What is Biomedical Engineering?

‘The application of engineering principles to understand, modify or control biological (human and animal) systems’

*J. Bronzino, Introduction to Biomedical Engineering*
Examples

- Cochlear implants
- Pacemakers
- Deep brain stimulation
- Artificial limbs
- Rehabilitation
- Tissue engineering
- Gait analysis
- Hip implants
- Biomedical signal processing
- MR imaging
- Physiological modelling
- Angioplasty
Sample research areas: Neural Control of Movement
Sample research areas: Deep Brain Stimulation
Orthopaedic mechanics

Relevant Modules:
- Biomaterials
- Biomechanics I & II
Medical Device Design (E O’Cearbhaill)

Relevant Modules:

- Medical device design

UCD
- Islet Cell Delivery for treatment of diabetes
- Reducing pain of bone marrow aspiration
- Venous Thrombus Extraction
- Improved Drug Delivery to the Synovium & Cartilage Repair
- High throughput analysis of chemotherapeutics in vivo

Harvard
- Cardiac Patch Delivery
- Growing Annuloplasty Ring
- Right Ventricular Remodeling
- Improved Drug Delivery to the Synovium & Cartilage Repair

MIT/BWH, Boston
- Improve method of fistula access for haemodialysis patients

PhD, NUIG
- Vascular Biomechanics
- Safer laparoscopic access
- 1st Prize MIT-Sloan Bioinnovations Conference 2012
- Microneedle Adhesive
- IChemE’s Innovative Product of the Year 2013

Harvard/UCD
- Venous Thrombus Extraction

UCD, St. Vincent’s Hospital
- Delivery devices to the Large Intestine

Perfleex, NUIG
- Infrapopliteal Segmented Stent Delivery

Veryan
- SFA 3D Vascular Stent
Heart Valves - Dr. Malachy O’Rourke

Left Heart Simulator

Relevant Modules:
- Fluid mechanics I, II, III
- Biomechanics II
Tissue Mechanics (M Gilchrist & A NíAnnaidh)

Injury & trauma modelling
Skin
Bone
Neural Tissue

Relevant Modules:
Biomechanics I & II
Biomedical Ceramics & Metals (K Stanton)

Orthopaedic and dentistry examples . . .

Protein adsorption on wear particles

Nano-toughening for dental cements

Apatite-mullite glass-ceramics

In-vivo: rat femur

Coating of Ti dental screws

Relevant Modules:
Biomaterials
Soft and Wearable Robotics

Relevant Modules:
- Biomechanics I
- Medical Device Design
Project: Exotendon
Glove
Tubing
Splint
Separator
Motors
Glove
Studying UCD Engineering

**YEAR 1**
- EXPLORE YOUR OPTIONS
  - Physics
  - Chemistry
  - Mathematics
  - Energy Engineering
  - Mechanics
  - Electrical/Electronic
  - Creativity in Design
  - Energy Challenges
  - Robotics Design Project
  - Biosystems Design Challenge

**YEARS 2 & 3**
- CHOOSE YOUR PATHWAY
  - Chemical & Bioprocess
  - Civil
  - Electrical/Electronic
  - Mechanical
  - Biomedical
  - Energy Systems

  **OPTIONAL STUDY ABROAD**

**YEARS 4 & 5**
- FOCUS ON YOUR AREA(S) OF SPECIALISATION
  - BE (4 years)
    - Bachelor of Engineering
      - Biomedical
      - Chemical & Bioprocess
      - Civil
      - Electrical
      - Electronic
      - Energy Systems
      - Mechanical
  - ME (5 years)
    - Master of Engineering
      - Biosystems
      - Biomedical
      - Civil
      - Civil & Environmental
      - Electrical Energy
      - Electronic & Computer Engineering with Business
      - Energy Systems
      - Materials Science & Engineering
      - Mechanical
      - Mechanical Structural
      - Optional industrial placement
  - BSc (3 years)
    - Conversion/Complementary Courses
      - Graduate Medicine
      - Postgraduate Diploma in Education
      - MSc Business
UCD Biomedical Engineering

School of Electrical and Electronic Engineering
School of Mechanical and Materials Engineering
with
School of Medicine
School of Chemical & Bioprocess Engineering
Biomedical Engineering Paths at UCD

At end of stage 3:
- graduate with BSc (Engineering Science)
- progress to stage 4 of BE in Biomedical Engineering

Or, if eligible (weighted GPA ≥ 2.8):
- enter ME programme in Biomedical Engineering
Biomedical Engineering Programmes at UCD

Stage 1: Introduction to Engineering

Stage 2: Foundations in Electronic and Mechanical Engineering and Introduction to Physiology and Anatomy

Stage 3: Specialised Electronic and Mechanical Engineering skills with introductory Biomedical Engineering modules

Stage 4: Interdisciplinary Biomedical Engineering modules and advanced Electronic and Mechanical modules; work placement

Stage 5: Advanced physiology modules; Biomedical Engineering research project
## What will I study?

### Stage 2 Biomedical Engineering

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivariable Calculus for Engineers</td>
<td>Statistics and Probability for Engineers</td>
</tr>
<tr>
<td>Electrical &amp; Electronic Circuits</td>
<td>Engineering Electromagnetics</td>
</tr>
<tr>
<td>Mechanics of Fluids I</td>
<td>Mechanics of Solids I</td>
</tr>
<tr>
<td>An Introduction to Physiology</td>
<td>Applied Dynamics I</td>
</tr>
<tr>
<td>Computer Engineering I</td>
<td>Options</td>
</tr>
<tr>
<td>Elective</td>
<td>Options</td>
</tr>
</tbody>
</table>

### Options
- Electronic Circuits
- Materials Sci & Eng I
Stage 2 Biomedical Engineering
In-Programme elective modules

**Semester 1**
Manufacturing Engineering I
Digital Electronics
Biotechnology for Engineers
Heat Transfer

**Semester 2**
Mechanical Engineering Design I
Electronic Circuits
Functional Anatomy & Kinesiology
Biotechnology Principles
## Stage 3 Biomedical Engineering
### Core and Option Modules

### Core Semester 1
- Multivariable Calculus for Engineers II
- Medical Sciences for Biomedical Engineers
- Biomedical Signals and Images
- Elective

### Core Semester 2
- Modelling and Simulation
- Bionstrumentation
- Elective

### Option Modules
- Signals and Systems
- Circuit Theory
- Engineering Thermodynamics II
- Materials Science & Engineering II
- Mechanical Engineering Design II
- Materials Sci & Eng I
- Electromagnetic Waves
- Signal Processing (DSP)
- Analogue Electronics
- Communication Theory
- Materials Science & Engineering III
- Mechanics of Solids II
- Applied Dynamics II

### RULE: Select 5 Option Modules:
The combination of Option modules MUST be either Group 1 or Group 2 listed below:

#### Group 1: Bioelectronic Stream:
- EEEN30110 Signals and Systems
- EEEN30030 Electromagnetic Waves
- EEEN30050 Signal Processing
- EEEN30020 Circuit Theory
- One other Option module of your choice.

#### OR

#### Group 2: Biomechanical Engineering:
- MEEN30100 Engineering Thermodynamics II
- MEEN30020 Mechanics of Solids II
- MEEN30010 Applied Dynamics II
- MEEN30090 Materials Science and Engineering II
- One other Option module of your choice.
Stage 4 BE Biomedical Engineering
or
ME Biomedical Engineering

Sample modules:

Biomechanics
Medical Device Design
Biomaterials
Neural Engineering
Rehabilitation Engineering
Cell Culture and Tissue Engineering
Biomedical Engineering Project
ME Biomedical Engineering
Semester 2, Year 1 : 30-Credit Work Placement

Organizations in which Biomedical Engineering students placed to date include:
Sector employs over 25,000 people.
18 of the world’s top 25 medical technology companies have a base in Ireland.
UCD Centre for Biomedical Engineering

Educate, Collaborate, Innovate...

Welcome to the UCD Centre for Biomedical Engineering, an interdisciplinary collaboration involving Engineering, Physical and Medical Sciences.

People
Applying interdisciplinary creativity to develop tomorrow's therapies

News & Events

For information on all upcoming events and seminars, please visit our Upcoming Events section.

Introduction to 3D Printing - Workshop
Published: 16 October 2015
A workshop offering a basic introduction to 3-D printing is taking place at The Innovation Academy - UCD on Monday, October 19th, from 5.30pm to 7.30 pm. Not only will you get fed, you will get the chance to make and keep your very own 3D printed object. This workshop is open to all from experts to those with little to no experience with 3D printing and Computer Aided Design (CAD) software. More info can be found here.

Engineers Ireland Debate: '3D printing, is it all just hype?'
Published: 27 September 2015

http://www.ucd.ie/biomedicalengineering/
UCD Student Summer Research Awards (SSRA) Elective Module

8-week supervised undergraduate student project within research laboratories or at our affiliated clinical sites

5 credit module can be selected as an elective for Stage 2

Grade neutral (PATH30090)

Entry on a competitive basis

More details: https://www.ucd.ie/medicine/ssra/

Ciara Giles Doran received the Silver Medal Award at the 2016 UCD Student Summer Research Awards (SSRA) Symposium
Stage 3 Biomedical Engineering
In-Programme Electives

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module Code</th>
<th>Module Title</th>
<th>Credits</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sem 1</td>
<td>COMP 20080</td>
<td>Computer Sci for Engineers II</td>
<td>5 Credits</td>
<td>level: 2 (Inter.)</td>
</tr>
<tr>
<td>Sem 1</td>
<td>EEEN 30020</td>
<td>Circuit Theory</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 1</td>
<td>EEEN 30110</td>
<td>Signals and Systems</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 1</td>
<td>MEEN 30030</td>
<td>Mechanical Engineering Design II</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 1</td>
<td>MEEN 30090</td>
<td>Materials Science &amp; Engineering II</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 1</td>
<td>MEEN 30100</td>
<td>Engineering Thermodynamics II</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 1</td>
<td>MEEN 30140</td>
<td>Professional Engineering (Finance)</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>EEEN 30030</td>
<td>Electromagnetic Waves</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>EEEN 30050</td>
<td>Signal Processing</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>EEEN 30120</td>
<td>Analogue Electronics</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>EEEN 30060</td>
<td>Communication Theory</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>MEEN 20030</td>
<td>Applied Dynamics I</td>
<td>5 Credits</td>
<td>level: 2 (Inter.)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>MEEN 20070</td>
<td>Materials Sci &amp; Eng I</td>
<td>5 Credits</td>
<td>level: 2 (Inter.)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>MEEN 40040</td>
<td>Materials Science &amp; Engineering III</td>
<td>5 Credits</td>
<td>level: 4 (Masters)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>MEEN 30020</td>
<td>Mechanics of Solids II</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>Sem 2</td>
<td>MEEN 30010</td>
<td>Applied Dynamics II</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
<tr>
<td>SEM_2</td>
<td>RDGY30440</td>
<td>Intro Image Analysis in Matlab</td>
<td>5 Credits</td>
<td>level: 3 (Degree)</td>
</tr>
</tbody>
</table>

- As Biomedical Engineering is inherently multidisciplinary, in general, we would recommend students choose from the selection of In-Programme Electives.
Stage 4 Biomedical Engineering Option modules

### Semester 1, Select 1 Option Module:

**Rule text:**
EEEN30160 Biomedical Signals and Systems must be taken as this Option, if not previously taken.

<table>
<thead>
<tr>
<th>Semester 1 Module Code</th>
<th>Module Title</th>
<th>Credits</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEM 1</td>
<td>COMP 20080</td>
<td>Computer Sci for Engineers II</td>
<td>5</td>
</tr>
<tr>
<td>SEM 1</td>
<td>EEEN 30160</td>
<td>Biomedical Signals and Images</td>
<td>5</td>
</tr>
<tr>
<td>SEM 1</td>
<td>EEEN 30110</td>
<td>Signals and Systems</td>
<td>5</td>
</tr>
<tr>
<td>SEM 1</td>
<td>MEEN 30030</td>
<td>Mechanical Engineering Design II</td>
<td>5</td>
</tr>
</tbody>
</table>

### Semester 2, Select 1 Option Module:

<table>
<thead>
<tr>
<th>Semester 2 Module Code</th>
<th>Module Title</th>
<th>Credits</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEM 2</td>
<td>EEEN30030</td>
<td>Electromagnetic Waves</td>
<td>5 credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>EEEN30050</td>
<td>Signal Processing</td>
<td>5 credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>EEEN30060</td>
<td>Communication Theory</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>EEEN30120</td>
<td>Analogue Electronics</td>
<td>5 credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>EEEN40130</td>
<td>Advanced Signal Processing</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>EEEN40060</td>
<td>Digital Communications</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN30010</td>
<td>Applied Dynamics II</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN 30020</td>
<td>Mechanics of Solids II</td>
<td>5 credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN40040</td>
<td>Materials Science &amp; Eng III</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN40070</td>
<td>Advanced Metals/Materials Processing</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN40180</td>
<td>Nanomaterials</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN40430</td>
<td>Professional Engineering (Mgt)</td>
<td>5 Credits</td>
</tr>
<tr>
<td>SEM 2</td>
<td>MEEN40670</td>
<td>Technical Communication</td>
<td>5 Credits</td>
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</tbody>
</table>
## ME Biomedical Engineering

### Stage 1 Semester 1

#### Major Code: T160 ME Biomedical Engineering FT

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
<th>Pre-Requisite: UCD Module Code No.</th>
<th>Core Credits</th>
<th>Option Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANAT40010</td>
<td>Medical Sciences for Biomedical Engineers (unless already taken)</td>
<td></td>
<td>5</td>
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<tr>
<td>MEEN40620</td>
<td>Biomechanics</td>
<td></td>
<td>5</td>
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<tr>
<td>MEEN40630</td>
<td>Biomaterials</td>
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</tr>
<tr>
<td>MEEN40600</td>
<td>Medical Device Design</td>
<td></td>
<td>5</td>
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</tr>
</tbody>
</table>

**YEAR 1, SEMESTER 1 = 30 CREDITS REQUIRED. CHOOSE TWO or THREE OPTION MODULES FROM THE LIST BELOW OR ELSEWHERE - AS AGREED BY THE PROGRAMME COORDINATOR & THE ENGINEERING PROGRAMME BOARD**

### Biomedical Engineering Modules

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEEN30160</td>
<td>Biomedical Signal and Image Analysis</td>
</tr>
</tbody>
</table>

### Engineering Modules

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEEN30110</td>
<td>Signals and Systems</td>
</tr>
<tr>
<td>EEEN40010</td>
<td>Control Theory</td>
</tr>
<tr>
<td>EEEN40050</td>
<td>Wireless Systems</td>
</tr>
<tr>
<td>EEEN40150</td>
<td>Radio Frequency Electronics</td>
</tr>
<tr>
<td>MEEN30030</td>
<td>Mechanical Engineering Design II</td>
</tr>
<tr>
<td>MEEN40060</td>
<td>Fracture Mechanics</td>
</tr>
<tr>
<td>MEEN40020</td>
<td>Mechanics of Fluids II</td>
</tr>
<tr>
<td>MEEN30100</td>
<td>Engineering Thermodynamics II</td>
</tr>
<tr>
<td>MEEN30140</td>
<td>Professional Engineering (Finance)</td>
</tr>
<tr>
<td>EEE40300</td>
<td>Engineering Entrepreneurship</td>
</tr>
</tbody>
</table>

### Modules from outside Engineering

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUR30080</td>
<td>Neuromuscular and membrane biology</td>
</tr>
<tr>
<td>PHYC40430</td>
<td>Nanomechanics - from single molecules to single cells</td>
</tr>
<tr>
<td>PHYS20040</td>
<td>An introduction to Physiology: Human cells and tissues (unless already taken)</td>
</tr>
<tr>
<td>PHYS30010</td>
<td>Physiology of the Cardiovascular System</td>
</tr>
<tr>
<td>STAT30240</td>
<td>Linear Models I (Statistics)</td>
</tr>
</tbody>
</table>

**SEMESTER CREDIT TOTALS**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>10</td>
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</table>
### ME Biomedical Engineering

**Stage 2 Semester 1**

<table>
<thead>
<tr>
<th>Module Code No.</th>
<th>Module Code</th>
<th>Core Credits</th>
<th>Option Credits</th>
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</thead>
<tbody>
<tr>
<td>EEN40220</td>
<td>Biomedical Thesis - Part 1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>MEEN40560</td>
<td>Research Skills and Techniques</td>
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</tbody>
</table>

YEAR 2, SEMESTER 1 = 30 CREDITS REQUIRED. CHOOSE FOUR OPTION MODULES FROM THE LIST BELOW OR ELSEWHERE - AS AGREED BY THE PROGRAMME COORDINATOR & THE ENGINEERING PROGRAMME BOARD

#### Biomedical Engineering Modules

<table>
<thead>
<tr>
<th>Module Code No.</th>
<th>Module Code</th>
<th>Core Credits</th>
<th>Option Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEN30160</td>
<td>Biomedical Signal and Image Analysis</td>
<td>5</td>
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<td>MEEN30100</td>
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<tr>
<td>MEEN30140</td>
<td>Professional Engineering (Finance)</td>
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<tr>
<td>EEN40300</td>
<td>Engineering Entrepreneurship</td>
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</table>

#### Modules from outside Engineering

<table>
<thead>
<tr>
<th>Module Code No.</th>
<th>Module Code</th>
<th>Core Credits</th>
<th>Option Credits</th>
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<tbody>
<tr>
<td>NEUR30080</td>
<td>Neuromuscular and membrane biology</td>
<td>5</td>
<td></td>
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<tr>
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<td>Nanomechanics - from single molecules to single cells</td>
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<tr>
<td>PHYS30010</td>
<td>Physiology of the Cardiovascular System</td>
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<tr>
<td>STAT30240</td>
<td>Linear Models I (Statistics)</td>
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</table>

**SEMESTER CREDIT TOTALS**

<table>
<thead>
<tr>
<th>Core Credits</th>
<th>Option Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
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</tbody>
</table>
# ME Biomedical Engineering

## Stage 2 Semester 2

<table>
<thead>
<tr>
<th>Modules</th>
<th>Semester 2, Year 2</th>
<th>Pre-Requisite: UCD Module Code No.</th>
<th>Core Credits</th>
<th>Option Credits</th>
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</thead>
<tbody>
<tr>
<td>EEEN40220</td>
<td>Biomedical Thesis (C) - Part 2</td>
<td></td>
<td>15</td>
<td></td>
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</table>

YEAR 2, SEMESTER 2 = 30 CREDITS REQUIRED. CHOOSE THREE OPTION MODULES FROM THE LIST BELOW AS INDICATED BELOW OR ELSEWHERE - AS AGREED BY THE PROGRAMME COORDINATOR & THE ENGINEERING PROGRAMME BOARD

At least 1 module from the following Biomedical Engineering Modules

- EEEN40350 Rehabilitation Engineering
- EEEN40070 Neural Engineering
- CHEN40470 Cell Culture and Tissue Engineering

### Engineering Modules

- MEEN30020 Mechanics of Solids II
- MEEN40040 Materials Science and Engineering III
- MEEN40180 Nanomaterials
- MEEN30010 Applied Dynamics II
- MEEN40070 Advanced Metals/Materials Processing
- MEEN40430 Professional Engineering (Management)
- MEEN40670 Technical Communication
- EEN30030 Electromagnetic Waves
- EEN30050 Signal Processing Theory and Applications
- EEN40130 Advanced Signal Processing
- EEN40060 Digital Communications
- EEN30060 Communication Theory
- EEN30120 Analogue Electronics

### Modules from outside Engineering

- RDGY30440 Image Analysis in Matlab
- PHYS20020 Neurophysiology: Physiology of Sensing and Responding to the Internal and External Environment
- PHYS10020 Physiology of the internal environment of the human body

**SEMESTER CREDIT TOTALS**

| 15 | 15 |