MEU55BM7 - 5BIO7 Advanced Medical Imaging [5 credits]

Coordinator: Ussher Assistant Professor Michael Monaghan, School of Engineering (monaghmi@tcd.ie).

Semester: 1

Module Organisation
This module runs during semester 1 and comprises of lectures and corresponding laboratory demonstrations and hands-on experience. (excluding study/revision/review week). Total contact time is 33 hours. One laboratory session is mandatory as part of this course.

Module Description
This objective of this module is to equip students with an understanding of engineering approaches to advanced biomedical imaging. A strong focus is placed on understanding the physical processes that occur between a particular imaging modality and the biological material being investigated. This module introduces the physical concepts of advanced medical imaging followed by lectures focused on specific imaging modalities. Modules will cover various imaging techniques to provide an advanced understanding of the physics of the signal and its interaction with biological tissue; image formation or reconstruction; modality-specific issues for image quality; clinical applications; and biological effects and safety. State-of-the-art emerging imaging modalities in research will be studied in detail and engineering approaches to advance such techniques to the clinic. Finally, the importance of advanced medical imaging in the quality control of medical devices and tissue engineered constructs will be covered along with their implantation and monitoring in vivo.

Learning Outcomes
At the end of this module it is anticipated that students will have obtained:

1. A theoretical understanding of the fundamental physical and mathematical principles underlying major modern medical imaging technologies in both clinical and research settings.

2. An appreciation of the pre-requisites of imaging modalities in clinical and research
settings and the safety

3. The ability to function on multidisciplinary teams

4. Understand how the structure and composition of tissues and cells influences and determines the application and/or combination of imaging modalities

5. Awareness of current “state of the art”, emerging technologies and advances in the field.

6. An understanding of the application of medical imaging in the quality control of implants and tissue engineered constructs

7. Ability to identify, formulate and adapt advanced medical imaging solutions to unmet biological needs

8. Ability to perform a quantitative analysis of in vitro multiphoton imaging data, and interpretation thereof.

9. The ability to extract, through comprehensive analysis of the literature, information pertinent to the design of an imaging solution to an unfamiliar problem

Module Content

- Overview of medical imaging
- Basic principles of physics applied to medical imaging
- Instrumentation in medical imaging
- Principles of X-Ray imaging modalities and Applied X-Ray Imaging Modalities
- Computed tomography
- Applications and principles of ultrasound
- Magnetic Resonance Imaging (MRI) including functional MRI and diffusion tensor imaging MR
- Principles of microscopy, Histology and immunohistology
- Biomedical optics
- Nuclear Medicine in Imaging
- Non-invasive microscopy
- Fluorescent Lifetime Imaging Microscopy (FLIM)
- Fluorescence Recovery After Photobleaching (FRAP)
- Forster Resonance Energy Transfer (FRET)
- Principles and application of magnetic resonance imaging
- Modalities of electron microscopy
• Advanced biomedical imaging in the evaluation and characterization of biomedical and tissue engineered implants

**Module Notes**
Provided via Blackboard. At the end of each lecture students will receive more specific learning outcomes for the lecture and be expected to undertake self-directed further reading and research.

**Teaching Strategies**
The module is taught using a combination of lectures, laboratories, and study assignments. At the end of each lecture students will receive more specific learning outcomes for the lecture and be expected to undertake self-directed further reading and research.

**Assessment Modes**
Assessment is through an end of semester examination and coursework throughout the semester. All coursework must be submitted via blackboard.

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<tr>
<th>Type of assessment</th>
<th>%</th>
<th>Period</th>
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<tbody>
<tr>
<td>Written Examination</td>
<td>60%</td>
<td>Sem 1 Assessment Week</td>
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<tr>
<td>Group Assignment (Emerging Technology Report)</td>
<td>20%</td>
<td>Week 4 Teaching Week</td>
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<tr>
<td>Online Test</td>
<td>10%</td>
<td>Week 9 Teaching Week</td>
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<tr>
<td>Laboratory Practical and Report</td>
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<td>Week 11 Teaching Week</td>
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**Recommended Texts**
• Medical Imaging: Principles and Practices
  Analoui (Ed)
• Fluorescence Microscopy: from Principles to Biological Applications
  Kubitscheck (Ed)

A wide range of introductory and advanced reading materials will also be provided via blackboard.

Updated 07.08.18