Where humans and machines intersect, Biomechanical Design provides solutions that allow the biological and mechanical systems to function effectively together.

<table>
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<tr>
<th>Diploma</th>
<th>Master of Science Mechanical Engineering Track: Biomechanical Design</th>
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<tbody>
<tr>
<td>Credits</td>
<td>120 ECTS, 24 months</td>
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<tr>
<td>Starts in</td>
<td>September</td>
</tr>
<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>% international students</td>
<td>12%</td>
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Designing systems where humans and machines meet
One facet of Biomechanical Design is to investigate human movement, human perception, and human control characteristics. Another facet is to design user-friendly, intuitive technologies based on an understanding of human characteristics. The knowledge of human behaviour acquired can be used to diagnose diseases, or serve as input for the development of systems that interact with or mimic biological systems. In contrast to the more clinically oriented MSc Programme in Biomedical Engineering, Biomechanical Design focuses on the engineering challenges of developing bio-inspired robots, fine-mechanical systems, haptic interfaces, and tools for top athletes.

Programme
The first year of the track consists of a combination of compulsory courses, specialisation courses, and electives. During the second year, students are required to complete a Master’s thesis project, preceded by an internship and a literature study.

Specialisations
- BioRobotics (BR)
  Until recently, robots only played a significant role in the manufacturing industry. Nowadays robots begin to perform a wide variety of tasks in society. The requirements for these service robots are vastly different from those for manufacturing robots.
  Instead of speed, accuracy, and power, service robots require safety, adaptability, and gentleness. This is the field of biorobotics. The word ‘bio’ has two meanings. First, biology is the environment for the robots. They have to cope with humans and nature. Second, biology serves as a source of inspiration, as the human body excels when it comes to adaptability and gentleness.
  This specialisation focuses on the analysis and development of robots that physically interact with humans. Topics include humanoid robots, robot vision, and robot touch. You will learn how to design, simulate, and control robots, how to model the human body and brain as a control system, and how to create mechanisms that interact successfully with humans. The knowledge obtained during this study is highly regarded within the traditional mechanical engineering industries; our alumni find jobs in all major industrial sectors.
BioInspired Technology (BITE)
Probably the greatest diversity of mechanical designs is found in nature. For each challenge posed by the often hostile environment, a wealth of solutions to cope with the threats has evolved. Inspiration from nature drives the search for innovative solutions in such fields as medicine, rehabilitation, microsystems, and mechatronics. In the BioInspired Technology specialisation, an extensive excursion into biology provides the inspiration to search for innovative solutions to what are often uncommon challenges. You will gain the skills required to develop innovative fine-mechanical systems that are inspired by mechanical approaches in biology. You will learn, for example, how to use springs and elastic materials to make lightweight and inherently safe, elegant constructions, inspired by muscular skeleton systems. You will gain knowledge about innovative design approaches in nature and skills to translate the biological working principles into technological solutions. You will also be trained to develop mechanical systems that naturally complement the behaviour of biological systems, in particular humans, so that the mechanisms are easy to use by a human controller.

Haptics Interfaces (HI)
Traditionally, most human-machine interfacing has focused on providing visual and auditory information, neglecting an important communication channel: haptics. Haptic sensation incorporates the sense of touch and proprioception, which allows quick and intuitive physical interaction with our environment. In the last decade, the use of haptics has seen a great surge of interest in a number of fields such as in: (a) restoring physical interaction (e.g., in teleoperation systems for interaction with remote environments as encountered in space and deep sea applications); (b) simulating physical interaction (e.g., for medical and automotive simulators); and (c) enhancing physical interaction (e.g., providing additional guidance for rehabilitation or driver support systems). This specialisation focuses on developing human-centered haptic interfaces in all of the above fields. Such human-centered design requires a good understanding of the mechatronics of haptic interfaces as well as of human control strategies, perception, and motion control. You will focus on the development of haptic devices (hardware and controller software), on the design requirements of devices for specific tasks, and on studies into the way humans interact with such devices.

Curriculum Biomechanical Design

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<thead>
<tr>
<th>First year (60 EC)</th>
<th>Specialisation Obligatory (15-16 EC)</th>
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<tbody>
<tr>
<td>Control Systems Design</td>
<td>Physics and Measurement</td>
</tr>
<tr>
<td>Nonlinear Mechanics</td>
<td>Advanced Heat Transfer</td>
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<tr>
<td>Multibody Dynamics B</td>
<td>Man-Machine Systems</td>
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<tr>
<td>The Human Controller</td>
<td>Experimental Design, Statistics and the Human</td>
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<table>
<thead>
<tr>
<th>BR</th>
<th>BITE</th>
<th>HI</th>
<th>SE</th>
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<tbody>
<tr>
<td>Humanoid Robots</td>
<td>Bio Inspired Design</td>
<td>Neuromechanics &amp; Motor Control</td>
<td>Neuromechanics &amp; Motor Control</td>
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<tr>
<td>Control Systems Lab</td>
<td>Precision Mechanism Design</td>
<td>System Identification and Parameter Estimation</td>
<td>Tissue Biomechanics of Bone, Cartilage and Tendon</td>
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<tr>
<td>Control Methods for Robotics</td>
<td>Compliant Mechanisms</td>
<td></td>
<td>Bio Mechatronics</td>
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<table>
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<tr>
<th>Second year (60 EC)</th>
<th>Elective Courses (16 EC or more)</th>
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<tr>
<td>First Semester</td>
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<tr>
<td>Second Semester</td>
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<tr>
<td>Internship/Research Project (15 EC)</td>
<td>Literature Study (10 EC)</td>
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<tr>
<td>Graduation Project (35 EC)</td>
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1 EC = 28 hrs study, according to the European Credit Transfer System (ECTS), total amount of credits MSc programme = 120 EC

For more information on all courses please visit: www.studyguide.tudelft.nl
Sports engineering (SE)
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.

Career prospects
Graduates of this track can be found in a wide variety of jobs, including management or technical project leadership positions in multinationals, heads of technical development in academic medical centres, and scientists in university or technology transfer institutions. A growing number of graduates are setting up their own businesses.

Sarvesh Kolekar (India)

I have always been fascinated by automobiles and was fortunate to be a part of the Formula Student team during my bachelors degree in India. I was surprised by the amount of work load the driver had. This got me interested into driver assistance systems and in particular modelling the driver himself. I wanted to pursue research in this field and started searching for courses which offer a blend of biomechanical design and automotive engineering. With facilities like fixed and moving based driving simulators, haptics and sensorimotor control labs, the BMD course at TU Delft was a perfect and obvious choice.

I started my Master BioMechanical Design in September 2013, still skeptic about how I would adjust into this new social and academic environment. All those were put to rest after the introduction programme and a few lectures. The programme has been systematically planned and offers a lot of freedom, so does the city of Delft. It’s a very nice and friendly place, with beautiful architecture and lots of canals. It is very fascinating to meet and get to know people from all parts on the world.

I am interested in making a mathematical model of the human driver and use it in virtual simulations for designing vehicles. It is a very satisfying experience when you come up with an idea and it is fine tuned by the expertise of your supervisors. During my first year, I attended various courses from biomechanics and automobiles, which have given me a strong foundation to build my research upon. These strong credentials also helped me fetch an internship abroad, which is also an essential part of the Master’s programme. My internship was in the field of sensorimotor learning and has prepared me well for my Master’s thesis project.

I am quite happy to have made the decision of coming to Delft and so far, its been a great experience with great friends, great atmosphere, friendly people and very encouraging faculty.
**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.

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 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.hbodoorstroom.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 A or the University of Cambridge ‘Certificate of Proficiency in English’.

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!

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

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

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