ME5M19 BIOMECHANICS – [5 Credits]

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Semester: 1

Module Organisation
The module runs for 12 weeks of the academic year and comprises three lectures per week and one tutorial per fortnight. Total contact time is 38 hours. In addition, there is one laboratory practical and one self-learning assignment.

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<th>Start Week</th>
<th>End Week</th>
<th>Lectures/week</th>
<th>Lectures Total</th>
<th>Tutorials/week</th>
<th>Tutorials Total</th>
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<td>1</td>
<td>12</td>
<td>3</td>
<td>33</td>
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Module Description
This module explores the biomechanics of human cells, tissues and joints, how they change with age and disease and how implants can be used to either replace or repair tissues and joints following injury or degeneration. A strong focus is placed on understanding the biomechanics of the musculoskeletal and cardiovascular system. The module begins with a description of how the mechanical properties of different tissues are derived from their structure and composition which leads to an introduction to the forces and moments that act on the musculoskeletal system. Concepts of tissue remodelling and repair are explored. Next, the biomechanics of the main joints of the body are studied. Finally, the student is introduced to the use of implants and medical devices for reconstruction and repair of human tissues and systems. Throughout the module students will use engineering principles to analyse tissues, organs and implants, from the use of solid mechanics theory to analyse bone-implant interfaces, to the use of fluid mechanics theory to model blood flow through the cardiovascular system. The module also aims to promote independent and lifelong learning through the use of individualised assignments.
Learning Outcomes

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

1. Apply the principles of statics to analyse the musculoskeletal system (e.g. determination of muscle forces and joint loads).
2. Understand how the structure and composition of hard tissues (e.g. bone, teeth) determine their mechanical properties.
3. Explain how tissues such as bone and cartilage grow, develop, adapt and repair.
4. Understand how the structure and composition of soft tissues (e.g. cartilage, ligament, tendon, muscle, vascular tissue) determine their mechanical properties.
5. Explain how synovial joints function and how they are replaced with artificial prostheses.
6. Analyse the performance of joint replacement prostheses.
7. Have completed an independent learning assignment unique to them. This requires researching a specific bioengineering problem and producing an electronic report.
8. Understand the anatomy of joints, soft tissues and the cardiovascular system
9. Model the cardiovascular system based on mathematical models
10. Understand basic cellular biology, mechanobiology and mechanotransduction.

Module Content

- Bone Development, Growth and Biomechanics
- Articular Cartilage Biomechanics
- Intervertebral Disc Biomechanics
- Ligament and Tendon Biomechanics
- Muscle Biomechanics
- Vascular Tissue Mechanics
- Biofluid Mechanics
- Friction and lubrication in synovial joints
- Gait Analysis
- Loads and Motion in the Musculoskeletal System
- Biomechanics of the Hip
- Biomechanics of the Knee
- Biomechanics of the Shoulder and Elbow
- Biomechanics of the Spine
• Total Hip Replacements
• Total Knee Replacements
• Fracture Fixation Devices
• Repair and restoration of the cardiovascular system
• Cell Biomechanics
• Mechanobiology and Mechanotransduction

**Module Notes**
Provided in Lectures and uploaded to Blackboard

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

**Assessment Modes**
2hr formal written exam (75%) and self-learning assignment (case-study report) & continuous assessment (25%).

**Recommended Text(s)**
• Orthopaedic Biomechanics, Bartel, Davy & Keaveny (Pearson Prentice Hall).
• Basic Orthopaedic Biomechanics, Mow & Huiskes (Lippencot-Raven)
• Biomechanics: Mechanical Properties of Living Tissues, Y.C. Fung (Springer)
• Introduction to Cell Mechanics and Mechanobiology, Jacobs, Huang, Kwon (Garland Science)

**Laboratory**
Rat musculoskeletal dissection