Cell &amp; Tissue Engineering</td>
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<td>ME7B16</td>
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<td>Design/Innovation</td>
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<tr>
<td><strong>Total Mandatory</strong></td>
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<td></td>
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Select one of the following 5 credit modules:

- Biomechanics                      | 5       | ME5M19  |
- Basic Medical Sciences (not available to intercalated medical students) | 5 | ME7B04 |
| **Total ECTS**                     | **90**  |         |

<table>
<thead>
<tr>
<th><strong>Medical Device Specialisation Stream</strong></th>
<th><strong>ECTS</strong></th>
<th><strong>Code</strong></th>
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<td>Biomaterials</td>
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<td>ME5M20</td>
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<tr>
<td>Medical Device Design</td>
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<td>ME5BIO1</td>
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<td>Research Methods</td>
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<td>ME7B07</td>
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<td>Research Project</td>
<td>30</td>
<td>ME7B08</td>
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<tr>
<td>Current Research Topics and Techniques in Medical Device Design</td>
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Select one of the following 5 credit modules:

- Tissue Engineering                    | 5       | ME5BIO3 |
- Basic Medical Sciences (not available to intercalated medical students) | 5 | ME7B04 |
<p>| <strong>Total ECTS</strong>                         | <strong>90</strong>  |         |</p>
<table>
<thead>
<tr>
<th>Key Dates</th>
<th>Outline Structure of Academic Year 2016/17</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Dates 2016/2017 (week beginning)</td>
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<tr>
<td>26-Sep-16</td>
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<td>Michaelmas Lecture term begins</td>
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<td>03-Oct-16</td>
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</tr>
<tr>
<td>10-Oct-16</td>
<td>Teaching Week 3</td>
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<td>17-Oct-16</td>
<td>Teaching Week 4</td>
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<td>24-Oct-16</td>
<td>Teaching Week 5</td>
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<td>31-Oct-16</td>
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<tr>
<td>07-Nov-16</td>
<td>Teaching Week 7 – Study Week</td>
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<td>14-Nov-16</td>
<td>Teaching Week 8</td>
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<td>21-Nov-16</td>
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<td>28-Nov-16</td>
<td>Teaching Week 10</td>
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<tr>
<td>05-Dec-16</td>
<td>Teaching Week 11</td>
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<td>12-Dec-16</td>
<td>Teaching Week 12</td>
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<tr>
<td>21-Dec-16</td>
<td>Christmas Period (College closed 23rd December 2016 to 2nd January</td>
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<td>28-Dec-16</td>
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<td>2017, inclusive)</td>
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<td>02-Jan-17</td>
<td>Examination Period (Commences Wednesday 4th Jan)</td>
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<td>09-Jan-17</td>
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<td>16-Jan-17</td>
<td>Teaching Week 1</td>
<td>Hilary Term begins</td>
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<td>23-Jan-17</td>
<td>Teaching Week 2</td>
<td>Bioengineering in Ireland conference BINI 2017 TBC</td>
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<td>30-Jan-17</td>
<td>Teaching Week 3</td>
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<tr>
<td>06-Feb-17</td>
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<tr>
<td>13-Feb-17</td>
<td>Teaching Week 5</td>
<td></td>
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<tr>
<td>20-Feb-17</td>
<td>Teaching Week 6</td>
<td></td>
</tr>
<tr>
<td>27-Feb-17</td>
<td>Teaching Week 7 - Study Week</td>
<td>NCAD – Industrial Design Module</td>
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<td>06-Mar-17</td>
<td>Teaching Week 8</td>
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<tr>
<td>13-Mar-17</td>
<td>Teaching Week 9 (Friday, Public Holiday)</td>
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<tr>
<td>20-Mar-17</td>
<td>Teaching Week 10</td>
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<tr>
<td>27-Mar-17</td>
<td>Teaching Week 11</td>
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<tr>
<td>03-Apr-17</td>
<td>Teaching Week 12</td>
<td>←Hilary Term ends Sunday 09 April 2017</td>
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<td>10-Apr-17</td>
<td>Revision Trinity Week (Monday, Trinity Monday; Friday, Good Friday)</td>
<td>Trinity Term begins</td>
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<td>17-Apr-17</td>
<td>Revision (Monday, Easter Monday)</td>
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<td>24-Apr-17</td>
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<td>08-May-17</td>
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<td>15-May-17</td>
<td>Annual Examinations 3</td>
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<tr>
<td>22-May-17</td>
<td>Annual Examinations 4</td>
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<tr>
<td>Early June</td>
<td>Video Presentations</td>
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<tr>
<td>22nd/23rd/24th June</td>
<td>Oral &amp; Poster Presentations with External Examiner</td>
<td>←Trinity Term ends Friday 1 July 2017</td>
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<tr>
<td>25-Aug-17</td>
<td>Thesis Submission</td>
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MSc Bioengineering General Stream

This programme aims to provide a sound and broad basis in bioengineering. In particular, we aim to provide engineers and scientists with the education needed to practice bioengineering in the medical devices industry.

Specifically the learning outcomes are:

- To give students a broad understanding of the key subjects of bioengineering, viz., biomechanics, biomaterials, bioinstrumentation, cell and tissue engineering and neural engineering.
- By way of case studies and assignments, to provide students a familiarity with bioengineering applied in the main surgical disciplines; e.g. orthopaedics, cardiology, gastroenterology, ENT Surgery, neurology.
- To give students a sound understanding of how to apply the scientific method to research in an industrial or clinical context.
- To give students the ability to exploit information technology for monitoring the performance of medical devices or the health of patients through medical devices.
- To give students a knowledge of how the medical device industry is regulated and of how to obtain acceptance of new products onto the market.
<table>
<thead>
<tr>
<th>Module Title</th>
<th>Code</th>
<th>ECTS</th>
<th>Coordinator</th>
<th>Semester</th>
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</thead>
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<td>Biomechanics</td>
<td>ME5M19</td>
<td>5</td>
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<td>1</td>
</tr>
<tr>
<td>Biomaterials</td>
<td>ME5M20</td>
<td>5</td>
<td>Prof. C. Buckley</td>
<td>1</td>
</tr>
<tr>
<td>Basic Medical Sciences</td>
<td>ME7B04</td>
<td>5</td>
<td>Prof. D. Edge</td>
<td>1</td>
</tr>
<tr>
<td>Neural Engineering</td>
<td>EE7B09</td>
<td>5</td>
<td>Prof. R. Reilly</td>
<td>1</td>
</tr>
<tr>
<td>Tissue Engineering</td>
<td>ME5BIO3</td>
<td>5</td>
<td>Prof. C. Buckley</td>
<td>2</td>
</tr>
<tr>
<td>Design / Innovation</td>
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<td>10</td>
<td>Prof. M. Monaghan</td>
<td>2</td>
</tr>
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<td>Medical Device Design</td>
<td>ME5BIO1</td>
<td>10</td>
<td>Prof. B. Murphy</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>Research Methods</td>
<td>ME7B07</td>
<td>15</td>
<td>Prof. M. Monaghan</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>Research Project</td>
<td>ME7B08</td>
<td>30</td>
<td>Prof. C. Buckley</td>
<td>1 &amp; 2</td>
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<tr>
<td><strong>Total ECTS</strong></td>
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<td>90</td>
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MSc Bioengineering Tissue Engineering Specialisation

This programme has been developed to educate and train the next generation of biomedical tissue engineers. This is an exciting multidisciplinary field of research which holds significant potential in the treatment of many diseases and disorders. This programme aims to give a sound and broad basis in tissue engineering. In particular, we aim to provide engineers and scientists with the education needed to practice tissue engineering in the international medical devices industry.

Specifically the learning outcomes are:

- To give students a broad understanding of key topics in tissue engineering
- To provide students with an understanding of stem cells, animal/human cell culture processes, and strategies to regenerate or repair damaged tissues
- To provide “hands-on” training in state of the art tissue engineering techniques
- To develop students ability to identify, formulate and adapt engineering solutions to unmet biological needs
- Develop students ability to critically analyse the scientific literature in the field of biomedical engineering through interactive discussion (including student presentations) and through grounding in the fundamentals of experimental techniques and data analysis
- To give students a knowledge of how the biomedical industry is regulated and the route to market for tissue engineered products
- To develop students understanding of how to apply the scientific method to research and the knowledge and capability to perform independent research.

<table>
<thead>
<tr>
<th>Tissue Engineering Specialisation Modules</th>
<th>Code</th>
<th>ECTS</th>
<th>Lecturers</th>
<th>Semester</th>
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<tbody>
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<td>5</td>
<td>Prof. C. Buckley</td>
<td>1</td>
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<td>Biomaterials</td>
<td>ME5M20</td>
<td>5</td>
<td>Prof. C. Buckley</td>
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<tr>
<td>Current Topics in Cell and Tissue Engineering</td>
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<td>Research Methods</td>
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<td>15</td>
<td>Prof. M. Monaghan</td>
<td>1&amp;2</td>
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<tr>
<td>Research Project</td>
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<td>Prof. C. Buckley</td>
<td>1&amp;2</td>
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<tr>
<td>Advanced Cell &amp; Tissue Engineering</td>
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<tr>
<td>Design/Innovation</td>
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<td>10</td>
<td>Prof. M. Monaghan</td>
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<tr>
<td><strong>Total Mandatory</strong></td>
<td></td>
<td><strong>85</strong></td>
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<td></td>
</tr>
</tbody>
</table>

Select one of the following 5 credit modules:

- Biomechanics | ME5M19 | 5 | Prof. B. Murphy | 1 |
- Basic Medical Sciences *(not available to intercalated medical students)* | ME7B04 | 5 | Prof. D. Edge | 1 |

**Total ECTS** | | **90** | | |
MSc Bioengineering Neural Engineering Specialisation

As students of the Neural Engineering stream within the MSc in Bioengineering, you are among the select few who have joined the neural engineering community at the Trinity Centre for Bioengineering for an education that will enable you to become the next leaders in the field of neural engineering. Some of the most exciting work in biomedical engineering today takes place at the intersection of disciplines. Neural engineering or Neuroengineering is a perfect example of this. Neural engineering is not just about signal processing of neuroimaging data; it is seeing how problems affect patients and society at large and how society actually changes because of the solutions you provide. You have an opportunity here as students in neural engineering to come involved in that community, so that, as you move into your professional life, you will become a leader who has an impact on the human condition.

This programme aims to give a sound and broad basis in neural engineering. In particular, we aim to provide engineers and scientists with the education needed to practice neural engineering in the international medical devices industry.

Specifically the learning outcomes are:

• To give students a broad understanding of the key subjects of neural engineering, viz., neural signal analysis, neuroimaging technology, implantable neural systems and current research topics and techniques in neural engineering.

• To develop students ability to critically analyse the scientific literature in the field of biomedical engineering through interactive discussion (including student presentations) and through grounding in the fundamentals of data analysis and modern neurotechnology

• By way of case studies and assignments, to give students a familiarity with bioengineering applied in the main neurological disciplines

• To give students a sound understanding of how to apply the scientific method to research in an industrial context.

• To give students the ability to exploit information technology for monitoring the performance of neural systems and related devices.

• To give students a knowledge of how the neural engineering and neurotechnology industry is regulated and of how to obtain acceptance of new products onto the market.
<table>
<thead>
<tr>
<th>Module Title</th>
<th>Code</th>
<th>ECTS</th>
<th>Lecturers</th>
<th>Semester</th>
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<tbody>
<tr>
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<td>1</td>
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<td>5</td>
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<td>Research Methods</td>
<td>ME7B07</td>
<td>15</td>
<td>Prof. R. Reilly</td>
<td>1&amp;2</td>
</tr>
<tr>
<td>Current Research Topics and Techniques in Neural ...</td>
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<td>10</td>
<td>Prof. R. Reilly</td>
<td>1&amp;2</td>
</tr>
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<td>30</td>
<td>Prof. R. Reilly</td>
<td>1&amp;2</td>
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<tr>
<td>Neuroimaging Technology</td>
<td>PR7908</td>
<td>5</td>
<td>Dr. A. Bokde</td>
<td>2</td>
</tr>
<tr>
<td>Implantable Neural Systems</td>
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<td>Prof. R. Reilly</td>
<td>2</td>
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<tr>
<td>Design/Innovation</td>
<td>ME7B18</td>
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<td>Prof. C. Buckley</td>
<td>2</td>
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<tr>
<td><strong>Total ECTS</strong></td>
<td></td>
<td>90</td>
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**MSc Bioengineering Medical Devices Specialisation**

This programme has been developed to educate and train the next generation of biomedical device design engineers. This is an exciting multidisciplinary field of research which holds significant potential in the treatment of many diseases and disorders.

**Specifically the learning outcomes are:**
- To give students a broad understanding of the key topics in medical device design
- To provide students with an understanding of design processes
- To provide “hands-on” training in state of the art medical device design techniques
- To develop students ability to identify, formulate and adapt engineering solutions to unmet clinical needs
- Develop students ability to critically analyse the scientific literature in the field of biomedical engineering through interactive discussion (including student presentations) and through grounding in the fundamentals of experimental techniques and data analysis
- To give students a sound understanding of how to apply the scientific method to research
- To give students a knowledge of how the biomedical industry is regulated and the route to market of for medical device design

### Medical Devices Specialisation Modules

<table>
<thead>
<tr>
<th>Module Title</th>
<th>Code</th>
<th>ECTS</th>
<th>Lecturers</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomechanics</td>
<td>ME5M19</td>
<td>5</td>
<td>Prof. B. Murphy</td>
<td>1</td>
</tr>
<tr>
<td>Biomaterials</td>
<td>ME5M20</td>
<td>5</td>
<td>Prof. C. Buckley</td>
<td>1</td>
</tr>
<tr>
<td>Medical Device Design</td>
<td>ME5BI01</td>
<td>10</td>
<td>Prof. B. Murphy</td>
<td>1&amp;2</td>
</tr>
<tr>
<td>Research Methods</td>
<td>ME7B07</td>
<td>15</td>
<td>Prof. B. Murphy</td>
<td>1&amp;2</td>
</tr>
<tr>
<td>Research Project</td>
<td>ME7B08</td>
<td>30</td>
<td>Prof. B. Murphy</td>
<td>1&amp;2</td>
</tr>
<tr>
<td>Current Research Topics and Techniques in Medical Device Design</td>
<td>ME7B15</td>
<td>10</td>
<td>Prof. B. Murphy</td>
<td>1&amp;2</td>
</tr>
<tr>
<td>Design / Innovation</td>
<td>ME7B18</td>
<td>10</td>
<td>Prof. C. Buckley</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Mandatory</strong></td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Select one of the following 5 credit modules:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Medical Sciences <em>(not available to intercalated medical students)</em></td>
<td>ME7B04</td>
<td>5</td>
<td>Prof. D. Edge</td>
<td>1</td>
</tr>
<tr>
<td>Tissue Engineering</td>
<td>ME5BIO3</td>
<td>5</td>
<td>Prof. C. Buckley</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total ECTS</strong></td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thesis Guidelines

Objectives
The project forms the final part of the course. Members of staff propose projects pertinent to their own research interests. Candidates may propose their own projects, particularly in cases where the candidate has an industrial link, but these projects must be linked to the expertise of the proposed supervisor. Each project is supervised by an academic in the Trinity Centre for Bioengineering, Department of Mechanical & Manufacturing Engineering and Department of Electronic and Electrical Engineering. In some cases other academics (either within TCD or the other institutions affiliated to the course) may also have a substantial involvement. Furthermore, additional guidance may come from medical or healthcare professionals. In these cases, the project usually sets out to solve a problem experienced by these healthcare professionals in the use of a particular medical device.

Project titles will be issued and students will be allocated their project during Michaelmas term. In Trinity term, there will be a meeting at which each student delivers a presentation to the External Examiner of the purpose of their work, and how they intend achieving their goals followed by a questions and answers session. This allows all candidates to gain an appreciation of the work being carried out by their peers, and comments from staff and other candidates can help define the project objectives more clearly.

Project Titles

Here are some recent project titles undertaken by TCD M.Sc. students:

- Articular Chondrocytes in response to the pro-inflammatory cytokines, IL-1β and TNF-α, in an in vitro, intervertebral-disc-like environment
- Mechanical Testing of 3D Printed Cartilage Scaffolds
- Development of closed-loop optogenetic brain-computer interface
- Improved Spring-Assisted Craniectomy for the Treatment of Craniosynostosis
- Investigating the relationship between lung function, gait and cognition in COPD patients hospitalised with an acute exacerbation
- A comparative study between nasal and articular chondrocytes using a rapid digestion protocol for the treatment of degenerative disc disease
- Design of a perforation catheter system used in the treatment of primary paediatric pulmonary hypertension
- Improved decoding of attentional selection in a cocktail party environment
- Development of a novel biomaterial for nerve tissue engineering
- Spike-timing dependent regulation of neuronal activity evoked with brain-computer interface
- Changes in Inhaler Inhalation Acoustics May Detect Lung Function Decline in Asthma Patients
Guidelines for Thesis Report and Presentations

This section emphasises the Trinity Centre for Bioengineering’s important regard for the acquisition of communication skills. These notes will help you to develop those skills and that you will take pride and pleasure in that development. You will find that you will not absorb all this information in a single reading. You should refer to these notes whenever you are carrying out a significant piece of writing and especially when you are writing your thesis.

These instructions have been prepared to indicate to both thesis supervisors and students the expected standard of report writing. It is likely that up to 20% of marks
are lost by poor presentation of work. These notes are designed to help students to avoid common faults and improve presentation of work. The advice can be applied to major theses but also relevant to short reports and essays which may form part of in-course assessments.

**Preparing a Synopsis**
It is essential to prepare a detailed synopsis of any piece of written work which is likely to be more than one page long. A synopsis helps the writer to see clearly what the main points are and to arrange the material so as to bring out the important points. For the MSc thesis, the synopsis would show the order in which the material is to be presented, some idea of the length of each section, what is to be included in each section and an indication of the location of Figures and Tables.

There are two main objectives in preparing a synopsis:-
a) to produce a written document which can be discussed with the supervisor before a great deal of writing is performed.
b) to help the writer to plan the work to the maximum effect
This is essential for large reports and is strongly recommended as a general practice.

A carefully produced synopsis can save hours of writing time and will allow alterations and additions. Work which is not well-planned is likely to ramble and the main points will be lost.

**Report Outline**
Reports should be divided into the following standard sections:

1. Title Page
2. Abstract (Summary)
3. Acknowledgements
4. Table of Contents Page
5. List of Tables
6. List of Figures
7. Introduction
8. Literature Review
9. Methods
10. Results
11. Discussion
12. References
13. Appendix

Occasionally the nature of the material may require a different format. Students should consult supervisors before deviating from the standard arrangement.
Scheduling

Literature Review should be written early in the project when you have read in detail journal articles in the project area. The Literature Review will need to be brought up to date with new, more relevant papers as you continue to research the project. The Methods section should also be written very early in the project, after the Literature Review and “polished” later.

Results should be in the process of being written up during the experimental part of the project.

The Introduction is normally written last and is used to build the argument why the area of study is of interest and importance in bioengineering.

Now follows a short discussion of the headings listed above.

Title Page

This page should include:
- Concise title (not more than 15 words). Should be informative. Abbreviations should be avoided
- Author’s name
- Supervisors name
- Affiliation
- Date
- Degree for which thesis is being submitted

Abstract

- The abstract (maximum one A4 sheet) should be clearly written and readily comprehensible to a broad readership. The abstract should provide a concise summary of the objectives, methodology, key results, and major conclusions of the study. It should be written in complete sentences, without explicit subheadings.

Table of Contents

- This should include chapter headings and details of sections within chapters, with page numbers.

List of Tables

- This should include details of all tables with page numbers.

List of Figures

- This should include details of all figures with page numbers.

Acknowledgements

- Acknowledge all those who provided support to you and your project (e.g., organisation, funding body, supervisor, technicians).
- The Acknowledgements should be placed at the end of the text (before the references) except in the MSc Thesis, when they should immediately follow the Title and Summary.
- As a matter of courtesy all staff mentioned should be given a title (Prof., Dr, Mr, Ms) and both forename and surname. Only intimates should be referred to by first name only.
- Work contributed by others to your project must be acknowledged. Such a situation would arise if, for example, stored samples generated by another researcher were used in the project or if the nature of specific experiments to be included in the project dictated that they must be carried out by an experienced researcher. The titles and names of such contributors and the precise nature of their contribution must be included in this section in a clear statement of acknowledgement. An omission of such an acknowledgement, where required, is plagiarism. Plagiarism, as outlined elsewhere in this Handbook, is regarded by College as a serious offence and the student concerned will be penalised.
- All the foregoing are ‘preliminaries’ and should not be numbered with the main body of the text. Instead, give preliminaries Roman numerals (i, ii etc.). The pages of the main text should be numbered using Arabic numerals (1, 2, etc).

**Introduction**

- This should emphasise the importance of the research study and provide an overview of the key concepts and questions posed. Therefore, the Introduction should include a statement of the problem, research question or hypothesis, the objectives of the study, operational definitions of term used and the background to the study.

**Literature Review**

- A summary of the background literature is necessary. You should aim to produce a detailed overview of the current knowledge of the problem under study and outline a theoretical framework or rationale as a basis for your study. It is important to critically analyse existing literature on your research project.
- A clear statement of the problem and the immediate background as well as the aims of the project and its relevance should be given.

**Methods**

- A clear account of all the experimental, materials, methods (including statistical analyses) and experimental designs used must be given so that others can repeat the experiments. (The anonymity of human subjects must be preserved, by using code numbers or letters.) In particular, it should always be clear to the reader exactly what is being measured, and how many measurements (or animals or subjects) there are in each value. Failure to do this will result in loss of marks. It may be useful to clarify here the contribution of others to the practical work (see Acknowledgements).
- This section will provide a comprehensive explanation of the procedures used including details of the following:
  - Overall design and justification of methods used.
• A clear indication of the sample sizes used.
• A detailed description of all experimental procedures; this should be sufficiently detailed to allow replication.
• A description of the instruments used.
• An indication, if appropriate, of how published methods or available equipment was modified for the current study.
• An account of how data was analysed.
• A sample of any questionnaire used, if appropriate.
• A description of ethical issues for example, the process by which approval was obtained, ethical issues in sample selection, data collection, publication of results etc.

Results
- This section, or sections should be a description and explanation of results using narrative, tables and figures as appropriate. It should deal with facts and findings only, without interpretation (which will be included in the Discussion).
- This is usually the most poorly-presented section of a thesis and yet it is one of the most important. The reader must be led carefully through the results step by step. You should carefully consider the order of the figures to be presented. The order of figures presented may or may not follow the order the experiments were originally performed. You should consider which figures need to be presented. The objective is not to include all your figures to simply show how much work you have done, but to include those figures which are pertinent to the work. The main observations must be brought out; it is NOT sufficient to present figures or tables and then leave the reader to work out the conclusions (see later sections: Figures and Tables).
- Second-order variables. If you are using some transformation of the raw data, you should explain why you are doing so and, if possible, what, if any, difference the transform makes. When results are presented as % control, the absolute value of the control should be given in the Figure/Table legend.
- Presentation of Statistics. This requires particular attention and is a skill which must be acquired. Always state clearly what measure (mean, etc.) and what measure of variation (SD, etc.) is being used. The number of observations (n) must be clearly stated and specifically given if SDs are used. Do not give excessive numbers of decimal places; measures of variation should have one more significant figure than the mean. It is important to clearly state the direction and magnitude of the change observed. Do this first, and then give the result of any statistical tests used to determine significance.
- Over-interpretation of results is a serious error. You must demonstrate that you understand the significance of statistical testing. If a difference (or other statistical result, e.g. correlation) is not statistically significant, you should not treat it as if it is. If you want to discuss a non-significant ‘trend’ in your results, make it clear that you know the difference.

Discussion
- This section should deal with discussion and interpretation of the data obtained and should include a critical assessment of the data in light of
previous findings, speculation on the meaning of the results obtained, analysis of the original hypothesis in the context of the findings, a discussion of whether or not the findings support the hypothesis proposed and an assessment of the limitations of the study. This should be concluded with a summary and conclusions and suggestions for further research.

- This section often presents the most problems. In particular, it is often difficult to decide what should go in the Discussion and what should go in the Results (see Preparation of a Synopsis, below). A good guideline is ‘When in doubt, put it in the Discussion’, and leave the presentation of results as uncluttered as possible.

- The Discussion will include the following:
  - Interpretation of the significance of your results.
  - A comparison of results (not forgetting control values) with those in the literature.
  - A discussion of your results in context of the relevant literature.
  - A critical discussion of possible sources of error in the results. Critical means not only listing the sources of error but also saying how important they are likely to be.

This list is by no means exhaustive and the categories will often overlap, but it should be helpful at the planning stage.

References
- All cited references and only cited references should be included. The format used is the Harvard referencing system.
- Note that all references cited in text must appear in the list of references. General reading such as textbooks should not be cited, unless you are using a figure or referring to a very specific point.
- In the text...
  - When you make a scientific statement of fact, you must reference an original article with data to support this fact (Smith et al., 1999).
  - If there is only one author, quote the name only followed by the year the paper was published (Jones, 2000). If there are two authors, use both names followed by the year the paper was published (Murphy & Quinn, 2001). If there are more than two authors, use et al. (always in italics with a full stop afterwards), which is the Latin term for ‘and others’ (Smith et al., 1999).
  - If you want to reinforce the point and use several articles, they should be listed from the earliest to latest, and separated by a semicolon (Smith et al., 1999; Jones, 2000; Murphy & Quinn, 2001).
  - If you are quoting two articles by the same person in the same year, denote one as ‘a’ and one as ‘b’. This is done alphabetically according to the second author on the paper (Smith et al., 1999a; Smith et al., 1999b).
  - When including the reference in the text, follow the following formats. ‘Smith et al. (1999) have shown that...’, ‘It was shown by Smith et al. (1999) that...’.
Style of References

- Most journals use an abbreviated format for Journal titles. When abbreviating Journal titles make sure to use the correct abbreviation. You can find the correct abbreviation of any journal on PUBMED (http://www.ncbi.nlm.nih.gov/pubmed/). Some examples are as follows:
  - A = “Ann Biomed Eng” (single word journals are not abbreviated)
  - Annals of Biomedical Engineering = “Ann Biomed Eng”
  - Journal of Biomechanics = “J Biomech”
  - Journal of Neural Engineering = “J Neural Eng”
- Below is the reference style used by the IEEE Transactions on Biomedical Engineering. There are different styles for journal articles, books, and book chapters as illustrated below.

Journal article

Cited in text as: (McMahon et al., 2008)

Book

Cited in text as: (Simms and Wood, 2009).

Chapter in a book

Cited in text as: (Lalor, 2009)

The most important thing to remember when citing references is to be consistent.

Appendices

- This should include details of equipment and instruments used, details of software developed and, in some cases tables of raw data. When appropriate, it should also include a copy of any questionnaire used.
- This should contain essential data and details of any other methods. Note that all entries in the Appendix must be properly described in suitable legends. It is not inappropriate to repeat relevant statistical summaries in the Appendix. All Tables in the Appendix must have fully descriptive titles so that they can be understood without reference to the main text.

Figures and Tables

- These are a great deal of trouble to prepare and it is a pity to waste them for the sake of a little attention to detail. All Figures and Tables must be numbered and have a descriptive legend, so that each can be understood without reference to
the text. **Legends precede Tables and follow Figures.** It may be desirable to include the important observation or conclusion in the legend. All units of measurement and statistical parameters must be identified. Axes on graphs and columns in tables must be labelled so that it is clear what each point or value represents.

- Try to keep graphs uncluttered. Use conventional symbols of open and filled squares, triangles or circles. Shading aids clarity in histograms. Tables should be as simple as possible. Try not to put all your results in one huge Table because it is daunting for the reader.

- The most common fault is failure to integrate Figures and Tables with the text. The reader must be guided and the main points clearly brought out — even at the cost of some repetition of material between legend and text. If Figures or Tables are large it may not be possible to include the legend on the same page. In such cases, put the legend on the facing page. If Figures, Tables or collages (mounted groups of photographs) are brought together, rather than being interspersed with the text, say so and tell the reader where they are. If it is necessary to put a figure or table sideways in the text, it should be arranged so that is viewed from the right.

- **You should avoid directly copy-pasting figures/mechanistic diagrams from elsewhere; you will not be awarded any marks for using previously published figures/mechanistic diagrams.** You are expected to take time to draw the major parts of such figures/mechanistic diagrams that are most relevant to your research. If you do decide to copy a figure from somewhere else, or modify it only a little, the original figure must be acknowledged (with reference in the legend and in the list) (see Plagiarism).

**Grades of Heading**

Careful attention should be given to this point at the planning stage. Examples of the usual grades of heading are given below with a short description of each in brackets). Use bold or italic type as shown.

**HEADING: RESULTS** [capitals in bold print, centered, no underline or stop]

**Subheading: Electroencephalographic Analysis** [Upper and lower case in bold print, centred, no stop]

**Further subheading: EEG Feature Extraction** [Upper and lower case in bold italic print, centred, no stop]

**Word Processing**

- There are some conventions which should be followed. Paragraphs should be created by leaving a blank line and not by indenting. Do not put spaces before a punctuation mark because it might be carried over to the beginning of a new line.

- All punctuation marks should have only a single space after them, never before.
Spelling, English and Grammar
- Poorly written reports stem from poorly crafted sentences. Sentences that are long or poorly written can be frustrating to read and will lose you a great deal of marks. You are expected to spend time on writing each and every sentence in your thesis with care. Make sure you do not forget the basic rules of English. Use nouns, verbs, adverbs, adjectives accordingly in each sentence. A common mistake is to make sentences too long. Keep sentences short and simple as far as possible.
- Do not expect that the reader will remember what has been said in previous sentences. Make sure you clearly spell out what is meant in each sentence, even if it means repeating yourself. Be specific and clear and avoid being vague. Ideally each sentence should be self-explanatory.
- Your supervisor will focus on the scientific content and is not expected to check spelling, to correct your English or any mistakes in grammar. A spell check should be performed before handing documents to your supervisor and before final submissions. Ask a colleague to read your report before handing any material to your supervisor and before final submission. If your colleague does not understand what you have written, you should make corrections before handing to your supervisor.
- Ensure the spell checker is set to ‘English (UK)’ and not ‘English (US)’ by using the ‘Language’ option on the Tools menu. Remember that you will still need to proof-read the final draft; the spelling checker will not find all errors. Pay special attention to names and technical terms
- Here is a list of the correct forms of words that are commonly mis-spelled.

<table>
<thead>
<tr>
<th>Word</th>
<th>Correct Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>accommodate</td>
<td>dependent (adj.)</td>
</tr>
<tr>
<td>occurred</td>
<td>separate</td>
</tr>
<tr>
<td>loose (i.e. not tight)</td>
<td>lose (i.e. mislay)</td>
</tr>
<tr>
<td>principal (i.e. main)</td>
<td>principle(i.e.underlying tenet)</td>
</tr>
</tbody>
</table>
- ‘UK English’ rather than ‘US English’ forms should be used: e.g. fibre not fiber.
- Student’s t test should have a capital and apostrophe); the t should be italicised.
- “It’s” should never be written in formal prose; always use ‘it is’. The possessive is “its”.
- Numbers less than eleven should be spelt in full unless they refer to specific units, e.g. '6 days', but 'six subjects.'
- Note that ‘sec’, ‘h’, ‘min’ [no stop] and ‘d’ are the abbreviations for seconds, hours, minutes and days, respectively. The multiplier ‘k’ as in km (kilometre) is always lower case. The abbreviations for units never take an 's-plural'.

Headers and Footers
Header can be used to insert space and/or a running title at top of each page; a Footer does the same at the bottom of the pages.
Pagination
Should be checked as the last stage in preparing a manuscript. It is usual to adjust the text so that odd lines or parts of lines do not appear at the beginning or end of a page. The adjustment may be done by inserting blank lines in appropriate places or by using the Insert Page Break command. Word has a ‘Control widows and orphans’ option (see Format menu, Paragraph, Line & Page breaks tab). Remember to set the page style (Page Setup) and printer type (via Chooser) before doing this and work from the beginning of the text.

Font Style
- Choose your font with care. Some fonts take up a lot of space and others may not be suitable for laser-printing. Avoid fonts named after cities. Arial has been found to be a satisfactory, clear and reasonably compact font.
- Fonts are designed for different purposes and a font that is easy to read on a screen (e.g. Geneva) is not necessarily suitable for body-text. Times is designed for narrow columns and does not look well in A4 pages and should not be used. Times New Roman shares many of the characteristics of Times (compact, with a lot of white space) but looks better.

Spacing
If a type-size larger than 10 pt is used, it is unnecessary to double-space. If you use 12 pt body text, 1.5 spacing may be adequate. Check with your supervisor if in doubt.

Special Sorts
There are many special characters which will be useful to you, such as the degree symbol (° — alt+k) and acute accents or fada (alt+e, followed by the letter you wish to accent) and grave accents (alt+~), followed by the letter). For Greek characters it is better to use the ‘insert font’ function rather than using the font Symbol. This allows you to change the font in the document and keep the Greek characters. If you use font Symbol and decide to change the font in the document you will have to go back and individually change all the Greek characters back to Symbol font.

Preparing Material for PowerPoint
Students are required to make oral presentations - another important skill. PowerPoint presentation will be used. Legibility. Anything less than 18 pt body text will be difficult to read. Headings should be about 24 pt. Use Arial font to improve legibility. Times is not suitable for projection. Bolding the text is helpful too. Diagrams will usually need to be enlarged. It is useless to merely copy pages from papers or books — the print size will be neither big enough nor dense enough. Density. Five lines is the useful maximum per slide; and bullet points are better than continuous prose. If you are tempted to put more on, think again. Practice, Practice, Practice your talk: Avoid reading from your notes and from your slides. Are you trying to write your speaking notes onto the slide? It is not good
technique to simply read out what is on the screen. If you practice your talk beforehand, you will not need to read from your notes.

**Plagiarism**

In the academic world, the principal currency is ideas. As a consequence, you can see that plagiarism – i.e. passing off other people’s ideas as your own– is tantamount to theft. It is important to be aware the plagiarism can occur knowingly or unknowingly, and the offence is in the action not the intent.

Plagiarism is a serious offence within College and the College’s policy on plagiarism is set out in a central online repository hosted by the Library which is located at [http://tcd-ie.libguides.com/plagiarism](http://tcd-ie.libguides.com/plagiarism)

This repository contains information on what plagiarism is and how to avoid it, the College Calendar entry on plagiarism and a matrix explaining the different levels of plagiarism outlined in the Calendar entry and the sanctions applied.

Undergraduate and postgraduate new entrants and existing students, are required to complete the online tutorial ‘Ready, Steady, Write’. Linked to this requirement, all cover sheets which students must complete when submitting assessed work, must contain the following declaration:

*I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at: [http://www.tcd.ie/calendar](http://www.tcd.ie/calendar)*

*I have also completed the Online Tutorial on avoiding plagiarism ‘Ready, Steady, Write’, located at [http://tcd-ie.libguides.com/plagiarism/ready-steady-write](http://tcd-ie.libguides.com/plagiarism/ready-steady-write)*

Plagiarism detection software such as “Turnitin” and Blackboard’s “SafeAssign” may be used to assist in automatic plagiarism detection. Students are encouraged to assess their own work for plagiarism prior to submission using this or other software.

**Turnitin**

Students must submit their thesis to TurnItIn which is the standard in online plagiarism prevention. It instantly identifies papers containing unoriginal material from over 40 Million Student Papers, 12 Billion Web Pages, over 10,000 newspapers, Magazines & Scholarly journals and Thousands of Books. Turnitin allows educators to check students’ work for academic integrity by searching for improper citation or potential plagiarism by comparing it against continuously updated databases using the industry’s most advanced search technology. Every Originality Report provides instructors with the opportunity to teach their students proper citation methods as well as to safeguard their students’ academic integrity. Turnitin is also web Based so compatibility between different computers and operating systems isn’t a problem.

TurnItIn can also be used for the following:
Peer Review: Students can review and respond to their classmates' work online and also encourages collaborative learning and improving student writing

GradeMark: The ability to mark student work in a unique, paperless environment and view assessment over time

GradeBook: A tool that enables instructors to manage grades and assignments online

Student FAQs on Turnitin:

What if Turnitin finds text matches in my paper?
Turnitin determines if text in a paper matches text in any of the Turnitin databases. The service does not detect or determine plagiarism – an instructor needs to make that call based on the matches shown in the Originality Report. Indeed, the text in the student's paper that is found to match a source may be properly cited and attributed. It is recommended that instructors carefully review the Originality Report before making any determination of plagiarism. Such determinations of plagiarism require human judgment, and instructors and students alike should understand their institution's academic integrity policies before turning in written assignments.

Who can see my paper?
Only the instructor, and possibly a TA assigned to the course, can see a student's paper. If a match is found between the student's paper and another student's paper, the instructor can request the matching paper from the other student's instructor. That instructor then decides whether to share the matching paper depending on the circumstances. The only exception to this rule is in the case of peer review assignments.

Does Turnitin violate student copyrights?
No - student works are the property of the student, and are copyrighted and protected. iParadigms, LLC (the parent company of Turnitin) makes no claim of copyright to any of the works submitted to the Turnitin system.

Withheld access (a “stay”)
Should an author of a thesis wish to withhold permission for the use of her/his work, a written application must be made to the Dean of Graduate Studies at the time of submission of the thesis for examination. Such applications must have the written support of the graduate student's Supervisor or Director of Teaching and Learning (Postgraduate), must state the reasons for the request for a stay on access and must provide a contact address. The maximum length of a stay is five years. During this period of withheld permission the thesis may be consulted, lent or copied only by written permission of the author who is under an obligation to reply to all inquiries within a reasonable time.
Exit Form
An Exit form must be included at the back of your thesis submission. The information on this form is to document a record of what data you recorded and how it can be accessed. It is imperative that you return this form when submitting your thesis. The exit form template is at the back of this handbook.

Thesis Submission

Submission Deadline: Friday 25th August 2017

Submit two hard bound copies to the Course Administrator in Trinity Centre for Bioengineering office before 5.00pm on 25th of August 2017. A copy must also be emailed to tcbe@tcd.ie or provided on a USB key to programme administrator.

It is the duty of the postgraduate student to familiarise him- or her-self with College regulations in relation to submission of theses. Please see thesis submission guidelines, these regulations are on the Graduate Studies website. The thesis must be put through turnitin (www.turnitin.com). The thesis must contain immediately after the title page the declaration page (see sample page 2 below) signed by the author.

Note: Late submission could potentially result in a continuance fee being levied by the Graduate Studies Office. Dissertations should be written according to the style outlined below. Dissertations are assessed by academics who may not be expert in the precise field of study. The style of the dissertation should be designed for that readership.

An external and internal examiner will be nominated and their names sent to the Dean of Graduate Studies in consultation with the supervisor of the thesis. The thesis will be sent to these examiners. They may at this time specify that they wish to examine the candidate by viva voce. Such an oral examination would be held in TCBE.
Comparison of soft tissue material parameters derived from indentation tests with conventional compression testing techniques

by

Seán Wall

A thesis submitted to the University of Dublin in partial fulfilment of the requirements for the degree of

Masters in Bioengineering

Trinity College Dublin

September 2008

Supervisor

Dr. Ciarán Simms
Declaration

I declare that I am the sole author of this dissertation and that the work presented in it, unless otherwise referenced, is entirely my own. I also declare that the work has not been submitted, in whole or in part, to any other University as an exercise for a degree or any other qualification.

I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at: http://www.tcd.ie/calendar

I have also completed the Online Tutorial on avoiding plagiarism ‘Ready, Steady, Write’, located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write

I agree that the library of Trinity College Dublin may lend or copy this dissertation upon request.

John Murphy

John Murphy
The Supervisor and the Student

An outline of the role of the supervisor has been provided by the TCD Graduate Studies Office:
The relationship between the supervisor and research student is a critical factor in
determining the quality of the postgraduate experience. Best practice leads to a relationship
that may be described as mentoring on the part of the supervisor and learning on the part of
the student. For a successful collaboration between student and supervisor, both parties have
to recognize their own separate responsibilities. Due to the diverse demands of different
disciplines, it is not possible to legislate in detail across the whole academic range of college
for the practices that supervisors and students should follow. However certain general
principles should be clearly understood by all involved in postgraduate education. These are
set out below.

Responsibilities of the supervisor
A research student is admitted by the Dean of Graduate Studies on the recommendation of
the Director of Postgraduate Teaching and Learning and course coordinator all of whom sign
to this effect. The course coordinator will assign each student to a supervisor for the duration
of their research project.

The supervisor has a reactive and proactive role. He or she must be reasonably accessible
to the student for academic help and advice during progress of the research and particularly
during preparation of the research thesis; he or she has a duty to be in touch with progress of
the research student’s work and inform the student of what is expected of him or her. In
addition the supervisor should help student in the latter’s dealings with College officialdom
and should be aware of College regulations as they affect postgraduates. Many of the cases
of poor relationships between research students and their supervisors stem from a differing
interpretation of what constitutes reasonable access. Supervisors need to recognize that the
lack of adequate analysis of work submitted to them, undue delay in its return, and refusal to
make, or inability to keep, appointments, damage the relationship with their students. Such
inadequacies of supervision cannot be excused on the grounds of pressure of other work.

Responsibilities of the student
A research student must keep in contact with his/her supervisor and advise the latter on
progress of research. He/she should submit written work or perform other academic
exercises (for example contribute to seminars) when requested by supervisor. When seeking
the academic services of a supervisor, a research student must acknowledge that the
supervisor is likely to have other commitments and cannot be expected to drop everything to
attend to his/her needs. This is particularly important during period of preparation of
research thesis; supervisor and student should devise a timetable, which can be adhered to
on both sides.

Additional points
1. Project supervisor will read one complete draft of literature review and project report prior
to submission. Do not expect your supervisor to read incomplete or multiple drafts of your
work.
2. You should provide your supervisor with a draft of your literature review/project two weeks
before submission date, in order to leave plenty of time for them to read it, and for you to
take on board any suggestions that they may have for improvements.
University Rules and Regulations

Description of the European Credit Transfer and Accumulation System (ECTS)

The 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 assigned to 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 module year. Progression from one year to the next is determined by the module regulations. Students who fail a year of their degree will not obtain credit for that year even if they have passed certain component modules. Exceptions to this rule are one-year and part-year visiting students, who are awarded credit for individual modules successfully completed.

Examinations and Assessment

Individual module results are based on a combination of written examination and/or continuous assessment as described in the individual module descriptors included in this handbook. Note that some modules do not have a written examination and are therefore not available for assessment during the Supplemental Exam period.

The overall result for the year is the weighted average of the individual module results. The weighting is based on the ECTS credits associated with each module.

Students are obliged to be present and make a serious attempt at all their examinations. Examination timetables are published on College and School websites some weeks before the examinations take place. It is your responsibility to note these carefully – you will be informed that timetables have been published but you must check them continuously, as examination details may change. All marks for labs/assignments are provisional until after the court of examiners meet.

Attendance, Non-Satisfactory Attendance, Module 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 module 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 module in any term.

At the end of the teaching term, 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.

College regulations are set out in the University Calendar, which may be consulted in any College Library, the Enquiries Office, any academic or administrative office or online – [www.tcd.ie/calendar/](http://www.tcd.ie/calendar/).

You are expected to be aware of the various regulations - ignorance of the regulations is not a valid reason for failure to comply.

**Collaboration and Individual Work**

Engineering is about co-operation, but also individual effort. The everyday fruits of engineering, such as jet aircraft, suspension bridges, microprocessors or software systems, have been designed and built by teams of hundreds, even thousands, of engineers working together. These engineers exchange ideas and ultimately co-ordinate their efforts to achieve the overall project goal. However, each component of even the largest project is the result of one individual’s engineering skill and imagination. If you want to become a successful engineer, you must develop your own ability to analyse problems. This means that, while it is useful to work as a team initially, you must ultimately produce your own work. For example, for a computing exercise, discuss the task with your classmates, swap ideas on how to solve the problem, but at the end of the day, implement your own solution. The examinations will test your ability rather than just your knowledge and the only way to develop your ability for engineering analysis is to complete the laboratory and tutorial exercises yourself.

**Examinations, Assessment and Results**

The overall pass mark is 50%. Students are required to pass all modules of the course. TCD does not award grades to M.Sc. degrees. Individual module results are based on a combination of written examination and/or continuous assessment as described in the individual module descriptors included in this handbook. Note that some modules do not have a written examination and are therefore not available for assessment during the Supplemental Exam period. The overall result for the year is the weighted average of the individual module results. The weighting is based on the ECTS credits associated with each module.
Taught modules are assessed by examination papers at the end of Michaelmas and Hilary Terms together with in-course assessments and are non-compensatable. To qualify for the award of the M.Sc. in Bioengineering, students are required to pass all modules of the course including the research dissertation. Both the examinations and the dissertation are subject to external moderation.

Candidates who do not proceed to the dissertation, or who have failed their dissertation but have passed all required modules, may, on the recommendation of the Examiners, be awarded a Postgraduate Diploma in Bioengineering, provided that they have passed individual modules amounting to 60 ECTS credits. Any student awarded the postgraduate diploma automatically forfeits the possibility of being awarded the M.Sc. at any later stage.

**Regulations for re-checking/reamarking of Examination Scripts**

i) All students have a right to discuss their examination and assessment performance with the appropriate members of staff as arranged for by the Course Coordinator. This right is basic to the educational process.

ii) Students’ examination performance cannot be discussed with them until after the publication of examination results.

iii) To obtain access to the breakdown of their results students should make a request to the Course Coordinator.

iv) Having received information about their results and having discussed these and their performance with the Course Coordinator and the appropriate staff, students may ask that their results be reconsidered if they have reason to believe that:
   1. the grade is incorrect because of an error in calculation of results,
   2. the examination paper specific to the student’s course contained questions on subjects which were part of the course prescribed for the examination, or
   3. bias was shown by an examiner in marking the script.

In the case of the above, the request should be made to the Course Coordinator. Once an examination result has been published it cannot be amended without the permission of the Course Coordinator.

**Commendation for Projects**

The Course Committee, in consultation with the External Examiner, may award a commendation for projects of exceptional merit.

Should you have any queries regarding regulations and guidelines that apply to postgraduate students at Trinity, please consult the Graduate Studies website [www.tcd.ie/Graduate_Studies/](http://www.tcd.ie/Graduate_Studies/) or the University Calendar [www.tcd.ie/calendar/](http://www.tcd.ie/calendar/)

This Calendar contains all information concerning graduate studies in Trinity College, Dublin.
Grading Descriptors
The following Descriptors are given as a guide to the qualities that assessors are seeking in relation to the grades usually awarded. A grade is the anticipated degree class based on consistent performance at the level indicated by an individual answer. In addition to the criteria listed examiners will also give credit for evidence of critical discussion of facts or evidence.
<table>
<thead>
<tr>
<th>Mark Range</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>IDEAL ANSWER; showing insight and originality and wide knowledge. Logical, accurate and concise presentation. Evidence of reading and thought beyond course content. Contains particularly apt examples. Links materials from lectures, practicals and seminars where appropriate.</td>
</tr>
<tr>
<td>80-89</td>
<td>OUTSTANDING ANSWER; falls short of the ‘ideal’ answer either on aspects of presentation or on evidence of reading and thought beyond the course. Examples, layout and details are all sound.</td>
</tr>
<tr>
<td>70-79</td>
<td>MAINLY OUTSTANDING ANSWER; falls short on presentation and reading or thought beyond the course, but retains insight and originality typical of first class work.</td>
</tr>
<tr>
<td>65-69</td>
<td>VERY COMPREHENSIVE ANSWER; good understanding of concepts supported by broad knowledge of subject. Notable for synthesis of information rather than originality. Sometimes with evidence of outside reading. Mostly accurate and logical with appropriate examples. Occasionally a lapse in detail.</td>
</tr>
<tr>
<td>60-64</td>
<td>LESS COMPREHENSIVE ANSWER; mostly confined to good recall of coursework. Some synthesis of information or ideas. Accurate and logical within a limited scope. Some lapses in detail tolerated.</td>
</tr>
<tr>
<td>55-59</td>
<td>SOUND BUT INCOMPLETE ANSWER; based on coursework alone but suffers from a significant omission, error or misunderstanding. Usually lacks synthesis of information or ideas. Mainly logical and accurate within its limited scope and with lapses in detail.</td>
</tr>
<tr>
<td>50-54</td>
<td>INCOMPLETE ANSWER; suffers from significant omissions, errors and misunderstandings, but still with understanding of main concepts and showing sound knowledge. Several lapses in detail.</td>
</tr>
<tr>
<td>45-49</td>
<td>WEAK ANSWER; limited understanding and knowledge of subject. Serious omissions, errors and misunderstandings, so that answer is no more than adequate.</td>
</tr>
<tr>
<td>40-44</td>
<td>VERY WEAK ANSWER; a poor answer, lacking substance but giving some relevant information. Information given may not be in context or well explained, but will contain passages and words which indicate a marginally adequate understanding.</td>
</tr>
<tr>
<td>35-39</td>
<td>MARGINAL FAIL; inadequate answer, with no substance or understanding, but with a vague knowledge relevant to the question.</td>
</tr>
<tr>
<td>30-34</td>
<td>CLEAR FAILURE; some attempt made to write something relevant to the question. Errors serious but not absurd. Could also be a sound answer to the misinterpretation of a question.</td>
</tr>
<tr>
<td>0-29</td>
<td>UTTER FAILURE; with little hint of knowledge. Errors serious and absurd. Could also be a trivial response to the misinterpretation of a question.</td>
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</table>
### Guidelines on Marking for Project/Dissertation Assessment

<table>
<thead>
<tr>
<th>Mark Range</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-100</td>
<td>Exceptional project report showing broad understanding of the project area and excellent knowledge of the relevant literature. Exemplary presentation and analysis of results, logical organisation and ability to critically evaluate and discuss results coupled with insight and originality.</td>
</tr>
<tr>
<td>70-84</td>
<td>A very good project report showing evidence of wide reading, with clear presentation and thorough analysis or results and an ability to critically evaluate and discuss research findings. Clear indication of some insight and originality. A very competent and well presented report overall but falling short of excellence in each and every aspect.</td>
</tr>
<tr>
<td>60-69</td>
<td>A good project report which shows a reasonably good understanding of the problem and some knowledge of the relevant literature. Mostly sound presentation and analysis of results but with occasional lapses. Some relevant interpretation and critical evaluation of results, though somewhat limited in scope. General standard of presentation and organisation adequate to good.</td>
</tr>
<tr>
<td>50-59</td>
<td>A moderately good project report which shows some understanding of the problem but limited knowledge and appreciation of the relevant literature. Presentation, analysis and interpretation of the results at a basic level and showing little or no originality or critical evaluation. Insufficient attention to organisation and presentation of the report.</td>
</tr>
<tr>
<td>40-49</td>
<td>A weak project report showing only limited understanding of the problem and superficial knowledge of the relevant literature. Results presented in a confused or inappropriate manner and incomplete or erroneous analysis. Discussion and interpretation of result severely limited, including some basic misapprehensions, and lacking any originality or critical evaluation. General standard of presentation poor.</td>
</tr>
<tr>
<td>20-39</td>
<td>An unsatisfactory project containing substantial errors and omissions. Very limited understanding, or in some cases misunderstanding of the problem and very restricted and superficial appreciation of the relevant literature. Very poor, confused and, in some cases, incomplete presentation of the results and limited analysis of the results including some serious errors. Severely limited discussion and interpretation of the results revealing little or no ability to relate experimental results to the existing literature. Very poor overall standard of presentation.</td>
</tr>
<tr>
<td>0-19</td>
<td>A very poor project report containing every conceivable error and fault. Showing virtually no understanding or appreciation of the problem and of the literature pertaining to it. Chaotic presentation of results, and in some cases incompletely presented and virtually non-existent or inappropriate or plainly wrong analysis. Discussion and interpretation seriously confused or wholly erroneous revealing basic misapprehensions.</td>
</tr>
</tbody>
</table>
Commencements

All registered postgraduate students expecting to be conferred with a higher degree in the current academic year, are annually invited by email, to make application to the Proctors’ Office. The invitation includes provision of all the information necessary to make application. Candidates are advised that closing dates are very strictly adhered to, and late applicants will not be admitted to the selected ceremony; however, they may be admitted to the next available commencement session. Commencement ceremony will take place in April 2018 for the MSc Bioengineering. Further information about the application process is available at www.tcd.ie/academicregistry/graduation/

Recommended Reading Material

Developments in bioengineering and medical technology have led to spectacular progress in clinical medicine. As a result, increased numbers of courses are available in the area of bioengineering and clinical technology. These often include modules dealing with basic biological and medical sciences, aimed at those taking up these studies, who have a background in engineering.

To date, relatively few participants from medicine have taken up courses in biomedical engineering, to the detriment of scientific exchange between engineers and medics. The European Society for Engineering and Medicine (ESEM) aims to bridge the gap between engineering and medicine and biology. It promotes cultural and scientific exchanges between the engineering and the medical/biological fields.

This primer consists of a series of First Step chapters in engineering and is principally presented for those with a medical or biology background who intend to start a MSc programme in biomedical engineering, and for medics or biologists who wish to better understand a particular technology. It will also serve as a reference for biomedical engineers.

Written by engineers and medics who are leaders in their field, it covers the basic engineering principles underpinning: biomechanics, bioelectronics, medical informatics, biomaterials, tissue engineering, bioimaging and rehabilitation engineering. It also includes clinically relevant examples. Available in Trinity College library, the Primer can also be purchased online at www.iospress.nl or To purchase click here

All other recommended reading material will be listed in the module descriptors
Careers in Bioengineering

Where are the jobs?

The medical device and diagnostic industry continues to be a vibrant growth sector and a cornerstone of the Irish economy. Circa 160 companies are involved in developing, manufacturing and marketing a diverse range of products and services from disposable plastic and wound care products to precision metal implants including pacemakers to microelectronic devices, orthopaedic implants, diagnostics, contact lenses and stents.

Some key facts/figures:

- There are currently over 160 medical technology companies in Ireland, exporting €6.8b worth of product annually and employing 24,000 people - the highest number of people working in the industry in any country in Europe, per head of population.

- Exports of medical devices and diagnostics products now represent 8% of Ireland’s total merchandise exports; and growth prospects for the industry globally remain good.

- Many of the world’s top medical technology companies have invested significantly in Ireland and a number of exciting, research-based, indigenous companies are emerging and competing internationally.

- Over 90 of the companies in the sector are indigenous (ref Enterprise Ireland)

- The Irish government has identified the medical technology sector as one of the key drivers of industrial growth for the future and provides a wide range of supports to encourage and foster this growth.

- The medical technology industry in Ireland is changing from being prominently manufacturing to being more complex and driven by R&D. It now involves intensive collaboration between a broad range of partners, including research institutions, clinicians, manufacturing companies and government agencies.

Ireland is well placed to capitalise on the growing global market for medical technology products and services. The challenge is to continue to develop and integrate the broad range of strategic competencies and support systems that will enable this island to compete as a mature, high value added economy, with innovation at its core.

Employment in the bioengineering industry in Ireland has grown to the level where the industry now directly employs over 12,000 people in Ireland, of which up to 20%
are graduate engineers and scientists (see www.ida-ireland.ie). The engineer working in this industry needs to be both technically competent and capable of integrating those aspects of biology and medicine related to the medical device. Many bioengineers are involved in applying science and engineering knowledge to the manufacture of medical products.

Finding Opportunities: recommended resources
www.tcd.ie/Careers
www.gradireland.com
www.prospects.ac.uk

Jobs websites such as
www.monster.ie/

Professional Bodies IMDA, IEI
www.ibec.ie/Sectors/IMDA
www.iei.ie

Graduate Employer Careers Fairs: RDS in June and October
http://www.gradireland.com/Jobs

CAS surveys on pharmaceutical, chemical & bio industry, medical devices
http://www.tcd.ie/Careers/resources/occupations/

FAME Directory
Scientific and Professional Journals

But........ Not all jobs are advertised so you need to use creative approaches
Using your networks for information/ advice and opportunities
Information and advisory interviews
Taking the stepping stone approach
Scanning media
Letting people know you are looking
Professional networks – organisations, journals
Work shadowing
Training in area related to your target
Speculative applications to employers

And make use of your network!
**Student Representation**

**Student – Staff Committee**

The student – staff committee was established as a formal channel of communication between students, researchers and staff and to enhance the experience for researchers and students in the Centre. It is an opportunity for students’ to express their views and opinions on matters such as facilities in TBSI, resources, teaching etc.

Members of the committee will be elected at the beginning of each academic year for a term of one full academic year and will consist of two staff members, two student members and a secretary. The secretary, will be responsible for convening meetings, drawing up agendas and acting as meeting secretary. You should liaise with the committee members or email ssc.tcbe@gmail.com if you would like an issue raised at the Committee.

**The Class Rep**

A class rep should be appointed by all the class members at the beginning of the academic year. The role of the class rep is to primarily act as a contact point for the class in urgent matters.

Academically, the main tasks of class rep are as follows:
- to create a contact list for class members in case there is a need to contact the whole class or individual class members
- to act as a first contact point for the class should course director need to urgently contact the whole class
- to relay any comments from class to course director and vice versa
- organise social events for the class, although this is normally shared by all in the class.

**Postgraduate Advisory Service**

The Postgraduate Advisory Service is a unique and confidential service available to all registered postgraduate students at Trinity College. It offers a comprehensive range of academic, pastoral, and professional supports dedicated to enhancing your student experience.

If you require specific advice, or would like to arrange a confidential meeting with the dedicated Student Support Officer, you can make an appointment by phoning 353 1 896 1417, or by e-mail at pgsupp@tcd.ie
College Information

Academic Registry

To contact Academic Registry all enquiries should be directed through one of the 4 channels:

- Log an enquiry via ASK AR on the my.tcd.ie portal
- Via email at academic.registry@tcd.ie
- Via phone at #4500 [students] or #4501 [staff]

From there they will be answered directly or escalated to the correct team.

Student Disability Services

Do you know what supports are available to you in College if you have a disability or a specific learning disability? If you have a disability or a specific learning disability (such as dyslexia) you may want to register with Student Disability Services. Further information on our services can be found at 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 6083111, or emailing them at: disab@tcd.ie.

Skills4Study Campus (S4SC)

Skills4studycampus (S4SC) is a fully interactive e-learning resource, which helps students to develop study skills and is suitable for students on all modules and in any year of study. Published by Palgrave Macmillan, core skills are developed through personalized interactive activities, tests and assessments. Utilised by HEIs in UK and in ROI includes UCC and UCD. Feedback from staff has been very encouraging. Fully embedded by School of Nursing (module handbook, skills module) and end of year analysis of academic performance indicates positive correlation with S4SC usage / module completion.

Study skills can be provided ‘anytime, anywhere’, fully accessible to students living outside of Dublin, or who commute long distances, have family or work commitments, extensive off campus placements, or heavy timetables. Login will be provided via the link on www.tcd.ie/local, additional links should be added on Student Homepage, Orientation website and the new student portal my.tcd.ie.

Student 2 Student

S2S offers trained Peer Supporters if you want to talk confidentially to another student or just to meet a friendly face for a coffee and a chat. Peer Supporters are there to assist with everything from giving you the space to talk about things to helping you access resources and services in the College. You can email us directly to request a meet-up with a Peer Supporter or can pop in to the Parlour to talk directly to one of our volunteers and arrange a meeting. S2S is supported by the Senior Tutor’s Office and the Student Counselling Service (http://student2student.tcd.ie)
Safety

We operate 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 facilities. Thus safety is also your personal responsibility and it is your duty to work in a safe manner. By adopting safe practices you ensure both your own safety and the safety of others.

Please read the following Safety Documents for working practices in the Departments of Mechanical and Manufacturing Engineering and in the Department of Electronic and Electrical Engineering:

http://www.mme.tcd.ie/ (bottom left tab)

Please ensure you comply with the instructions given in these important documents. Failure to behave in a safe manner may result in your being refused the use of departmental facilities.
Contact Details:

Course Administrators:
Ms. Melissa Caffrey
Ms. June O'Reilly

Trinity Centre for Bioengineering, Trinity Biomedical Sciences Institute,
Trinity College Dublin, 152-160 Pearse Street, Dublin 2, Ireland
Tel: +353-1-8964214
Email: tcbe@tcd.ie
Web: www.tcd.ie/bioengineering

Campus Maps:
# MSc Bioengineering 2016/2017

**EXIT FORM**

*The information on this form is so there is a record of what data you recorded and how it can be accessed. It is mandatory that you return this form when submitting your thesis.*

<table>
<thead>
<tr>
<th><strong>Student Name &amp; ID Number</strong></th>
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<tbody>
<tr>
<td><strong>Your contact details (mobile &amp; email address)</strong></td>
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<td><strong>Title of research project</strong></td>
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<td><strong>Supervisor</strong></td>
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<td><strong>Where is your data stored?</strong></td>
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<td><strong>What are the login details and passwords to retrieve the data?</strong></td>
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<td><strong>Have you returned all documentation (publications, textbooks, articles, etc.) to your Supervisor?</strong></td>
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<tr>
<td><strong>Have you returned all equipment to the Lab or Workshops(s)?</strong></td>
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<td><strong>Does this equipment function correctly or are their issues of maintenance to be addressed to have it function correctly for the next project?</strong></td>
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<td><strong>Any Other relevant information</strong></td>
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