The biomedical field closes the gap between engineering and medicine

As medical science has advanced, physicians and patients have relied on increasingly sophisticated medical devices for diagnosis, treatment, and long-term health care. Biomedical engineers are key players in the development, design, and continuing refinement of devices such as joint replacement prostheses, micro sensors, imaging and pattern recognition, as well as advanced instruments for use in such domains as minimally invasive surgery and the diagnosis of movement disorders.

The TU Delft Master’s Programme in BioMedical Engineering is a multidisciplinary programme which aims to provide you with both an understanding of biology and medical theory and with highly specialised technical training in such fields as electrical, physics, material and mechanical engineering. You will take courses offered by three TU Delft faculties – Applied Sciences; Electrical Engineering, Mathematics and Computer Sciences; and Mechanical, Marine and Materials Engineering. The programme also benefits from the clinical input provided by three teaching hospitals: Leiden University Medical Center, Erasmus Medical Center in Rotterdam, and Academic Medical Center in Amsterdam. You will learn how to develop conceptual models from a technical perspective and you will work in close collaboration with physicians, researchers and other healthcare professionals, including on-site at the collaborating academic institutions.

### Program Details

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<tr>
<th>Diploma</th>
<th>Master of Science BioMedical Engineering</th>
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<tr>
<td>Credits</td>
<td>120 ECTS, 24 months</td>
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<tr>
<td>Starts in</td>
<td>September</td>
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<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>% international students</td>
<td>35%</td>
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**Programme**

The MSc programme in BioMedical Engineering is a two-year programme. It is advisable to begin your studies in September, but the programme is flexible enough to accommodate mid-year entry.

**Specialisations**

The six available specialisations are divided among three orientations.

**Specialisations with a mechanical engineering orientation:**

- **Sports Engineering**
  
  Humans continuously explore the limits of human performance, and technical innovations have played a key role in this process. For the best results, top athletes need the best materials and techniques. But how do you gain speed? How to develop the best equipment? How can you beat records? Such questions keep modern top athletes constantly busy. Technology and innovation are ubiquitous in top sports, and engineers can help athletes breaking records. This specialization focuses on studying the human body at its extreme, optimizing its interface with sports equipment, and implementing the research results into challenging designs, for the benefit of top athletes. Problems range from predicting and improving the bouncing behaviour of a ball to real-time measuring of forces generated during skating. You will develop a deep understanding of the physiology and biomechanics of athletes and their interaction with equipment and physical elements. You will learn how to use biomechanics for improving training, enhancing performance, and for avoiding injury. You will learn techniques for lab and field measurements and study the thin line between top performance, injury risk, and rehabilitation.

- **Biomaterials and Tissue**

  Biomechanics studies the biomechanical properties of skeletal tissues and biocompatible materials. Bone is able to adapt its mass and architecture to changes in external loads, for instance as a result of implantation of a prosthesis. In developing prostheses, scientists try to predict these changes and take advantage of the adaptive capability of the skeleton using mechanical tests and advanced computer models. Biomaterials used for prostheses do not yet have the characteristics of the living tissues such as self-repairing and the ability to change their structure and properties in response to environmental factors. Therefore, multifunctional biomaterials with hierarchical structures are highly desirable. Starting with biomaterials evolution and biofunctionalities needed for specific clinical applications, the focus within biomaterials is placed on technological challenges to achieve the required combination of properties and multi-scale biocompatibility.

- **Medical Instruments and Medical Safety**

  Medical Instruments and Medical Safety focuses on the development of instruments and methods for minimally invasive interventions, such as keyhole surgery, colonoscopy, and catheter interventions. Medical instrument research also focuses on the quality of medical instruments and their optimal use, maintenance and sterilisation. New training equipment such as virtual reality trainers and simulators with force/haptic feedback is being developed to train surgeons outside the operating theatre.

**Specialisation with an applied physics orientation**

Medical Physics focuses on Medical Imaging and on Radiotherapy. In Medical Imaging methods such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Nuclear Medicine Imaging are providing high-quality 3D and 4D information of the human anatomy. In radiotherapy, clinical, technical and bio-physical concepts resulting in optimised treatment planning are addressed.

**Specialisation with an electrical engineering orientation**

Biomedical Electronics focuses on the development of electronic design methodologies and proof-of-concept vehicles for low-power adaptive integrated circuits for biomedical wearable, implantable and injectable devices. These are battery powered or battery-less biomedical electronic devices, such as hearing aids, cochlear implants, neuro-stimulators, pacemakers, and wireless links for biomedical sensors used in health monitoring and telemedicine applications. Major design constraints that are taken into account are reliability, low voltage, and ultra-low power operation.

<table>
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<tr>
<th>First year (60 EC)</th>
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<tr>
<td><strong>1st semester</strong></td>
<td><strong>2nd semester</strong></td>
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<tr>
<td>Biomedical courses (30 ECTS)</td>
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</tr>
<tr>
<td>E.g. general medical technology, physiology, surgical instruments, the human movement system, neuroscience, bone mechanics, orthopedic implants etc. These courses are given by engineers and clinicians and cover clinical problems and progress in clinically-related research. Students also have access to medical courses in Leiden and Rotterdam. Fundamental technical courses (30 ECTS)</td>
<td></td>
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<tr>
<td>Identification and control, human machine interaction, multi-body and finite element simulation, mechanism design, biomaterials, imaging and image processing, radiation, sensing and electronics.</td>
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<table>
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<th>Second year (60 EC)</th>
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<tbody>
<tr>
<td><strong>1st semester</strong></td>
<td><strong>2nd semester</strong></td>
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<tr>
<td>Internship in a biomedical research group or company.</td>
<td>Literature study for graduation project.</td>
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<tr>
<td></td>
<td>Graduation project</td>
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<td></td>
<td>A biomedical research and/or development project in Delft.</td>
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Graduation projects
- Design of a steerable laparoscopic instrument for cleaning and sterilization
- Design of an electric series-elastic actuated joint for robotic gait rehabilitation training
- Bone cement injection for the infixation of hip prostheses - A viscosity and flow model
- Nitinol drug eluting surfaces for coronary stents
- Multi-modal cardiac data visualization for ventricular tachycardia ablation
- A stretchable multi-electrode array (MEA) for cardio-toxic drug screening
- Cosmetic glove stiffness compensation for body-powered hand prostheses - Design of a novel negative stiffness element

Career prospects
Career opportunities for biomedical engineers are excellent. To develop the innovative technologies that drive the biomedical industry, it requires personnel with the unique combination of skills, knowledge and experience in biology, medicine and engineering that graduates of the MSc programme in BioMedical Engineering can offer. Graduates find employment in hospitals; private firms producing equipment, medical devices and instruments; and in research institutions.

I surely find the human body the greatest machine of them all
Curiosity is and has always been my motive to try and understand man-made structures, mechanisms, or simple products. During my BSc in Mechanical Engineering I started to be able to understand and explain them. However, combined with my secret interest in biology, I surely find the human body the greatest machine of them all. This drew my attention towards the Master programme BioMedical Engineering, where medicine and engineering are combined in order to mimic, enhance, aid, measure, and understand the complex mechanisms of the human body. Moreover, it is where you have to crawl inside the head of doctors, nurses, patients, and even insurance companies in order to solve actual clinical problems. This wide field attracts many different people with different backgrounds, allowing me to work with and learn from many disciplines. With the field of biomedical engineering growing rapidly, I hope to play a meaningful role in it someday.

Ronald Bos (The Netherlands)
Admission requirements and application procedure

Dutch BSc degree
In most cases, if you hold a BSc degree and the Master’s programme is closely related to your Bachelor’s programme, you will be admitted directly into the programme. However, if the Master’s programme does not follow directly from your undergraduate programme, you will be required to take additional courses in what is called a bridging programme. This may be a standard programme, or it may be tailored to your specific situation.

To see which Master’s programmes are open to you on completion of your Bachelor’s degree Dutch university, go to www.doorstroommatrix.nl.

Students who’s bachelor is not mentioned in the ‘doorstroommatrix’ will be evaluated on an individual basis.

Application goes through Studielink: tudelft.studielink.nl

Dutch HBO degree
An HBO Bachelor’s degree does not qualify you for direct admission to a TU Delft Master’s degree programme. To start a Master’s degree programme, you will first need to complete a supplementary programme in order to bring your knowledge to the required level. You can do this during your HBO programme by completing a bridging minor or by means of a bridging programme after securing your HBO diploma.

Entrance requirements for mathematics and English (some exceptions) apply for both the bridging minor and the bridging programme. See www.hbooorstroom.tudelft.nl for detailed information.

Application goes through Studielink: tudelft.studielink.nl

International applicants
To be considered for admission to a MSc Programme you’ll need to meet TU Delft’s general admission requirements.

1. A BSc degree (or a proof that you have nearly completed a BSc programme) in a field closely related to the MSc programme.
2. A BSc Cumulative Grade Point Average (CGPA) of at least 75% of the scale maximum.
3. Proof of English language proficiency:
   - TOEFL (Test of English as a Foreign Language) with a minimum score of 21 for each section and an overall band score of at least 90 (internet-based test). Please note that we only accept the TOEFL internet-based test.
   - or IELTS (academic version) with a minimum score 6.0 for each section and an overall Band score of at least 6.5.
   - or proof that you have passed the University of Cambridge ‘Certificate in Advanced English’ with a minimum grade B or the University of Cambridge ‘Certificate of Proficiency in English’.

For more information about the application procedure and studying at TU Delft in general, go to: www.admissions.tudelft.nl.

For international students, the application period starts in October and closes on 1 April. To start an MSc application, fill in the online application and pay the refundable application fee of €100. Then send hard copies of the application documents to TU Delft’s International Office. Please note that you should apply early when you want to be considered for a scholarship as well!

Introduction Event
At the start of the academic year an Introduction Event is organized. This five-day event presents you with comprehensive information on the master BioMedical Engineering in general and on each of the specialisations in particular. At the end of the event you will be able to make an educated choice for a specialisation and to compose your individual Study Programme accordingly. As students of the BioMedical Engineering master programme come from many different previous educations and have many different nationalities, the Introduction Event also aims at community building.

Please visit the webpage for all details, complete requirements, deadlines and contact information:
www.bme.msc.tudelft.nl

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