Directory of Modules for Visiting Students

*Diplom* Programme in Mechatronics

Faculty of Electrical and Computer Engineering

Information Package for International Visiting and Exchange Students

September 2016
The Faculty of Electrical and Computer Engineering (Fakultät Elektrotechnik und Informationstechnik), the Faculty of Mechanical Science and Engineering and the “Friedrich List” Faculty of Transportation and Traffic Sciences at the Technische Universität Dresden offer the Diplom degree programme in Mechatronics. This programme is an integrated five-year (single-tier) programme and thus includes Bachelor as well as Master’s level.

**Structure of the Diplom degree programme in Mechatronics**

The degree programme in Mechatronics is divided into basic studies and main studies. The basic studies include semester 1 until semester 4 (= the first two years of the programme); the main studies start in the 5th semester and are concluded in the 10th semester (= 3rd until 5th year of the programme).

The following catalogue is organized according to these two stages. In the first part, you will find the modules listed that are part of our basic studies (please see here for the list). From page 3 on, you will find information on the modules that are part of our main studies (please see here for a list).

**SWS – Semesterwochenstunden**

In the module descriptions (line „modes of teaching and learning“) you will find the abbreviation SWS. This abbreviation stands for the German term Semesterwochenstunde and gives the amount of lessons per week.

1 SWS = 1 lesson of 45 minutes per week during the semester

At the TU Dresden, lessons usually last for 90 minutes (= 1 Doppelstunde (DS)).

1 DS = 2 SWS

What does this mean for your timetable?

For example, for the module MT-12 02 22 Power Electronics, the amount of SWS is given as follows: 2/1/0. This means that the module includes the following modes of teaching: 2 SWS lecture (1st number), 1 SWS tutorial (2nd number), 0 SWS lab course (3rd number); which means:

- 90 minutes lecture every week during the semester
- 90 minutes tutorial every 2nd week during the semester
  
  (Also possible, but less common: 45 minutes tutorial every week during the semester)
- No lab course

**Academic calendar of the TU Dresden**

The academic year at the TU Dresden is divided into the winter semester (October–March) and summer semester (April–September). The semester dates for the following academic years can be found here.

Our module descriptions inform you in which semester, i.e. winter or summer semester, the respective module is offered. When setting up your learning agreement, it is important to consider at first which semester you are coming to the TU Dresden (either the winter or summer semester) and then choose appropriate modules.

Note: The English version of our module descriptions is not legally binding.
## Basic studies modules (Bachelor level)

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Winter semester</th>
<th>Summer semester</th>
<th>Level</th>
<th>Language of instruction</th>
<th>ECTS-credits</th>
</tr>
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<tbody>
<tr>
<td>MT-12 08 01</td>
<td>Fundamentals of Electrical Engineering (Grundlagen der Elektrotechnik)</td>
<td>2/2/0 PL</td>
<td>2/2/0 PL</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; year</td>
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<td>MT-12 08 23</td>
<td>Electric and Magnetic Fields (Elektrische und magnetische Felder)</td>
<td>2/2/0 PL</td>
<td>2/2/0 PL</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; year</td>
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<td>Electronic Systems Design (Geräteentwicklung)</td>
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<td>1&lt;sup&gt;st&lt;/sup&gt; year</td>
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<tr>
<td>MT-13 00 01</td>
<td>Materials and Engineering Mechanics (Werkstoffe und Technische Mechanik)</td>
<td>2/1/0 PL</td>
<td>2/2/0 PL</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; year</td>
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<tr>
<td></td>
<td></td>
<td>3/3/0 PL</td>
<td>2/2/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
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<tr>
<td>MT-12 08 24</td>
<td>Dynamic Networks (Dynamische Netzwerke)</td>
<td>2/2/1 PL</td>
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<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
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<td></td>
<td></td>
<td>3/3/0 PL</td>
<td>2/2/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
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<tr>
<td>MT-12 09 01</td>
<td>Systems Theory (Systemtheorie)</td>
<td>2/1/0 PL</td>
<td>2/2/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
<td>7</td>
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<td>MT-12 01 02</td>
<td>Automation Engineering and Measurement (Automatisierungs- und Messtechnik)</td>
<td>3/2/0 PL</td>
<td>3/2/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
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<td>5</td>
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<td>MT-12 04 01</td>
<td>Electrical Power Engineering (Elektroenergieotechnik)</td>
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<td>0/0/1 PL</td>
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<td>3/3/0 PL</td>
<td>2/2/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
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<td>MT-12 02 21</td>
<td>Circuit Design (Schaltungstechnik)</td>
<td>2/1/0 PL</td>
<td>2/0/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
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<td>MT-13 01 03</td>
<td>Fundamentals of Kinematics and Kinetics (Grundlagen der Kinematik und Kinetik)</td>
<td>2/2/0 PL</td>
<td>2/2/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
<td>5</td>
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<tr>
<td>MT-13 12 01</td>
<td>Construction and Manufacturing Engineering (Konstruktion und Fertigungstechnik)</td>
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<td>0/1/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
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<td>2/2/0 PL</td>
<td>3/3/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
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<tr>
<td>MT-13 01 04</td>
<td>Kinematics and Materials of Mechanics, Advanced (Vertiefung Kinematik und Festigkeitslehre)</td>
<td>3/3/0 PL</td>
<td>3/3/0 PL</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; year</td>
<td>German</td>
<td>7</td>
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</table>

The numbers in the columns “winter semester” and “summer semester” indicate in which semester the respective module is delivered. Further, these numbers refer to the SWS for the respective module. The 1<sup>st</sup> number refers to the SWS for the lecture, the 2<sup>nd</sup> to the SWS for the tutorial and the 3<sup>rd</sup> to the SWS for the lab course (Please see here for more details).

PL = Prüfungsleistung/assessment
**Main studies modules (5th until 10th semester)**

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Winter semester</th>
<th>Summer semester</th>
<th>Level</th>
<th>Language of instruction</th>
<th>ECTS- credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-13 01 01</td>
<td>Field Theory (Feldtheorie)</td>
<td>2/2/0 PL</td>
<td>PL</td>
<td>3rd year</td>
<td>German</td>
<td>5</td>
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<tr>
<td>MT-13 01 02</td>
<td>Numerical Methods/System Dynamics (Numerische Methoden/Systemdynamik)</td>
<td>4/2/0 PL</td>
<td>0/0/1 PL</td>
<td>3rd year</td>
<td>German</td>
<td>9 (8+1)</td>
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<tr>
<td>MT-12 02 22</td>
<td>Power Electronics (Leistungselektronik)</td>
<td>2/1/0 PL</td>
<td>PL</td>
<td>3rd year</td>
<td>German</td>
<td>4</td>
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<tr>
<td>MT-12 13 01</td>
<td>Control of Continuous-Time Processes and Discrete Event Systems (Regelungstechnik und Ereignisdiskrete Systeme)</td>
<td>5/2/0 PL</td>
<td>0/0/1 PL</td>
<td>3rd year</td>
<td>German</td>
<td>9 (8+1)</td>
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<tr>
<td>MT-12 01 23</td>
<td>Micro Computer Engineering/Embedded Controller (Mikrorechentechnik/Embedded Controller)</td>
<td>2/0/1 PL</td>
<td>3/0/3 PL</td>
<td>3rd year</td>
<td>German</td>
<td>10 (3+7)</td>
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<tr>
<td>MT-12 08 25</td>
<td>Measurement and Sensor Techniques/Actuators (Mess- und Sensortechnik/Aktorik)</td>
<td>2/1/0 PL</td>
<td>2/0/2 PL</td>
<td>3rd year</td>
<td>German</td>
<td>9 (4+5)</td>
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</tbody>
</table>

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<tr>
<th>Module number</th>
<th>Module name</th>
<th>Winter semester</th>
<th>Summer semester</th>
<th>Level</th>
<th>Language of instruction</th>
<th>ECTS-credits</th>
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<tbody>
<tr>
<td>MT-M01-G</td>
<td>Multi Body Systems, Basics (Mehrkörpersysteme Grundlagen)</td>
<td>1/1/0 PL</td>
<td>2/2/0 PL</td>
<td>4th year</td>
<td>German</td>
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<tr>
<td></td>
<td></td>
<td>Module begins in summer semester.</td>
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<td>MT-M01-V</td>
<td>Multi Body Systems, Advanced (Mehrkörpersysteme Vertiefung)</td>
<td>3/2/0 3 PL</td>
<td>5th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M02-G</td>
<td>Fluid Power Systems, Basics (Fluidtechnische Systeme Grundlagen)</td>
<td>1/1/0 2 PL</td>
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<td>German</td>
<td>7</td>
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<tr>
<td>MT-M02-V</td>
<td>Fluid Power Systems, Advanced (Fluidtechnische Systeme Vertiefung)</td>
<td>3/1/1 3 PL</td>
<td>5</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M03-G</td>
<td>Mechanical Construction, Basics (Maschinenkonstruktion Grundlagen)</td>
<td>4/0/2 4 PL</td>
<td>4th and 5th year</td>
<td>German</td>
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<td>Module begins in summer semester.</td>
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<tr>
<td>MT-M03-V</td>
<td>Mechanical Construction, Advanced (Maschinenkonstruktion Vertiefung)</td>
<td>2/2/0 2 PL</td>
<td>4</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M04-G</td>
<td>Control, Basics (Regelung und Steuerung Grundlagen)</td>
<td>4/2/0 2 PL</td>
<td>4th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M04-V</td>
<td>Control, Advanced (Regelung und Steuerung Vertiefung)</td>
<td>4/1/0 2 PL</td>
<td>4th and 5th year</td>
<td>German</td>
<td>7</td>
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<td></td>
<td></td>
<td>Module begins in summer semester.</td>
<td></td>
<td></td>
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<td>MT-M05-G</td>
<td>Electric Drive Technology, Basics (Elektrische Antriebstechnik Grundlagen)</td>
<td>4/2/0 2 PL</td>
<td>4th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M05-V</td>
<td>Electric Drive Technology, Advanced (Elektrische Antriebstechnik Vertiefung)</td>
<td>2/1/2 2 PL</td>
<td>5th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M06-G</td>
<td>Process Control Engineering, Basics (Prozessinformationsverarbeitung Grundlagen)</td>
<td>4/0/2 2 PL</td>
<td>4th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M06-V</td>
<td>Process Control Engineering, Advanced (Prozessinformationsverarbeitung Vertiefung)</td>
<td>2/4/0 2 PL</td>
<td>5th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M07-G</td>
<td>Design Techniques, Basics Entwurfstechniken Grundlagen</td>
<td>4/2/0 2 PL</td>
<td>4th and 5th year</td>
<td>German</td>
<td>7</td>
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<tr>
<td>MT-M07-V</td>
<td>Design Techniques, Advanced (Entwurfstechniken Vertiefung)</td>
<td>4/1/0 2 PL</td>
<td>4th and 5th year</td>
<td>German</td>
<td>7</td>
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</table>
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### Elective modules, group “applications”

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Winter semester</th>
<th>Summer semester</th>
<th>Level</th>
<th>Language of instruction</th>
<th>ECTS-credits</th>
</tr>
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<tbody>
<tr>
<td>MT-A01-G</td>
<td>Automotive Vehicle Engineering, Basics (Kraftfahrzeugtechnik Grundlagen)</td>
<td>4/0/1 2 PL</td>
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<td>4th year</td>
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<td>Automotive Vehicle Engineering, Advanced (Kraftfahrzeugtechnik Vertiefung)</td>
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<td>Railway Vehicle Engineering, Basics (Schienenfahrzeugtechnik Grundlagen)</td>
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<td>Railway Vehicle Engineering, Advanced (Schienenfahrzeugtechnik Vertiefung)</td>
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<td>MT-A03-G</td>
<td>Combustion Engines, Basics (Verbrennungsmotoren Grundlagen)</td>
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<td>Aerospace Engineering, Advanced (Luft- und Raumfahrttechnik Vertiefung)</td>
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<td>5th year</td>
<td>German</td>
<td>7</td>
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<td>MT-A06-G</td>
<td>Mobile Work Machines, Basics (Mobile Arbeitsmaschinen Grundlagen)</td>
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<td>4th year</td>
<td>German</td>
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<td>Mobile Work Machines, Advanced (Mobile Arbeitsmaschinen Vertiefung)</td>
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<td>5th year</td>
<td>German</td>
<td>7</td>
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<td>Motion Controlled Machine Systems, Basics (Bewegungsgeführte Maschinen systeme Grundlagen)</td>
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<td>Motion Controlled Machine Systems, Advanced (Bewegungsgeführte Maschinen systeme Vertiefung)</td>
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<td>MT-A08-G</td>
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<td>3/2/2</td>
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<td>4th year</td>
<td>German 7</td>
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<td>MT-A09-G</td>
<td>Specific Production Methods, Basics (Spezielle Fertigungsmethoden Grundlagen)</td>
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<td>2 PL</td>
<td>4th year</td>
<td>German 7</td>
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<td>MT-A09-V</td>
<td>Specific Production Methods, Advanced (Spezielle Fertigungsmethoden Vertiefung)</td>
<td>3/0/3</td>
<td>3 PL</td>
<td>5th year</td>
<td>German 7</td>
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<td>MT-A10-G</td>
<td>Electronic Systems and Technology, Basics (Geräteotechnik Grundlagen)</td>
<td>2/4/0</td>
<td>2 PL</td>
<td>4th year</td>
<td>German 7</td>
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<td>MT-A10-V</td>
<td>Electronic Systems and Technology, Advanced (Geräteotechnik Vertiefung)</td>
<td>4/2/0</td>
<td>2 PL</td>
<td>5th year</td>
<td>German 7</td>
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<td>MT-A12-G</td>
<td>Biomedical Engineering, Basics (Biomedizintechnik Grundlagen)</td>
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<td>3 PL</td>
<td>4th year</td>
<td>German 7</td>
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<td>MT-A12-V</td>
<td>Biomedical Engineering, Advanced (Biomedizintechnik Vertiefung)</td>
<td>2/2/2</td>
<td>2 PL</td>
<td>5th year</td>
<td>German 7</td>
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<td>MT-A13-G</td>
<td>Sensors and Measuring Systems, Basics (Sensoren und Messsysteme Grundlagen)</td>
<td>4/2/0</td>
<td>3 PL</td>
<td>4th and 5th year</td>
<td>German 7</td>
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<tr>
<td>MT-A13-V</td>
<td>Sensors and Measuring Systems, Advanced (Sensoren und Messsysteme Vertiefung)</td>
<td>2/0/3</td>
<td>3 PL</td>
<td>5th year</td>
<td>German 7</td>
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<td>MT-A14-G</td>
<td>Electrified Mobility (Elektrifizierte Mobilität)</td>
<td>3/0/2</td>
<td>2 PL</td>
<td>5th year</td>
<td>German 7</td>
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</tbody>
</table>

The numbers in the columns “winter semester” and “summer semester” indicate in which semester the respective module is delivered. Further, these numbers refer to the SWS for the respective module. The 1st number refers to the SWS for the lecture, the 2nd to the SWS for the tutorial and the 3rd to the SWS for the lab course (Please see here for more details).

PL = Prüfungsleistung/assessment
### Module descriptions

**Module descriptions – basic studies (1st–4th semester)**

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 01 02</td>
<td>Automation Engineering and Measurement (Automatisierungs- und Messtechnik)</td>
<td>Prof. Dr. techn. K. Janschek</td>
</tr>
</tbody>
</table>

### Contents and objectives

**Content of the module:**

1. Elements of automation engineering
   - Verhaltensbeschreibungen
   - Reglerentwurf im Frequenzbereich
   - Digitale Regelkreise
   - Industrielle Standardregler
   - Ereignisdiskrete Steuerungen
   - Elementare Regelungs- und Steuerungskonzepte
   - Automatisierungstechnologien
2. Fundamentals of measuring
   - Messprinzipien, SI-Einheiten
   - Analoges Messtechnik: Grundlagen, Messbrücken, Lock-in-Messtechnik, Quadratur-Demodulationstechnik, Messung von Laufzeiten und Abständen
   - Statistische Messdatenbewertung: Berechnung von Standardabweichungen und Konfidenzintervallen; Fortpflanzung der Messunsicherheit, Aufstellung des Messunsicherheitsbudgets

**Objectives:** The students

- understand fundamental behaviour description forms for technical systems. Further, they master the basic theoretical and computer-based handling of linear, time-invariant and discrete-event behaviour models for the control of technical systems. Control algorithms for simple tasks can be designed independently.
- are familiar with the principles of analogue measuring procedures and are able to evaluate measurement results by using statistical methods. They are able to calculate and interpret random and systematic measuring uncertainties.

### Modes of teaching and learning

3 SWS lecture, 2 SWS tutorial, and self-study

### Prerequisites

Competences acquired in basic modules on Physics

### Usability

This module is a compulsory module within the Diplom degree programmes in Electrical Engineering and Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are earned if the module assessment is passed. The module assessment consists of a written test of 210 minutes.

### ECTS credit points and grades

5 ECTS credit points
The module grade is the grade of the written exam.
<table>
<thead>
<tr>
<th><strong>Frequency</strong></th>
<th>annually, during the summer semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload</strong></td>
<td>150 working hours</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1 semester</td>
</tr>
<tr>
<td>Module number</td>
<td>Module name</td>
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<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>MT-12 01 23</td>
<td>Micro Computer Engineering /Embedded Controller (Mikrorechentechnik / Embedded Controller)</td>
</tr>
</tbody>
</table>

**Contents and objectives**

**Content:**
- Computer architecture, instruction set architecture
- Coupling with industrial processes
- Instruction set oriented programming (Assembler)
- Efficient and portable programming of data structures and algorithms in a typed procedural language
- Object-oriented analysis, design and generic implementation of data structures and algorithms on the basis of examples of Electrical and Computer Engineering
- Further knowledge of principles and possible fields of applications of embedded controller architectures

**Objectives:**
The students:
1. are able to formulate and implement basic data structures and algorithms in a procedural language in an instruction set architecture specific language (assembler) as well as portable in a higher level programming language (e.g. C)
2. are able to analyse complex issues by using object-oriented structuring and modelling methods, to transfer them in algorithms and data structures and to implement them in a suitable language (e.g. C++)
3. know the interactions of different architectural concepts of controller cores with peripheral units in the overall system design. They are able to recognize and to evaluate the potential of different concepts, to design systems with embedded controllers and to program embedded controllers with their coupling to external devices.

**Modes of teaching and learning**

5 SWS lecture, 4 SWS lab course, and self-study

**Prerequisites**

Competences acquired in basic modules on computer science

**Usability**

This module is a compulsory module within the Diplom degree programme in Mechatronics.

**Requirements for the award of ECTS credit points**
The credit points are earned if the module assessment is passed. The module assessment consists of
1. a graded entrance test of the lab courses and graded lab course reports (PL1)
2. a written test (K2) of 120 minutes
3. successful defence of lab course results (not graded)

**ECTS credit points and grades**

10 ECTS credit points
PL1 is determined by the weighted average of the graded entrance test (1/3) and the graded lab course reports (2/3).
The module grade M is calculated as follows:
\[ M = \frac{3}{5} \times PL1 + \frac{2}{5} \times K2 \]
<table>
<thead>
<tr>
<th><strong>Frequency</strong></th>
<th>Annually, module starts in the winter semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload</strong></td>
<td>300 hours</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>2 semesters</td>
</tr>
<tr>
<td>Module number</td>
<td>Module name</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>MT-12 02 21</td>
<td>Circuit Design (Schaltungstechnik)</td>
</tr>
<tr>
<td>RES-G10</td>
<td></td>
</tr>
</tbody>
</table>

**Contents and objectives**

**Content:**
- The mode of operation, dimensioning and characteristics of electronic circuits of analogue and digital technology
- Analysis of basic circuits in the low frequency range on the basis of circuit properties of diodes and transistors

**Objectives:**
The students:
- are able to dimension simple transistor circuits
- are able to analyse complex circuits on the basis of familiar properties of the elementary circuits
- know the methodology of the design of amplifier circuits in the time and frequency domain
- master the analysis and design of digital control and signal processing based on combinatorial and sequential circuit assemblies.

**Modes of teaching and learning**
2 SWS lecture, 1 SWS tutorial, and self-study

**Prerequisites**
Competences acquired in basic modules on Physics as well as in modules such as MT-12 08 01 Fundamentals of Electrical Engineering, MT-12 09 01 Systems Theorie and MT-12 01 02 Automation Engineering and Measurement

**Usability**
This module is a compulsory module within the Diplom degree programmes in Mechatronics and Renewable Energy Systems.

**Requirements for the award of ECTS credit points**
The credit points are earned if the module assessment is passed. The module assessment is a written exam (120 min).

**ECTS credit points and grades**
4 ECTS credit points
The module grade is the grade of the written exam.

**Frequency**
Annually, in the winter semester

**Workload**
120 hours

**Duration**
1 semester
### Module number | Module name | Lecturer in charge
--- | --- | ---
MT-12 02 22<br>RES-H05 | Power Electronics<br>(Leistungselektronik) | Prof. Dr.-Ing. St. Bernet

#### Contents and objectives

- The students are familiar with the mode of operation and methods for the analysis of basic power electronic topologies and semiconductor components.
- They are able to select appropriate circuits to dimension these. Further, they are able to select and interpret power semiconductor devices for power electronic systems in typical applications.
- They are able to verify the basic function of the observed power electronic subsystem by using simulation tools.

#### Modes of teaching and learning

- 2 SWS lecture, 1 SWS tutorial, 1 project, and self-study

#### Prerequisites

- Competences acquired in modules such as MT-12 08 01 Fundamentals of Electrical Engineering

#### Usability

- This module is a compulsory module within the Diplom degree programmes in Mechatronics and Renewable Energy Systems.

#### Requirements for the award of ECTS credit points

- The credit points are earned if the module assessment is passed. The module assessment consists of a project (PA, 30 hours) and a written exam (K, 120 min).

#### ECTS credit points and grades

- 4 ECTS credit points
- The module grade M is calculated as follows: 
  \[ M = \frac{4}{5}K + \frac{1}{5}PA \]

#### Frequency

- Annually, in the winter semester

#### Workload

- 120 hours

#### Duration

- 1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 04 01</td>
<td>Electrical Power Engineering (Elektroenergietechnik)</td>
<td>Prof. Dr.-Ing. P. Schegner</td>
</tr>
<tr>
<td>ET-12 04 01 RES-G09</td>
<td></td>
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</tr>
</tbody>
</table>

**Contents and objectives**

- Generation, transformation, transport, distribution and usage of electrical energy,
- Structure of electrical energy supply,
- Basics of three-phase power and their mathematical description,
- Electrical safety and coordination of stress and strength
- Basics of power electronics and electromechanic energy converters.

Intended learning outcome:

Students are able to perform basic calculations and measurements for simple three-phase systems. They are familiar with principles of protection measures in electrical networks. They can calculate simple insulation configurations. They know the basic function of power electronics, electrical machines and three-phase transformers.

**Modes of teaching and learning**

3 SWS lecture, 1 SWS tutorial, 1 SWS lab course, and self-study

**Prerequisites**

None

**Usability**

The module is a compulsory module for the basic studies in the Diplom programmes in Electrical Engineering, Mechatronics, and Renewable Energy Systems. It provides various tools for the passing of the modules within the main studies.

**Requirements for the award of ECTS credit points**

The credit points are earned if the module assessment is passed. The module assessment consists of a written test of 150 minutes and a lab course; both elements of assessment must be passed.

**ECTS credit points and grades**

5 ECTS credit points

The grade is determined by the weighted average of the grades of the assessments. The written exam contributes by 2/3 and the lab course by 1/3.

**Frequency**

Annually, in the winter semester

**Workload**

150 working hours

**Duration**

2 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 05 01</td>
<td>Electronic Systems Design (Geräteentwicklung)</td>
<td>Prof. Dr.-Ing. habil. J. Lienig</td>
</tr>
<tr>
<td>ET-12 05 01</td>
<td></td>
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<tr>
<td>RES-G19</td>
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</tr>
</tbody>
</table>

**Contents and objectives**

This module covers
- Basics of system engineering
- Device construction and requirements
- Reliability of electronic systems
- Electromagnetic compliance
- Thermal dimensioning

Intended learning outcomes:

Students completing this module obtain basic knowledge for construction and development of electronic devices and systems. They will have an understanding of engineering tasks as well as related requirements. Thus, the students will be enabled to follow engineering principles while developing and constructing such products under consideration of all relevant aspects.

**Modes of teaching and learning**

2 SWS lectures, 2 SWS tutorial, and self-study

**Prerequisites**

none

**Usability**

This module is a compulsory module for the basic studies within the Diplom programmes in Electrical Engineering, Mechatronics, and Renewable Energy Systems. It provides knowledge for passing module examinations of the main studies.

**Requirements for the award of ECTS credit points**

The credit points are obtained by passing the module examination. This examination is conducted as a written exam (120 minutes).

**ECTS credit points and grades**

4 ECTS credit points
The module grade is the grade of the written exam.

**Frequency**

annually, during the summer semester

**Workload**

120 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 08 01</td>
<td>Fundamentals of Electrical Engineering (Grundlagen der Elektrotechnik)</td>
<td>Prof. Dr.-Ing. habil. R. Merker</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The module contents: the analysis of electrical DC networks.

Outcomes:

After completing this module, students have basic knowledge of electrical engineering and electronics. They are enabled to apply methods to solve electrical engineering problems as a basis for further modules. The focus is on resistive circuits.

Students are able to describe linear and nonlinear two poles and to consider the temperature dependence of their parameters to systematically analyze electrical DC circuits and to apply simplified analysis methods (two pole theory, superposition theorem). They can calculate the power dissipation in circuits and are able to analyze and determine their thermal behavior.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Basic knowledge in mathematics and physics from higher education

**Usability**

The module is a compulsory module of the basic studies in the Diplom degree programmes in Mechatronics, and Renewable Energy Systems. It is designed to enable the students to pass the module exam of the module Dynamic Networks.

**Requirements for the award of ECTS credit points**

The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes.

**ECTS credit points and grades**

6 ECTS credit points

The module grade is the grade of the written exam.

**Frequency**

annually, in the winter semester

**Workload**

180 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 08 23</td>
<td>Electric and Magnetic Fields</td>
<td>Prof. Dr.-Ing. habil. R. Merker</td>
</tr>
<tr>
<td>RES-G07</td>
<td>(Elektrische und magnetische Felder)</td>
<td></td>
</tr>
</tbody>
</table>

**Contents and objectives**

Module content: the calculating of basic electric and magnetic fields.

Outcomes:
After completing this module, students are able to master fundamental concepts and methods for the calculating of basic electric and magnetic fields. They are able to calculate the stored field energy, force effects, and induction phenomena of magnetic fields. Basic principles and the elementary electronic components resistor, capacitor, inductor, and transformer are known.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Competences acquired in modules on Principles of Algebra and Analysis and basic modules on Physics as well as competences acquired in modules such as ET-12 08 01 Fundamentals of Electrical Engineering

**Usability**

The module is a compulsory module of the basic studies in the Diplom degree programmes in Mechatronics and Renewable Energy Systems. It is designed to enable the students to pass the module exam of the module Dynamic Networks.

**Requirements for the award of ECTS credit points**

The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes.

**ECTS credit points and grades**

4 ECTS credit points

The module grade is the grade of the written exam.

**Frequency**

annually, in the summer semester

**Workload**

120 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 08 24</td>
<td>Dynamic Networks (Dynamische Netzwerke)</td>
<td>Prof. Dr. phil. nat. habil. R. Tetzlaff</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The module contents: the calculating of linear dynamic networks and the measurement of electronic circuits.

Outcomes:

After completing this module, students are able to apply methods for analyzing linear dynamic circuits excited by periodic signals and to determine the transient behavior between stationary states. They are able to describe, to model and to analyze linear two-ports. They can determine transfer functions, analyze and graphically represent the network behavior for different frequencies, and determine basic filter structures. Pointer representation and stationary curves are mastered. The students know how to use electronic measurement instruments. The students acquire skills in setting up and conducting experiments, in analyzing and presenting experiment and measurement results, in evaluating measurement methods and measurement uncertainties and in writing lab course reports.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, 3 SWS lab course, and self-study.

**Prerequisites**

Competences acquired in modules on Principles of Algebra and Analysis, Multivariable Calculus and basic modules on Physics as well as competences acquired in modules such as ET-12 08 01 Fundamentals of Electrical Engineering.

**Note:** To be allowed to take part in the lab course in the winter semester, students must have passed the module exam of the module ET-12 08 01 Fundamentals of Electrical Engineering.

**Usability**

The module is a compulsory module within the basic studies in the Diplom programme in Mechatronics and Renewable Energy Systems. It is designed to enable the students to pass the basic studies.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and a lab course. Both assessments must be passed.

**ECTS credit points and grades**

8 ECTS credit points

The module grade is determined by the weighted average of the grades of both elements of assessment. The module grade consists to 2/3 of the grade of the written exam and to 1/3 of the lab course grade.

**Frequency**

annually, starting in the winter semester

**Workload**

240 hours

**Duration**

2 semester
## Module number

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 08 25</td>
<td>Measurement and Sensor Techniques/Actuators (for module part Mess- und Sensortechnik, for module part Aktorik)</td>
<td>Prof. Dr.-Ing. habil. J. Czarske</td>
</tr>
</tbody>
</table>

## Contents and objectives

The students master the basic principles and the practical implementation of measurement and sensor methods. The students are able to present and to evaluate the physical principle and the technical design of measurement and sensor methods under real conditions.

The method of electric and hydraulic drive technology is an established technique to provide kinetic energy and movement operations at the required location. It is used in many fields of automation systems, automotive engineering and mechanical engineering.

**Objectives:**

1a. The students know the principles of digital measurement techniques and electrical sensors for detecting positions, velocities, forces and temperatures. They are familiar with the calculation methods for measurement uncertainty taking into account noise processes.

1b. Due to the lab course, the students know the basic principles of analogue and digital measurement methods as well as sensors and are able to calculate their measurement uncertainty applying statistical methods.

2. The students are familiar with basic principles of electric and hydraulic drives. They understand the actuator as an element for motion control and are able to perform simple calculations.

## Modes of teaching and learning

4 SWS lecture, 1 SWS tutorial, 2 SWS lab course, and self-study

## Prerequisites

Competences acquired in basic modules on Physics as well as in modules such as MT-12 04 01 Electrical Power Engineering, MT-12 09 01 Systems Theory, and MT-12 01 02 Automation Engineering and Measurement

**Note:** To be allowed to register for the lab course, students must have passed the module MT-12 01 02 Automation Engineering and Measurement

## Usability

The module is a compulsory module within the basic studies in the Diplom programme in Mechatronics.

## Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of

- a written exam (K1, 120 min.) on objective 1a
- a lab course (P1) on objective 1b
- a written exam (K2, 120 min.) on objective 2
- a lab course (P2) on objective 2

All elements of assessment must be passed.
<table>
<thead>
<tr>
<th><strong>ECTS credit points and grades</strong></th>
<th>The module grade $M$ is calculated as follows: $M = (4<em>K1 + 1</em>P1 + 2<em>K2 + 2</em>P2)/9$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>Annually, starting in the winter semester</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>270 Stunden</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>2 semesters</td>
</tr>
</tbody>
</table>
### Systems Theory (Systemtheorie)

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-12 09 01</td>
<td>Systems Theory (Systemtheorie)</td>
<td>Prof. Dr.-Ing. E. Jorswieck</td>
</tr>
<tr>
<td>ET-12 09 01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Contents and objectives

The module content includes:

- The conceptual and methodical fundamentals for the description of dynamic processes in nature and engineering on the basis of digital systems, analog continuous time systems, and analog discrete time systems

Learning outcomes:

- The students are familiar with the fundamental, ordering significance of the system concept in engineering. They understand the approach of system theory in general and specifically its application to digital systems, analogue continuous time systems and analogue discrete time systems. They are able to employ signal transformations (e.g., Fourier-, Laplace-, and z-Transform) for the efficient description of a system’s behaviour in the frequency domain. In particular, they are able to apply the system theorist’s way of thinking to important areas of their own discipline, for instance, to the analysis of electrical networks with non-sinusoidal excitation or to the realisation of systems with desired transfer characteristics in discrete time (digital filters).

#### Modes of teaching and learning

- 4 SWS lecture and 3 SWS tutorial and self-study

#### Prerequisites

- Competences acquired in modules on Principles of Algebra and Analysis and on Multivariable Calculus
- Competences acquired in modules such MT-12 08 01 Fundamentals of Electrical Engineering, and MT-12 08 23 Electric and Magnetic Fields

#### Usability

- The module is a compulsory module within the basic studies for the Diplom programme in Electrical Engineering and Mechatronics.

#### Requirements for the award of ECTS credit points

- The credit points are awarded when the module assessment is passed. The module assessment is a written exam of 120 minutes.

#### ECTS credit points and grades

- 7 ECTS credit points
- The module grade is the grade of the written exam.

#### Frequency

- Annually, beginning in the winter semester

#### Workload

- 210 hours

#### Duration

- 2 semesters
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-13 01 03</td>
<td>Fundamentals of Kinematics and Kinetics (Grundlagen der Kinematik und Kinetik)</td>
<td>Prof. Dr.-Ing. habil. V. Ulbricht</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The module content includes:
- Kinematics of the point and the rigid body
- Kinetics of rigid bodies in translation
- Kinetics of a rigid body with arbitrary motion
- Momentum and angular momentum balance including cutting principle, static interpretation of the momentum balances, free planar motion
- Vibrations of systems with different degree of freedom
- Lagrange equations of the second kind
- Spatial rotor movements

Objectives:
The students are familiar with analytical methods for the analysis of rigid body motions, including the causative loads.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Knowledge in the fields of of Algebra and Analysis and Multivariable Calculus as well as competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics

**Usability**

The module is a compulsory module within the basic studies for the Diplom programme in Mechatronics and Renewable Energy Systems.

**Requirements for the award of ECTS credit points**

The credit points are awarded when the module assessment is passed. The module assessment is a written exam of 120 minutes.

**ECTS credit points and grades**

5 ECTS credit points
The module grade is the grade of the written exam.

**Frequency**

Annually, in the winter semester

**Workload**

150 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-13 01 04</td>
<td>Kinematics and Materials of Mechanics, Advanced <em>(Vertiefung Kinematik und Festigkeitslehre)</em></td>
<td>Prof. Dr.-Ing. M. Beitelschmidt</td>
</tr>
</tbody>
</table>

**Contents and objectives**

This module extends the students’ knowledge of strength of materials by imparting competences in the area of energy methods, multiaxial stress states and the linear elastic overall problem. The module also includes in-depth-study in the area of kinematics and kinetics of rigid bodies, principles of mechanisms technology and robotics.

Objectives:

The students master the spatial statics and the general theory of bending of the beam. They are familiar with general stress and strain states. They master energy methods such as Castigliano’s theorem and have an insight into the method of finite elements. They are able to calculate rotationally symmetric stress states and to evaluate these by means of strength theories. Furthermore, they are familiar with the general basic equations of linear elasticity theory. The students master the description of kinematic chains of rigid bodies and joints as well as other configurations that are typical in robots. They are able to apply analytical and constructive methods for the determination of rigid body motion and the instantaneous centre of rotation. They are familiar with the methods of forming the equations of motion for systems with closed loops and typical robot configurations.

**Modes of teaching and learning**

3 SWS lecture, 3 SWS tutorial, and self-study

**Prerequisites**

Knowledge in the fields of Physics, Algebra and Analysis and Multivariable Calculus as well as competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-13 01 03 Fundamentals of Kinematics and Kinetics

**Usability**

The module is a compulsory module within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded when the module assessment is passed. The module assessment is a written exam of 180 minutes.

**ECTS credit points and grades**

7 ECTS credit points

The module grade is the grade of the written exam.

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-13 12 01</td>
<td>Construction and Manufacturing Engineering (Konstruktion und Fertigungs-technik)</td>
<td>Prof. Dr.-Ing. B. Schlecht</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The module includes the basics of the calculation of the load bearing capacity of simple components and also includes the variety of manufacturing processes in mechanical engineering, vehicle and plant construction by means of product and process examples. It integrates engineering thinking and working methods in the manufacturing process as well as the interaction with other disciplines.

Objectives:

The students:

1. possess the essential knowledge for the development, design, manufacturing and testing of mechanical engineering products as well as skills in handling with CAD systems.

2. are able to evaluate the application areas of typical machine elements such as axes and shafts, elemental compounds, positive-mode shaft-hub connections, roller bearings, plain bearings and spur gear, to select and calculate these.

3. know which divisions of a company are involved in the manufacturing of products, which requirements of the product determine the manufacturing possibilities as well as how decisions regarding production are derived.

4. know the manufacturing process, in particular its active principles, the technical equipment and the technological parameters that are to be determined.

**Modes of teaching and learning**

4 SWS lecture, 4 SWS tutorial, and self-study

**Prerequisites**

Knowledge in the fields of Physics, Algebra and Analysis and Multivariable Calculus as well as competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-12 05 01 Electronic Systems Design

**Usability**

The module is a compulsory module within the Diplom programme in Mechatronics and Renewable Energy Systems.

**Requirements for the award of ECTS credit points**

The credit points are awarded when the module assessment is passed. The module assessment consists of

1. a written exam K1 on manufacturing methods (90 min., objectives 3 and 4)
2. a written exam K2 (180 min., objectives 1 and 2)
3. an assignment on construction.

All elements of assessment have to be passed.

**ECTS credit points and grades**

10 ECTS credit points
The module grade M is calculated as follows:

\[ M = \frac{1}{10} (3*K1 + 4*K2 + 3*B) \]
<table>
<thead>
<tr>
<th><strong>Frequency</strong></th>
<th>Annually, starting in the winter semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload</strong></td>
<td>300 hours</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>2 semesters</td>
</tr>
<tr>
<td>Module number</td>
<td>Module name</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>MT-13 01 01</td>
<td>Field Theory (Feldtheorie)</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The students:

1. master the fundamental correlations for the mathematical description of mechanical, thermal, electrical and magnetic phenomena in deformable materials as the basis of analytical and numerical calculations of space and time, which are essential for the function of components.

2. know the global and local balances of mechanics, thermodynamics and electrodynamics, the theory of constitutive equations as well as special constitutive equations of elasticity, viscosity, plasticity, thermal conductivity, electrical conductivity, polarization, magnetization and coupled properties.

3. are able to conduct a modeling of multi-functional structures.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Knowledge in the fields of Physics, Algebra and Analysis, Multivariable Calculus, Function Theory / Partial Differential Equations and Probability Theory as well as competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-12 08 01 Fundamentals of Electrical Engineering and MT-12-08 23 Electrical and Magnetic Fields.

**Usability**

The module is a compulsory module within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded when the module assessment is passed. The module assessment is a written exam (150 min.).

**ECTS credit points and grades**

5 ECTS credit points

The module grade is the grade of the written exam.

**Frequency**

Annually, in the summer semester

**Workload**

150 hours

**Duration**

1 semester
### Module Descriptions

<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-13 01 02</td>
<td>Numerical Methods/System Dynamics <em>(Numerische Methoden/Systemdynamik)</em></td>
<td>Dr.-Ing. habil. M. Scheffler</td>
</tr>
</tbody>
</table>

#### Contents and Objectives

The students:

1. possess knowledge and skills for the approximate solution of boundary value problems and coupled initial-boundary value problems based on the mathematical methods of weighted residuals, the weak and inverse formulation. They are familiar with the necessary algorithms for algebraing and discretisation, including the associated numerical methods.

2. master the system theoretic fundamentals of mechanic systems and their modelling with structure models. They know special problems on simple multi-body-mechanism with their specifics.

3. have an overview of the theory of linear oscillations with finite degrees of freedom, of the treatment of free and fettered torsional frequency response system of the drive dynamics, of bending vibrations with consideration of the gyroscopic effect. They are familiar with the basics of modal analysis as well as special procedures for estimating natural frequencies and mode shapes.

4. possess practical skills to apply modern methods of measurement and FEM software to determine and simulate the behaviour of mechanical structures under static and dynamic loading.

#### Modes of Teaching and Learning

4 SWS lecture, 2 SWS tutorial, 1 SWS lab course, and self-study

#### Prerequisites

Knowledge in the fields of Physics, Algebra and Analysis, Multivariable Calculus, Function Theory / Partial Differential Equations and Probability Theory as well as competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-12 08 01 Fundamentals of Electrical Engineering

#### Usability

The module is a compulsory module within the *Diplom* programme in Mechatronics.

#### Requirements for the Award of ECTS Credit Points

The credit points are awarded when the module assessment is passed. The module assessment consists of:

- a written exam K1 (120 min., on objective 1)
- a written exam K2 (120 min., on objective 2 and 3)
- lab course P, Two lab course reports have to be handed in.

#### ECTS Credit Points and Grades

9 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{2K1 + 2K2 + P}{5} \]

#### Frequency

Annually, beginning in the winter semester

#### Workload

270 hours

#### Duration

2 semesters
Module number  | Module name                                                                 | Lecturer in charge          |
-------------|-----------------------------------------------------------------------------|-----------------------------|
MT-12 13 01  | Control of Continuous-Time Processes and Discrete Event Systems (Regelungstechnik und Ereignisdiskrete Systeme) | Prof. Dr.-Ing. habil. K. Röbenack |

Contents and objectives

Content:
1. Fundamentals of control of linear systems (basic structures of control, signal and system descriptions, stability analysis, controller design in the frequency domain)
2. Fundamentals of behavioral description of discrete event systems (signal-based, finite automata, Petri nets) and for the design of discrete event control systems (bottom-up, top-down automata and Petri nets)
3. Examples of laboratory-based control systems

Objectives:
The students
1. understand the basic structure of controls. They are able to describe linear systems mathematically and to analyse these with regard to their stability. Further, they are able to design single-loop linear controllers.
2. understand the fundamental behavioral description forms for discrete event systems, they master the theoretical and computer-assisted handling of discrete event behavior models and are able to design independently discrete event control algorithms for manageable tasks.
3. are able to solve control problems on real technical-physical systems.

Modes of teaching and learning
5 SWS lecture, 2 SWS tutorial, 1 SWS lab course, and self-study

Prerequisites
Competences acquired in modules such as MT-12 09 01 Systems Theory, and MT-12 01 02 Automation Engineering and Measurement

Usability
The module is a compulsory module within the Diplom programme in Mechatronics.

Requirements for the award of ECTS credit points
The credit points are awarded when the module assessment is passed. The module assessment consists of:
- a written exam (K1, 120 min.) on objective 1
- a written exam (K2, 90 min.) on objective 2
- a lab course (P) on objective 3

ECTS credit points and grades
9 ECTS credit points
The module grade M is calculated as follows:
\[ M = \frac{4\times K1 + 4\times K2 + 1\times P}{9} \]

Frequency
Annually, starting in the winter semester

Workload
270

Duration
2 semesters
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-13 00 01</td>
<td>Materials and Engineering Mechanics (Werkstoffe und Technische Mechanik)</td>
<td>Prof. Dr.-Ing. habil. J. Bauch</td>
</tr>
<tr>
<td>ET-13 00 01</td>
<td>RES-G14</td>
<td></td>
</tr>
</tbody>
</table>

**Contents and objectives**

Content:

Materials:
- Overview of materials in Electrical Engineering and Mechatronics, practical examples
- Fundamentals of materials science
- Status diagrams and alloys
- Conductor, semiconductor, dielectric and magnetic materials
- Materials testing and diagnostics

Statics and Strength of Materials:
- Rigid bodies:
- Independent loads, power and torque, methods of sections
- Balance of planar structures (balances of forces and moments)
- Tensile, compressive and shear stresses including elementary dimensioning concepts
- Torsion of bars with circular cross-section, straight bending of prismatic beams, strength theories and bar buckling

Objectives:

The students are familiar with the relationship between the microscopic structure, the macroscopic properties and the practical aspects of application of materials. They know the theoretical principles of the atomic structure, of the bond type, of the crystal structure as well as of the microstructure and are familiar with material testing. Further, they are familiar with the fundamental laws of statics as well as the simplified relationships between loads, material properties and loads of parts. With regard to these topics, they master calculation methods of the structural design and strength evaluation.

**Modes of teaching and learning**

4 SWS lecture, 3 SWS tutorial, and self-study

**Prerequisites**

Basic knowledge in mathematics and physics from higher education

Competences acquired in modules on Principles of Algebra and Analysis

**Usability**

The module is a compulsory module within the basic studies of the Diplom programme in Mechatronics, Electrical Engineering and Renewable Energy Systems.

**Requirements for the award of ECTS credit points**

The credit points are awarded when the module assessment is passed. The module assessment consists of:

- a written exam (K1, 90 min.)
- a written exam (K2, 120 min.)

Both elements of assessment must be passed.
| ECTS credit points and grades | 7 ECTS credit points  
The module grade M is calculated as follows:  
\[ M = \frac{3}{7}K1 + \frac{4}{7}K2  
| Frequency | Annually, starting in the winter semester  
| Workload | 210 hours  
| Duration | 2 semesters |
### Module number | Module name | Lecturer in charge
--- | --- | ---
MT-M01-G | Multi Body Systems, Basics *(Mehrkörpersysteme, Grundlagen)* | Prof. Dr.-Ing. M. Beitelschmidt

### Contents and objectives
The method of multi-body system simulation is an established technique to calculate large movements of mechanical systems consisting of rigid and elastic bodies in the time domain. It is applied in general mechanical engineering, the automotive and aerospace engineering. The coupling with control technology is required in mechatronic systems in particular.

The students

1. master the methodology of movement equations of multi-body systems as well as their computer-assisted implementation for simple special cases
2. are familiar with the various algorithms of multi body simulation that are applied in commercial programmes and
3. are able to solve simple tasks of the control of multi-body systems.

### Modes of teaching and learning
3 SWS lecture, 3 SWS tutorial, and self-study

### Prerequisites
Competences in the field of Engineering Mechanics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics, MT-13 01 03 Fundamentals of Kinematics and Kinetics, and MT-13 01 02 Numerical Methods/System Dynamics

Competences in Principles of Algebra and Analysis, Multivariable Calculus, Function Theory / Partial Differential Equation, Probability Theory

Basic knowledge in Control and in a line-oriented programming language

### Usability
This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Multi Body Systems, Advanced.

### Requirements for the award of ECTS credit points
The credit points are awarded if the module assessment is passed. If 20 students or less take part in the module, the module assessment consists of an oral exam (30 min.) on objective 1 and 2 as well as an oral exam (30 min.) on objective 3. If more than 20 students take part in the module, the oral exams are replaced by written exams (90 min. each).

### ECTS credit points and grades
7 ECTS credit points
The module grade M is calculated as follows:

\[ M = \frac{5*PL1 + 2*PL2}{7} \]

### Frequency
Annually, starts in the summer semester

### Workload
210 hours

### Duration
2 semesters
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M01-V</td>
<td>Multi Body Systems, Advanced ((Mehrkörpersysteme, Vertiefung))</td>
<td>Prof. Dr.-Ing. M. Beitelschmidt</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The method of multi body system simulation is an established technique to calculate large movements of mechanical systems consisting of rigid and elastic bodies in the time domain. It is applied in general mechanical engineering, the automotive and aerospace engineering. For large structures elastic bodies are required as model elements. In mechatronic applications, the coupling with simulation models of other physical domains as well as the real-time simulation is required.

The students
1. understand the theoretical fundamentals of flexible multi-body systems. They are able to prepare elastic bodies from FE models for the simulation in multi body system programs.
2. know the fundamentals of the coupled simulation as well as of the real-time simulation.
3. are able to handle a commercial multi body systems simulation program, in particular, to create models independently, to conduct simulation calculations and to prepare and interpret results.
4. are able to implement controllers for simple multi body systems.

**Modes of teaching and learning**

3 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Competences in the field of engineering mechanics, in particular multi-body dynamics, that can be acquired in modules such as MT-M01-G Multi Body Systems, Basics
Basic knowledge in a line-oriented programming language
Competences in controller programming with signal flow methods

**Usability**

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. If 20 students or less take part in the module, the module assessment consists:
1. an oral exam (30 min.) on objective 1
2. an oral exam (30 min.) on objectives 2 and 4
If more than 20 students take part in the module, the oral exams are replaced by written exams (90 min. each).
3. assignment within the frame of the lab course (objective 3)

**ECTS credit points and grades**

7 ECTS credit points.
The module grade is the arithmetic mean of the grades of the 3 elements of assessment.

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M02-G</td>
<td>Fluid Power Systems, Basics (Fluidtechnische Systeme Grundlagen)</td>
<td>Prof. Dr.-Ing. J. Weber</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Hydraulic and pneumatic drive systems are applied in many machines and plants for the industrial production of goods. In the field of hydraulic drive systems, a high level of accuracy and dynamic as well as of force, e.g. in presses, plastic or machine tools, is demanded. Here modern controlled electro-hydraulic drives are used. The students are familiar with and understand the necessary concepts of control. They master the possibilities of control engineering description and are able to design the appropriate control loops.

Pneumatic drive systems are mainly used for the automated handling of industrial goods. These are usually controlled structures. Students are able to design and implement sequence control systems in pneumatic circuits. Particular attention is paid to electro-pneumatic solutions including programmable logic controllers (PLC). Based on this, they learn control engineering approaches for the dimensioning of pneumatic drive systems. During lab sessions on control engineering of hydraulic and pneumatic actuators, the students enhance and apply the knowledge imparted.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, 1 SWS lab course, and self-study

**Prerequisites**

Competences in Mathematics (Principles of Algebra and Analysis, Multivariable Calculus)

Competences on Physics that can be acquired in basic modules on Physics

**Usability**

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Fluid Power Systems, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 120 min.) on the key topic electro-hydraulic drive technology
2. a written exam (K2, 120 min.) on the key topic control of pneumatic drives
3. graded lab course experiments (P)

**ECTS credit points and grades**

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{1}{5}(2\times K1 + 2\times K2 + 1\times P) \]

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M02-V</td>
<td>Fluid Power Systems, Advanced <em>(Fluidtechnische Systeme Vertiefung)</em></td>
<td>Prof. Dr.-Ing. J. Weber</td>
</tr>
</tbody>
</table>

**Contents and objectives**
Hydraulic drives and controllers are the basis for the performance of mobile work machinery, such as construction machinery, agricultural machinery and municipal vehicles. The students are able to select and to dimension components and systems for mobile work machinery according to their demands. The focus is on working hydraulics systems, traction drive systems as well as steering systems of mobile work machinery. Due to the increasing use of electro-hydraulic systems in mobile work machinery, the students are taught in the fields of control engineering, software development and security issues for mobile work machinery. The students are able to evaluate the functional dimensioning of hydraulic systems as well as necessary aspects of machine safety. They are also able to carry out the activation of the systems by means of microprocessors. The students enhance and apply the knowledge imparted during lab sessions that deal with the functional and energetic behavior of typical mobile hydraulic systems and the implementation of control algorithms.

**Modes of teaching and learning**
3 SWS lecture, 1 SWS tutorial, 1 SWS lab course, and self-study

**Prerequisites**
Competences acquired in modules such as MT-M02-G Fluid Power Systems, Basics
Basic knowledge on the methods of control engineering that can be acquired in modules such as MT-12 13 01 Control of Continuous-Time Processes and Discrete Event Systems

**Usability**
This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**
The credit points are awarded if the module assessment is passed. The module assessment consists of:
1. a written exam (K1, 120 min.) on the key topic mobile hydraulics
2. a written exam (K2, 90 min.) on the key topic control, software development, and security
3. graded lab course experiments (P)

**ECTS credit points and grades**
7 ECTS credit points
The module grade M is calculated as follows:
\[ M = \frac{3 \times K1 + 1 \times K2 + 1 \times P}{5} \]

**Frequency**
Annually, in the winter semester

**Workload**
210 hours

**Duration**
1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M03-G</td>
<td>Mechanical Construction, Basics</td>
<td>Prof. Dr.-Ing. habil. R. Stelzer</td>
</tr>
<tr>
<td></td>
<td><em>(Maschinenkonstruktion Grundlagen)</em></td>
<td></td>
</tr>
</tbody>
</table>

**Contents and objectives**

The students are already familiar with the fundamentals of construction. The students’ knowledge and competences are enhanced to enable them to solve complex tasks with the appropriate tools and methods. The focus is on optimization of the development process as well as on special issues of material usage.

An introduction to the strategic product planning forms the basis. Here concepts for technology selection and decision making for the use of technology, for the market-technology portfolio for the planning of new products as well as for the quality function deployment for planning the advancement of products are discussed. In addition, methods and tools for a methodical development of products are treated.

In the subject area of “construction materials” knowledge of the mechanical behavior of materials under quasi-static and cyclic loading, at high temperature and in aggressive media are taught. Metallic, polymeric and composite materials including wood are introduced and the selectin of material that is appropriate to the load is discussed. Latest material developments for machinery, plant and vehicle are in the centre.

**Modes of teaching and learning**

4 SWS lecture, 2 SWS lab course, and self-study

**Prerequisites**

Knowledge and competences in physics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-13 12 01 Construction and Manufacturing Engineering as well as competences in computer science

**Usability**

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Mechanical Construction, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 120 min.) on the topic construction materials
2. a written exam (K2, 120 min.) on the topic constructive development process
3. a lab course (P) on construction materials
4. an assignment (B) on constructive development process

**ECTS credit points and grades**

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{(4 \times K1 + 1 \times P)/5 + (2 \times K2 + 1 \times B)/3)}{2} \]
| **Frequency**   | Annually, starting in the summer semester  
<p>|                | (summer semester: construction materials |
|                | winter semester: constructive development process) |
| <strong>Workload</strong>   | 210 hours |
| <strong>Duration</strong>   | 2 semesters |</p>
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M03-V</td>
<td>Mechanical Construction, Advanced <em>(Maschinenkonstruktion Vertiefung)</em></td>
<td>Prof. Dr.-Ing. habil. R. Stelzer</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The students are able to use CA techniques in the area of product development effectively. First, there is an introduction to the use of 3D CAD systems, which enables the students to prepare models of components and assemblies as well as the corresponding drawings independently. In the course of the module, the students become acquainted with the internal structure of 3D CAD models and learn how to synthesize the CAD models via available programming interfaces (production of complex, analytically describable geometries), to analyse them (including discharge of drilling plans and parts lists) as well as to use them for simulations (e.g. kinematics).

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Knowledge and competences that can be acquired in modules such as MT-13 12 01 Construction and Manufacturing Engineering and MT-M03-G as well as competences in computer science

**Usability**

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 90 min.) on the topic 3D-construction
2. a written exam (K2, 90 min.) on the topic CAD applications

**ECTS credit points and grades**

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{(K1 + 2\times K2)}{3} \]

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M04-G</td>
<td>Control, Basics <em>(Regelung und Steuerung Grundlagen)</em></td>
<td>Prof. Dr.-Ing. habil. K. Röbenack</td>
</tr>
</tbody>
</table>

**Contents and objectives**

**Content:**
1. State space methods and sampling control
2. Design and analysis of nonlinear control systems

The students
1. understand the solutions of state space models in time and frequency domain, are familiar with the concepts of controllability and observability and are able to check these properties for given systems, are able to design state controllers and state observers and understand the fundamentals of sampling control.
2. can deal with nonlinear control systems, the mathematical analysis of nonlinear systems and the dimensioning of simple controllers for nonlinear systems.

**Modes of teaching and learning**

4 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Knowledge and competences in dynamic systems that can be acquired in modules such as MT-12 09 01 Systems Theory

**Usability**

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Control, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of 2 written exams (120 min. each).

**ECTS credit points and grades**

7 ECTS credit points
The module grade is the arithmetic mean of the grades for the exams.

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-M04-V</td>
<td>Control, Advanced (Regelung und Steuerung Vertiefung)</td>
<td>Prof. Dr.-Ing. habil. K. Röbenack</td>
</tr>
</tbody>
</table>

### Contents and objectives

Content:

1. Analysis and design of optimal and/or robust and/or nonlinear control systems
2. System theoretical elements of complex control systems (e.g. spatially distributed systems)

The students

1. are able to analyze complex control systems and to dimension corresponding control facilities.
2. are able to model, analyse, actuate and control, by means of mathematical and system theoretical correlations, complex control systems (e.g. multivariable systems, systems with uncertainties, nonlinear systems, spatially distributed systems).

### Modes of teaching and learning

4 SWS lecture, 1 SWS tutorial, and self-study

### Prerequisites

Knowledge and competences in dynamic systems that can be acquired in modules such as MT-12 09 01 Systems Theory

Knowledge and competences in control engineering that can be acquired in modules such as MT-M04-G Control, Basics

### Usability

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of 2 written exams (90 min. each).

### ECTS credit points and grades

7 ECTS credit points

The module grade is the arithmetic mean of the grades for the exams.

### Frequency

Annually, starting in the summer semester

### Workload

210 hours

### Duration

2 semesters
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M05-G</td>
<td>Electric Drive Technology, Basics</td>
<td>PD Dr.-Ing. habil. G.-H. Geitner</td>
</tr>
</tbody>
</table>

### Contents and objectives

The method of electric drive technology is an established technique to provide the necessary kinetic energies via main drives and desired motions via actuators at the required location. It is applied in many areas of general automation engineering, e.g. manufacturing, packaging and processing industry or transport automation as well as in automotive and aerospace technology. In many of these cases, in particular in mechatronic systems, a coupling with control technology is necessary.

The students

1. are able to apply methods for the design and calculation of electric drive systems as well as to use various modeling tools for description, modeling and simulation.
2. master the internal processes in power electronic actuators, are able to model and to calculate these and understand their interaction with the electric drive and drive-related control systems.

### Modes of teaching and learning

4 SWS lecture, 2 SWS tutorial, and self-study

### Prerequisites

- Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus)
- Competences in Electrical Engineering/Energy that can be acquired in modules such as MT-12 08 25 Measurement and Sensor Techniques/Actuators, MT-12 04 01 Electrical Power Engineering, MT-12 02 22 Power Electronics
- Competences in control engineering that can be acquired in modules such as MT-12 01 02 Automation Engineering and Measurement and Control Engineering

### Usability

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Electric Drive Technology, Advanced.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of

- a written exam (PL1, 90 min.) on objective 1
- a written exam (PL2, 90 min.) on objective 2

### ECTS credit points and grades

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{4*PL1 + 3*PL2}{7} \]

### Frequency

Annually, in the summer semester

### Workload

210 hours

### Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
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</thead>
<tbody>
<tr>
<td>MT-M05-V</td>
<td>Electric Drive Technology, Advanced <em>(Elektrische Antriebstechnik Vertiefung)</em></td>
<td>PD Dr.-Ing. habil. G.-H. Geitner</td>
</tr>
</tbody>
</table>

### Contents and objectives

**Content:**

The basics of electrical machines in structure, function, performance, agitator speed and efficiency

- Fundamentals of electromagnetic energy conversion
- Transformers
- DC machines
- Synchronous machines
- Induction machines
- Small machines
- Linear Motors
- Testing of electrical machines

**Objectives:**

Having completed this module, the students are able to understand the steady-state operating performance of electrical machines as well as to evaluate the properties by means of suitable calculations, measurements and tests.

### Modes of teaching and learning

2 SWS lecture, 1 SWS tutorial, 2 SWS lab course, and self-study

### Prerequisites

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus)

Competences in Electric Drive Technology that can be acquired in modules such as MT-M05-G Electric Drive Technology, Basics

Competences in Electrical Engineering/Energy that can be acquired in modules such as MT-12 08 25 Measurement and Sensor Techniques/Actuators, MT-12 04 01 Electrical Power Engineering, MT-12 02 22 Power Electronics

Competences in control engineering that can be acquired in modules such as MT-12 01 02 Automation Engineering and Measurement and Control Engineering

### Usability

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of

- a written exam (PL1, 90 min.) on objective 1
- lab course (PL2) on objective 2

### ECTS credit points and grades

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{4 \times PL1 + 3 \times PL2}{7} \]

### Frequency

Annually, in the winter semester

### Workload

210 hours

### Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M06-G</td>
<td>Process Control Engineering, Basics (Prozessinformationenverarbeitung Grundlagen)</td>
<td>Prof. Dr.-Ing. habil. L. Urbas</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The process of information processing is concerned with the fundamentals, methods, algorithms and architectures for computer-assisted information retrieval, distribution, processing, display and use of process-near data. It is applied in automation engineering and process automation.

The students:

1. are able to design simple process-near information processing systems and to use appropriate algorithms within their limits.
2. are able to select and evaluate communication structures and components that are suitable for the task.
3. are able to draft, design, use and test information processing systems in distributed automation structures.

**Modes of teaching and learning**

4 SWS lecture, 2 SWS lab course, and self-study

**Prerequisites**

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus)

Basic knowledge in control engineering and in a line-oriented programming language (C, Matlab etc.) that can be acquired in modules such as MT-12 01 23 Micro Computer Engineering/Embedded Controller

**Usability**

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Process Control Engineering, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. If 20 students or less take part in the module, the module assessment consists of:

1. an oral exam (PL1, 30 min.) on objective 1 and 2
2. an oral exam (PL2, 30 min.) on objectives 3

If more than 20 students take part in the module, the oral exams are replaced by written exams (90 min. each).

3. lab course (including test and lab course report), the lab course must be passed

**ECTS credit points and grades**

7 ECTS credit points

The module grade M is calculated as follows:

$$ M = \frac{1}{2} \times PL1 + \frac{1}{2} \times PL2 $$

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M06-V</td>
<td>Process Control Engineering, Advanced (Prozessinformationsverarbeitung Vertiefung)</td>
<td>Prof. Dr.-Ing. habil. L. Urbas</td>
</tr>
</tbody>
</table>

Contents and objectives

**Content:**
Principles and methods for taking into account the human factor in the analysis, evaluation and design of complex, interactive technical systems

**Objectives:**
The students master the fundamental methods of the human-machine-system technology for the description, analysis, evaluation and design of dynamic interactive systems and are able to deal systematically with the domain-specific issues of human-machine interaction.

Modes of teaching and learning

2 SWS lecture, 2 SWS tutorial, 2 SWS project, and self-study

Prerequisites

Competences that can be acquired in modules such as MT-M06-G Process Control Engineering, Basics

Usability

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.

Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam (PL1, 120 min.) and a graded project (PL2).

ECTS credit points and grades

7 ECTS credit points
The module grade M is calculated as follows:
\[ M = \frac{2 \times PL1 + 1 \times PL2}{3} \]

Frequency

Annually, in the winter semester

Workload

210 hours

Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-M07-G</td>
<td>Design Techniques, Basics</td>
<td>Prof. Dr. techn. K. Janschek</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Content:
1. Elements of the physical modeling
   Energy-based modeling paradigms (Euler-Lagrange), tor-based modeling paradigms (generalized Kirchhoff’s networks), signal-based modeling paradigms, differential algebraic equation systems
2. Elements of simulation technology
   Numerical integration of ordinary differential equation systems, differential algebraic equation systems (DAE) and hybrid (discrete event-continuous) systems of equations, modular simulation (signal-/ object-oriented)
3. System design of mechatronic systems
   Multibody dynamics
   Mechatronic transducer principles
   Stochastic behaviour analysis
   System budget

Objectives:
The students
1. master the physical modeling paradigms and are able to create independently mathematical models, e.g. DAE-Systems.
2. are familiar with the basic structure of numerical integration algorithms and special features in their application for technical-physical systems.
3. are able to apply methods and tools of the physically based behaviour modeling and analysis (mechatronic systems) and are able to conduct an informed quantitative design evaluation and optimization.

**Modes of teaching and learning**
4 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**
Competences that can be acquired in modules such as MT-12 01 02 Automation Engineering and Measurement and MT-12 13 01 Control of Continuous-Time Processes and Discrete Event Systems

**Usability**
This module is an elective module of the group “methods” within the Diplom programme in Mechatronics. It lays the foundation for the module Design Techniques, Advanced.

**Requirements for the award of ECTS credit points**
The credit points are awarded if the module assessment is passed. The module assessment consists of
- a written exam (K1, 120 min.) on objective 1 and 2
- a written exam (K2, 120 min.) on objective 3
| **ECTS credit points and grades** | 7 ECTS credit points  
The module grade M is calculated as follows:  
M = (K1 + K2)/2 |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>Annually, starting in the winter or the summer semester</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>210 hours</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>2 semesters</td>
</tr>
<tr>
<td>Module number</td>
<td>Module name</td>
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<td>-------------</td>
</tr>
<tr>
<td>MT-M07-V</td>
<td>Design Techniques, Advanced (Entwurfstechniken Vertiefung)</td>
</tr>
</tbody>
</table>

### Contents and objectives

**Content:**
1. System design of complex automation systems
   - Definition of requirements, function-oriented behaviour modeling, object-oriented behaviour modelling, safety-related design
2a. Quality assurance
   - Models for the description of quality behaviour and time lapses
   - Analysis of data with regression and variance analysis
   - Application of Statistical Design of Experiments (DoE)
   - Factor and cluster analyzes, use of data mining methods
   - Analysis of reliability data and time-series analysis
   - Evaluation of measuring equipment and optimization of test processes

OR

2b. Fundamentals of product development
   - Systematic solving of design tasks, methods of product development, life stages of a product, constructive development process, areas of a product developer, factory tour

The students can choose between the module contents/objectives 2a and 2b.

**Objectives:**

The students

1. are able to work with the concepts, methods and tools of abstract behaviour modelling and analysis (complex automation systems). They are able to conduct an informed quantitative design evaluation and optimization.
2a. master fundamental methods of quality assurance.

OR

2b. are familiar with fundamental concepts and procedures of product development.

3. are able to solve a manageable design task by means of the imparted methods.

### Modes of teaching and learning

4 SWS lecture, 2 SWS tutorial, and self-study

### Prerequisites

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus, Probability Calculation, Functional Theory, Partial Differential Equation)

### Usability

This module is an elective module of the group “methods” within the Diplom programme in Mechatronics.
<table>
<thead>
<tr>
<th><strong>Requirements for the award of ECTS credit points</strong></th>
<th>The credit points are awarded if the module assessment is passed. The module assessment consists of two written exams (90 min., 120 min.).</th>
</tr>
</thead>
</table>
| **ECTS credit points and grades**                  | 7 ECTS credit points  
The module grade is the arithmetic mean of both elements of assessment. |
<p>| <strong>Frequency</strong>                                       | Annually, starting in the summer semester |
| <strong>Workload</strong>                                        | 210 hours |
| <strong>Duration</strong>                                        | 2 semesters |</p>
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A01-G</td>
<td>Automotive Vehicle Engineering, Basics</td>
<td>Prof. Dr.-Ing. G. Prokop</td>
</tr>
<tr>
<td></td>
<td>(Kraftfahrzeugtechnik Grundlagen)</td>
<td></td>
</tr>
</tbody>
</table>

**Contents and objectives**
Content:
Basic knowledge of design, construction and operation of the components of a motor vehicle and their interaction for the realization of the overall properties of the vehicle. This includes:
- Functionality of components and subsystems of the vehicle
- Design and dimensioning of the components
- Interaction of the individual components and systems
- Realization of the overall vehicle performance by means of specific design of components and systems

Having completed the module, the student knows the individual functions of the components of the motor vehicle as well as their interaction in the overall vehicle. She/he is thus in a position to evaluate and optimize the overall vehicle performance.

**Modes of teaching and learning**
4 SWS lecture, 1 SWS lab course, and self-study

**Prerequisites**
Knowledge and competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics, MT-13 01 02 Numerical Methods/System Dynamics, MT-12 08 25 Measurement and Sensor Techniques/Actuators, MT-12 08 01 Fundamentals of Electrical Engineering

**Usability**
This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module Automotive Vehicle Engineering, Advanced.

**Requirements for the award of ECTS credit points**
The credit points are awarded if the module assessment is passed. The module assessment consists of two written exams (K1 and K2, 90 min each.). The lab course must be passed.

**ECTS credit points and grades**
7 ECTS credit points
The module grade M is calculated as follows:
\[ M = 0,5 \times K1 + 0,5 \times K2 \]

**Frequency**
Annually, in the summer semester

**Workload**
210 hours

**Duration**
1 semester
### Module number | Module name | Lecturer in charge
--- | --- | ---
**MT-A01-V** | Automotive Vehicle Engineering, Advanced *(Kraftfahrzeugtechnik Vertiefung)* | Prof. Dr.-Ing. G. Prokop

### Contents and objectives

**Content:**
- In-depth-study of the functional design of motor vehicles and their components. The focus is on:
  - Simulation in automotive development
  - Development and release processes
  - Mobility and vehicle concepts
  - Driving dynamics and ride comfort
  - Control systems in motor vehicles
  - Lightweight construction, ergonomics

In the area of “mechatronic systems”, applications, methods for the design and modelling are pointed out and deepened by using the example of the motor vehicle for such systems. Attending this module, the student understands the structure and operation of networked mechatronic systems. She/he acquires knowledge of the structured winning and formulation of requirements for the design of mechatronic systems as well as knowledge of current methods for describing, modeling and simulating mechatronic systems. Practical experience in dealing with the functional units sensor systems, actuators and processing system.

Having completed this module, the student is able to map and implement certain component requirements, which are derived from the overall vehicle properties to be realized, to technical solutions.

### Modes of teaching and learning

6 SWS lecture and self-study

### Prerequisites

Knowledge and competences that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics, MT-13 01 02 Numerical Methods/System Dynamics, MT-12 08 25 Measurement and Sensor Techniques/Actuators, MT-12 08 01 Fundamentals of Electrical Engineering

### Usability

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of three written exams (K1, K2, K3, 90 min. each).

### ECTS credit points and grades

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = \frac{1}{3}K1 + \frac{1}{3}K2 + \frac{1}{3}K3 \]

### Frequency

Annually, in the winter semester

### Workload

210 hours

### Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A02-G</td>
<td>Railway Vehicle Engineering, Basics <em>(Schienenfahrzeugtechnik Grundlagen)</em></td>
<td>Prof. Dr.-Ing. G. Löffler</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Railway Vehicle Engineering is an area of specialization of mechanical engineering that deals with the design, construction and manufacturing as well as the maintenance of rail-guided vehicles. The railway vehicle is modularly designed, the modules are connected to one another by means of defined interfaces. For the control of the vehicle or train for railway operations, a variety of control algorithms is necessary.

The students
1. understand the system structure of a railway vehicle
2. are familiar with the control engineering of the subsystems brake and train safety system and the overall system
3. are able to design and calculate subsystems.

**Modes of teaching and learning**

4 SWS lectures and self-study

**Prerequisites**

Competences in engineering mechanics, in particular kinematics and vibrations theory, thermodynamics, and strength of materials that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-13 01 03 Fundamentals of Kinematics and Kinetics

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus, Functional Theory, Partial Differential Equation)

Basic knowledge in control and automation engineering as well as in a line-oriented programming language (C, Matlab etc.) that can be acquired in modules such as MT-12 01 23 Micro Computer Engineering/Embedded Controller MT-12 01 02 Automation Engineering and Measurement and Control Engineering

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment is a written exam (90 min.).

**ECTS credit points and grades**

7 ECTS credit points
The module grade is the grade for the exam.

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
### Contents and objectives

Railway Vehicle Engineering is an area of specialization of mechanical engineering that deals with the design, construction and manufacturing as well as the maintenance of rail-guided vehicles. The railway vehicle is modularly designed, the modules are connected to one another by means of defined interfaces. For the control of the vehicle or train for railway operations, a variety of control algorithms is necessary.

The students

1. understand the system structure of a railway vehicle
2. are familiar with the structure and function of the electric vehicle drive and its main components
3. understand the interactions of electric vehicles with the power supply systems
4. are familiar with the control engineering of the sub-systems and the overall system
5. are able to design and calculate sub-systems
6. are able to model railway vehicles as a complete system using simulation technology.

### Prerequisites

Competences in engineering mechanics, in particular kinematics and vibrations theory, thermodynamics, and strength of materials that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-13 01 03 Fundamentals of Kinematics and Kinetics

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus, Functional Theory, Partial Differential Equation)

Competences in electrical engineering, electrical machines, and energy supply systems that can be acquired in modules such as MT-12 08 01 Fundamentals of Electrical Engineering

Basic knowledge in control and automation engineering as well as in a line-oriented programming language (C, Matlab etc.) that can be acquired in modules such as MT-12 01 23 Micro Computer Engineering/Embedded Controller MT-12 01 02 Automation Engineering and Measurement and Control Engineering

### Usability

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment is a written exam (90 min.).
| **ECTS credit points and grades** | 7 ECTS credit points  
The module grade is the grade for the exam. |
<p>| <strong>Frequency</strong> | Annually, in the winter semester |
| <strong>Workload</strong> | 210 hours |
| <strong>Duration</strong> | 1 semester |</p>
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A03-G</td>
<td>Combustion Engines, Basics (Verbrennungsmotoren Grundlagen)</td>
<td>Prof. Dr.-Ing. H. Zellbeck</td>
</tr>
</tbody>
</table>

**Contents and objectives**

The module conveys basic knowledge of the combustion engine and the main components of the vehicle electronics. The area “Fundamentals of combustion engines” deals with the topics: design and operation of a combustion engine as well as physical and thermodynamic processes, pollutant formation and prevention, control.

The area “Car electronics” includes the technical and scientific description of all major electrical and electronic vehicle system components and the methodical presentation of associated development processes. The focus is on the following topics: vehicle electrical system, generator, battery systems, electronic systems in the drive train, safety and comfort electronics as well as communication systems.

Having completed this module, the students are able to evaluate the system performance of combustion engines with the associated electronic control systems in vehicles and to optimize these.

**Modes of teaching and learning**

4 SWS lecture, 1 SWS lab course, and self-study

**Prerequisites**

Competences in thermodynamics, fluid mechanics and electrical engineering that can be acquired in basic modules on physics and in modules such as MT-12 08 01 Fundamentals of Electrical Engineering

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A03-V Combustion Engines, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 90 min.) on combustion engines
2. a written exam (K2, 120 min.) on vehicle electronics
3. lab courses (including tests and lab course reports)

**ECTS credit points and grades**

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = 0.5 * K1 + 0.5 * K2 \]

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
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</thead>
<tbody>
<tr>
<td>MT-A03-V</td>
<td>Combustion Engines, Advanced (Verbrennungsmotoren Vertiefung)</td>
<td>Prof. Dr.-Ing. H. Zellbeck</td>
</tr>
</tbody>
</table>

**Contents and objectives**

This module conveys the thermodynamic calculation methods for the simulation of combustion engines and their components (such as line system, exhaust turbocharger). Having completed this module, the students are able to calculate step by step a complete cyclic process of a combustion engine incl. charge changing and have a deeper understanding of the complex system behaviour of combustion engines.

The module is supplemented by a lab course, during which the student can apply the theoretical knowledge and becomes acquainted with methods for the analysis and solution of engineering problems. The focus is on: setup of test facilities and measuring technique, thermodynamic and emission analysis of a combustion engine.

Another focus of this module is the course dynamics of the reciprocating engine with associated compensation measures, equations of motion for the characterization of toroidal chains, calculation methods for their natural frequencies and mode shapes.

**Modes of teaching and learning**

3 SWS lecture, 2 SWS tutorial, 1 SWS lab course, and self-study

**Prerequisites**

Competences in thermodynamics, fluid mechanics and electrical engineering that can be acquired in basic modules on physics and in modules such as MT-12 08 01 Fundamentals of Electrical Engineering and MT-A03-G Combustion Engines, Basics

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of

1. a written exam (K1, 90 min.)
2. a written exam (K2, 90 min.)
3. a written exam (K3, 120 min.)
4. lab courses (including tests and lab course reports)

**ECTS credit points and grades**

7 ECTS credit points

The module grade M is calculated as follows:

\[ M = 0,5 \times K1 + 0,2 \times K2 + 0,3 \times K3 \]

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A04-G</td>
<td>Motion Control, Basics <em>(Bewegungssteuerung Grundlagen)</em></td>
<td>PD Dr.-Ing. habil. V. Müller</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Motion controls determine the current possibilities and future developments in production, processing and transportation technology. Based on the components of the drive system, interactions in the mechatronic system that can be achieved by means of motion control of an axis and by chaining multiple axes by means of communication structures are dealt with.

Having completed the module, the students are familiar with the methodological fundamentals for the design of motion control, especially with:

1. the elements of the drive system: energy and information technology components as well as system integration of drives with complex mechanics
2. the converter supply of three-phase-drives and their control methods, interaction of actuator and motor
3. the design of quasi-continuous and discontinuous controllers for the application in motion control of electric drives.

**Modes of teaching and learning**

4 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Competences in Electrical Engineering/Energy that can be acquired in modules such as MT-12 08 25 Measurement and Sensor Techniques/Actuators, MT-12 04 01 Electrical Power Engineering, MT-12 02 22 Power Electronics

Competences in control engineering that can be acquired in modules such as MT-12 01 02 Automation Engineering and Measurement

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A04-G Motion Control, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam (150 min.) on the objectives 2 and 3.

**ECTS credit points and grades**

7 ECTS credit points

The module grade is the grade for the exam.

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
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<tbody>
<tr>
<td>MT-A04-V</td>
<td>Motion Control, Advanced <em>(Bewegungssteuerung Vertiefung)</em></td>
<td>PD Dr.-Ing. habil. V. Müller</td>
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</tbody>
</table>

### Contents and objectives

Motion controls determine the current possibilities and future developments in production, processing and transportation technology. Based on the components of the drive system, interactions in the mechatronic system that can be achieved by means of motion control of an axis and by chaining multiple axes by means of communication structures are dealt with.

The students

1. know the current state of the drive technology to solve problems of motion control and possess skills and knowledge for the analysis and design of electric drive systems.
2. are able to solve design and analysis tasks on test stands and by means of simulation tools.

### Modes of teaching and learning

2 SWS lecture, 1 SWS tutorial, 1 SWS lab course, and self-study

### Prerequisites

Competences in electric drive technology that can be acquired in modules such as MT-A04-G Motion Control, Basics

Competences in control engineering that can be acquired in modules such as MT-12 01 02 Automation Engineering and Measurement and Control Engineering

### Usability

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of

1. a written exam (K1, 90 min.) on objective 1
2. lab course (PL2) on objective 2. The grade for the lab course is the arithmetic mean of the individual lab sessions. Every lab session must be passed.

### ECTS credit points and grades

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{4\cdot K1 + 3\cdot PL2}{7} \]

### Frequency

Annually, in the winter semester

### Workload

210 hours

### Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A05-G</td>
<td>Aerospace Engineering, Basics (Luft- und Raumfahrttechnik Grundlagen)</td>
<td>Prof. Dr.-Ing. K. Wolf</td>
</tr>
</tbody>
</table>

**Contents and objectives**

This module conveys topics from different fields of aerospace that are fundamental for the understanding of the technology applied in aircraft and spacecraft. Theoretical, practical and system-oriented aspects are being considered; e.g. fibre composite construction of aircraft and spacecraft and attitude control systems for spacecraft.

In general, the objective of this module is to convey the fundamentals of representative areas of aerospace. As a result, the students will be able to understand basic technical interrelationships. Having acquired this knowledge, the students can attend advanced modules that deal with this topic in more detail.

Having attended this module, the students are able to:

1) to understand the difference of mechanical behaviour between anisotropic and classical structural materials and to apply methods and design criteria for the construction of aerospace structures using fibre composite materials.
2) to master the basic technical principles and system concepts for attitude control of spacecraft and to model, analyse, and interpret corresponding systems.

**Modes of teaching and learning**

3 SWS lecture, 3 SWS tutorial, and self-study

**Prerequisites**

Competences in engineering mechanics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-13 01 03 Fundamentals of Kinematics and Kinetics.

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus)

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A05-G Aerospace Engineering, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 120 min.) on objective 1
2. a written exam (K2, max. 120 min.) on objective 2.

**ECTS credit points and grades**

7 ECTS credit points

The module grade is determined by the weighted average of the grades for both elements of assessment. The module grade consists to 2/3 of the grade for K1 and to 1/3 of the grade for K2.

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A05-V</td>
<td>Aerospace Engineering, Advanced (Luft- und Raumfahrttechnik Vertiefung)</td>
<td>Prof. Dr.-Ing. K. Wolf</td>
</tr>
</tbody>
</table>

**Contents and objectives**

This module conveys in-depth content from various disciplines that are required for the interpretation of both aircraft and spacecraft vehicles. Theoretical, practical and system-oriented aspects are being considered; e.g. aircraft engineering and energy systems for spacecraft. To deepen the theoretical knowledge, the students are required to conduct and evaluate system-oriented analyses and design calculations.

The general objective of this module is to convey and deepen specific knowledge that is necessary to undertake well-founded scientific engineering work in this area and to be able working in science and industry.

In particular, having completed this module, the students are able

1. to understand the design of aircrafts, the technology applied and the process of development, to apply the methods necessary for the design as well as to analyse system configurations in terms of performance and profitability

and

2. to evaluate the autonomous and mobile energy conversion methods applied in spacecraft, to discuss requirements and to define development stages to a complete system.

**Modes of teaching and learning**

4 SWS lecture, 1 SWS tutorial, and self-study

**Prerequisites**

- Competences in engineering mechanics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-13 01 03 Fundamentals of Kinematics and Kinetics
- Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus)
- Competences in Aerospace Engineering that can be acquired in modules such as MT-A05-G Aerospace Engineering, Basics

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of two written exams (90 min. each, K1 on objective 1, K2 on objective 2).

**ECTS credit points and grades**

7 ECTS credit points

The module grade is determined by the weighted average of the grades for both elements of assessment. The module grade consists to 2/5 of the grade for K1 and to 3/5 of the grade for K2.

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A06-G</td>
<td>Mobile Work Machines, Basics (Mobile Arbeitsmaschinen, Grundlagen)</td>
<td>Prof. Dr.-Ing. habil. T. Herlitzius</td>
</tr>
</tbody>
</table>

**Contents and objectives**

For the computational dimensioning and structural design of hoist, construction and agricultural machinery, basic knowledge and skills in the area of structural design of typical assemblies, such as engines, structures, steering systems, tools, are required as well as knowledge of relevant variables in the working process of machines.

Learning objectives:

The students

1. have acquired methodical knowledge of function, design and dimensioning of actuators and steering of mobile work and utility vehicles and are able to analyse and design different drive concepts of off-road vehicles.

2. know the process features that are important for the dimensioning, have the ability necessary for the engineering design of assembly groups and tools (e.g. tillage tools, threshing and chippers, grave tools)

3. are able to apply the knowledge described in 1. and 2. to complex machinery (tractors, combines, loaders) and therefore have applicable knowledge for the dimensioning and construction of mobile work machines.

**Modes of teaching and learning**

4 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**

Competences in engineering mechanics and drive technology that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics and MT-12 08 25 Measurement and Sensor Techniques/Actuators

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A06-G Mobile Production Machines, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of

1. a written exam (K1, 90 min.) on objective 1
2. a written exam (K2, 90 min.) on objective 2 and 3.

**ECTS credit points and grades**

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \left( \frac{2 \times K1 + 1 \times K2}{3} \right) \]

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A06-V</td>
<td>Mobile Work Machines, Advanced (Mobile Arbeitsmaschinen, Vertiefung)</td>
<td>Prof. Dr.-Ing. habil. G. Kunze</td>
</tr>
</tbody>
</table>

**Contents and objectives**

During the lectures, the students acquire the ability to apply various modelling methods using examples of modelling and simulation of elements, assembly groups and working processes of mobile work machines. During tutorials, the students learn with selected simulation environments how to use computational tools. During the lab course, physical variables and technical parameters on hoist, construction and agricultural machinery are measured and evaluated with conclusions for machinery design.

Objectives:

1. The students are able to set up model approaches for the description of various technical problems
2. The students are familiar with different simulation processes and associated tools
3. The students are able to program simple simulations, to perform simulations and to prepare and interpret results
4. The students have practical knowledge, experience and skills in the use of measuring instruments for specialized tasks.

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, 2 SWS lab course, and self-study

**Prerequisites**

Competences in engineering mechanics, drive technology as well as measurement and sensor technique that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics, MT-12 08 25 Measurement and Sensor Techniques/Actuators and MT-A06-G Mobile Production Machines, Basics

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of

1. a written exam (K1, 90 min.) on objectives 1–3
2. a lab course (PL2) on objective 4. The grade for the lab course is the arithmetic mean of the individual lab sessions. Every lab session must be passed.

**ECTS credit points and grades**

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{2*K1 + 1*K2}{3} \]

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
</table>
| MT-A07-G      | Motion Controlled Machine Systems, Basics  
(Bewegungsgeführte Maschinensysteme Grundlagen) | Prof. Dr.-Ing. habil. K. Großmann |

**Contents and objectives**
The students are familiar with the characteristic functions, requirements and technical solutions regarding motion controlled machine systems of production engineering for the realization of deforming and chipping processes of machining as well as tool and workpiece handling processes. They recognize the mechatronic system character and the development potential based thereon. They are familiar with the main assembly groups of the drive, control and mounting systems of machine tools and their typical sub-functions as well as the interaction of mechanical, electrical and information-processing components. They master the specification, selection and dimensioning of the main assembly groups and are able to determine and evaluate the functionally relevant system behaviour.

**Modes of teaching and learning**
3 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**
Competences in physics and higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus, Functional Theory, Partial Differential Equation, Probability Theory)

**Usability**
This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A07-G Motion Controlled Machine Systems, Advanced.

**Requirements for the award of ECTS credit points**
The credit points are awarded if the module assessment is passed. The module assessment is a written exam (120 min.).

**ECTS credit points and grades**
7 ECTS credit points  
The module grade is the grade for the written exam.

**Frequency**
Annually, in the summer semester

**Workload**
210 hours

**Duration**
1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A07-V</td>
<td>Motion Controlled Machine Systems, Advanced</td>
<td>Prof. Dr.-Ing. habil. K. Großmann</td>
</tr>
<tr>
<td></td>
<td><em>(Bewegungsgeführte Maschinensysteme Vertiefung)</em></td>
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</tr>
</tbody>
</table>

**Contents and objectives**

The students have basic knowledge, methodological and practical skills regarding causes and effects, model description and calculation as well as target-oriented influencing and correction of the behaviour influencing the productivity and accuracy of manufacturing systems, in particular to evaluate the geometric-kinematic, static, thermal and dynamic properties. They have practical experience of the holistic and integrated approach of mechatronic applications on machine tools, such as

- position-controlled electromechanical traverse drive system
- piezoelectric fine adjustment system
- active magnetic bearing machine tool main spindles and
- parallel kinematic motion systems (Hexapod), especially in terms of modelling (lumped elements, beam elements, FEM), calculation (linear structural analysis, digital simulation) and experimental study of the functionally relevant behavioural influences (static, thermal, dynamic).

**Modes of teaching and learning**

2 SWS lecture, 1 SWS tutorial, 2 SWS lab course, and self-study

**Prerequisites**

Competences acquired in modules such as MT-A07-G Motion Controlled Machine Systems, Basics

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam (K, 150 min.) and a lab course (P).

**ECTS credit points and grades**

7 ECTS credit points
The module grade is calculated as follows:

\[ M = 0.7 \times K + 0.3 \times P \]

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
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</thead>
<tbody>
<tr>
<td>MT-A08-G</td>
<td>Robotics, Basics (Robotik Grundlagen)</td>
<td>Prof. Dr.-Ing. M. Beitelschmidt</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Robots as mechatronic systems par excellence play an important role in automation. They can unburden humans of unacceptable work especially in production as well as perform tasks in inaccessible places. This module introduces the students to the field of mechanics, especially kinematics and control; this knowledge is necessary for the design of robots.

Having completed this module, the students:

1. master the methodology of calculating forward kinematics and inverse kinematics of typical robot configurations
2. know the fundamentals of dynamics of robots
3. are familiar with the methodology and application for the control of robots.

**Modes of teaching and learning**

5 SWS lecture, 1 SWS tutorial, and self-study

**Prerequisites**

Competences in engineering mechanics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics, MT-13 01 03 Fundamentals of Kinematics and Kinetics and MT-13 01 02 Numerical Methods/System Dynamics

Competences in physics and higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus, Functional Theory, Partial Differential Equation, Probability Theory)

Basic knowledge in control engineering as well as in line-oriented programming language (C, Matlab etc.) that can be acquired in basic modules on computer science and in modules such as MT-12 01 23 Micro Computer Engineering/Embedded Controller

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A08-G Robotics, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. If 20 students or less take part in the module, the module assessment consists of:

1. an oral exam (PL1, 30 min.) on objective 1 and 2

If more than 20 students take part in the module, the oral exam is replaced by a written exam (150 min.).

2. a written exam (K2, 90 min.) on objective 3

**ECTS credit points and grades**

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{5 \times PL1 + 2 \times K2}{7} \]

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
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<tr>
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<td>MT-A08-V</td>
<td>Robotics, Advanced (Robotik Vertiefung)</td>
<td>Prof. Dr.-Ing. M. Beitelschmidt</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Robots as mechatronic systems par excellence play an important role in automation. They can unburden humans of unacceptable work especially in production as well as perform tasks in inaccessible places. This module introduces the students to these applications.

Having completed this module, the students

1. are familiar with the application of robots in the area of laser manufacturing engineering
2. know how to program robots for production tasks, especially for laser applications
3. are familiar with the fundamentals of autonomous robotics.

**Modes of teaching and learning**

3 SWS lecture, 2 SWS tutorial, 2 SWS lab course, and self-study

**Prerequisites**

Competences in engineering mechanics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics, MT-13 01 03 Fundamentals of Kinematics and Kinetics and MT-13 01 02 Numerical Methods/System Dynamics

Competences in higher mathematics (Principles of Algebra and Analysis, Multivariable Calculus, Functional Theory, Partial Differential Equation, Probability Theory)

Competences in robotics that can be acquired in modules such as MT-A08-G, Robotics, Basics

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 120 min.) on objective 1 and 2
2. a written exam (K2, 90 min.) on objective 3

**ECTS credit points and grades**

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{4*K1 + 3*K2}{7} \]

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A09-G</td>
<td>Specific Production Methods, Basics <em>(Spezielle Fertigungsverfahren Grundlagen)</em></td>
<td>Prof. Dr.-Ing. habil. E. Beyer</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Special manufacturing methods based on laser energy or plasma technology, which - although established - do not belong to the classical processes of mechanical or electrical engineering and interdisciplinary areas yet, play an increasingly important role in the production and application of coatings, tools and plants.

Having completed this module, the students:

1. are familiar with the structure and function of the main laser and plasma sources as well as the scientific and technological fundamentals of laser and plasma processes
2. are able to choose and implement suitable technology using mechatronic design principles in accordance with an identified profile of requirements.

**Modes of teaching and learning**

3 SWS lecture, 1 SWS lab course (optional), 1 SWS tutorial, and self-study

**Prerequisites**

Competences in physics and manufacturing engineering that can be acquired in basic modules on physics and in modules such as MT-13 12 01 Construction and Manufacturing Engineering

**Usability**

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A09-V Specific Production Methods, Advanced.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 90 min.) on objective 1
2. a written exam (K2, 90 min.) on objective 2

**ECTS credit points and grades**

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{4 \times K1 + 3 \times K2}{7} \]

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
### Module number

<table>
<thead>
<tr>
<th>MT-A09-V</th>
</tr>
</thead>
</table>

### Module name

| Specific Production Methods, Advanced (Spezielle Fertigungsmethoden Vertiefung) |

### Lecturer in charge

| Prof. Dr.-Ing. habil. E. Beyer |

### Contents and objectives

Special manufacturing methods, such as nanotechnology that is currently widely acclaimed and in the focus of research or the group of rapid prototyping methods that have been established for a long time in niches (designation according to the current standard: "generative manufacturing technology"), are part of the knowledge of well-trained future engineers.

Having completed this module, students

1. understand the materials science and technological fundamentals, requirements and characterization of nanotechnology and know its potential for a variety of fields of application.

2. know the possibilities of rapid product development and survey the width of processes of rapid prototyping processes / generative manufacturing technology.

3. are able to prepare components with commercial programs for the production by means of generative manufacturing technology as well as to set up and characterize these by means of appropriate processes.

4. have hands-on experience with various special production methods.

### Modes of teaching and learning

| 3 SWS lecture, 3 SWS lab course, and self-study |

### Prerequisites

Competences in physics

Competences that can be acquired in modules such as MT-A09-G Specific Production Methods, Basics

### Usability

This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. written exams (K1 and K2, 90 min. each) on objective 1 and 2
2. graded lab course reports (PL3, objective 3)
3. participation in the lab course (several sessions, objective 4)

### ECTS credit points and grades

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{3*K1 + 3*K2 + 1*PL3}{7} \]

The lab course must be passed.

### Frequency

Annually, in the winter semester

### Workload

210 hours

### Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A10-G</td>
<td>Electronic Systems and Technology, Basics <em>(Gerätetechnik Grundlagen)</em></td>
<td>Prof. Dr.-Ing. habil. J. Lienig</td>
</tr>
</tbody>
</table>

**Contents and objectives**

This module covers

1. **Finite Element Method (FEM) (Finite Elemente Methode, FEM)**
   - Fundamental theory of FEM for application in varying physical domains
   - Basic process steps for the creation of theoretical substantiated FEM models
   - Parametrization of FEM models based on script languages

2. **Optimization (Optimierung)**
   - Method of model creation and simulation, considering the holistic system-simulation approach for system design
   - Model experiments for the construction process (nominal value optimization, probabilistic optimization)
   - Solution finding as multi-objective optimization while accounting for tolerance cost

**Intended learning outcomes:**

Students completing this module will obtain qualified fundamentals for systematic application of FEM tools. They understand the key concept of holistic system simulation for the design process. They are capable of finding robust and cost-effective solutions in system-design processes by applying system simulations while accounting for ubiquitous parameter variations and functional behaviour.

**Modes of teaching and learning**

2 SWS lectures, 4 SWS tutorial, and self-study

**Prerequisites**

Some specific expertise is required, which can for example be acquired by completing the module MT-12 05 01 Electronic Systems Design.

**Usability**

This module is an elective module within the group “applications” for the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are obtained by passing the module assessment. This assessment consists of individual tutorial assignments.

**ECTS credit points and grades**

7 ECTS credit point
The module grade is determined by the grade obtained for the tutorial assignments.

**Frequency**

Annually, during summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-A10-V</td>
<td>Electronic Systems and Technology, Advanced (Gerätetechnik Vertiefung)</td>
<td>PD Dr.-Ing. T. Nagel</td>
</tr>
</tbody>
</table>

### Contents and objectives

This module covers

1. **Methodologies for Electromechanical Design (Präzisionsgerätetechnik)**
   - Method of development
   - Construction guidelines and principles derived from technology and nature
   - Constructive guidelines for system design (design considerations for functionality, stability, assembly, noise and recycling)
   - Failure mode and effect analysis (FMEA) for system design
   - Tolerance chains and stochastic tolerance determination
   - Accuracy parameters for drive systems
   - Examples on development of precise-mechanics devices

2. **Actuators for System Design (Aktorik für die Gerätetechnik)**
   - Composition of drive systems
   - Properties of different small-drive systems and actuators
   - Servomotors for system design
   - Innovative actuators

**Intended learning outcomes:**

Students completing this module will obtain qualified knowledge to develop and design modern precise-mechanics devices under consideration of general construction guidelines, design guidelines and failure-detection principles. They are furthermore familiar with relevant principles of actuators and their constructive mechanic. In combination with the knowledge of specific actuator properties, the students can chose actuators appropriately for different applications and requirements.

### Modes of teaching and learning

4 SWS lectures, 2 SWS tutorial, and self-study

### Prerequisites

Some specific expertise is required, which can for example be acquired by completing the module MT-12 05 01 Electronic Systems Design.

### Usability

This module is an elective module within the group “applications” for the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are obtained by passing the module assessment. This assessment comprises a written exam of 180 minutes and tutorial assignments. Both elements of assessment must be passed.

### ECTS credit points and grades

7 ECTS credit points

The module grade consists to ¾ of the grade for the written exam and to ¼ of the grade for the tutorial assignments.

### Frequency

Annually, during winter semester

### Workload

210 hours

### Duration

1 semester
### Module number | Module name | Lecturer in charge
---|---|---

**Contents and objectives**

With the help of the network theory, simple mechanical, magnetic, fluidic (acoustic) and coupled systems can be described in terms of a common circuitry representation of the different subsystems including their interactions. The advantages of this design method are the use of the clear and concrete methods of analysis of electrical networks, the better physical understanding, the possibility of the closed design of physically different subsystems and the application of existing circuit simulation software, such as pSpice. Complex problems of the design accompanying optimisation of the dynamic behaviour of electromechanical systems can be solved by the combination of network simulation of electromechanical systems using the method of finite element modelling.

Having completed this module, the students

1. have fundamental methodological and practical knowledge of the effective design and the illustrative analysis of the dynamic behaviour of electro-mechanical, magnetic and fluidic systems as well as of the function and modelling of electromechanical transducers
2. are familiar with the parameter determination using FEM methods and master the methodology of combining processes by means of virtual interface components.

**Modes of teaching and learning**

3 SWS lecture, 3 SWS tutorial, and self-study

**Prerequisites**

Competences in physics that can be acquired in basic modules on physics

Competences in mechanics that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics

**Usability**

This module is an elective module within the group “applications” for the Diplom programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are obtained by passing the module assessment. This assessment is a written exam (120 min.).

**ECTS credit points and grades**

7 ECTS credit points

The module grade is the grade for the written exam.

**Frequency**

Annually, in the summer semester

**Workload**

210 hours

**Duration**

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
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<th>Lecturer in charge</th>
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<tbody>
<tr>
<td></td>
<td><em>Mikro-Elektro-Mechanische Systeme Vertiefung</em></td>
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</tbody>
</table>

### Contents and objectives

Microsystems technology is an established technique for the development of complex, miniaturized systems, which consist of micro-sensors, micro-actuators and electronic components for signal processing and signal transmission. Micro systems are used in automotive industry, medical engineering and many other fields of application. The tight coupling between materials technology, micro technology and systems engineering is characteristic.

Having completed this modules, the students:

1. master the physical fundamentals for the understanding of material properties and the interaction between them
2. know the material groups that are most important for microsystems technology and understand how they work
3. know the most important individual technological processes and micro technologies for the production of microsystems
4. know the operating principle of important micro-mechanical micro-sensors and micro actuators,
5. master various processes for the development of energy supply solutions for self-sufficient microsystems.

### Modes of teaching and learning

4 SWS lecture, 2 SWS lab course, and self-study

### Prerequisites

- Competences in physics that can be acquired in basic modules on physics
- Competences in the area of materials that can be acquired in modules such as MT-13 00 01 Materials and Engineering Mechanics

### Usability

This module is an elective module within the group “applications” for the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 90 min.)
2. a written exam (K2, 90 min.)
3. a lab course (P)

### ECTS credit points and grades

7 ECTS credit points

The module grade is calculated as follows:

\[ M = \frac{35\times K1 + 35\times K2 + 30\times P}{100} \]

### Frequency

Annually, starting in the winter semester

### Workload

210 hours

### Duration

2 semesters
### Module number | Module name | Lecturer in charge
--- | --- | ---
MT-A12-G | Biomedical Engineering, Basics *(Biomedizintechnik Grundlagen)* | Prof. Dr.-Ing. H. Malberg

### Contents and objectives

**Content:**
- Requirements on equipment for medical application
- Structure and function of the organ systems cardiovascular system, ventilation system and urine-producing system
- Devices and methods of medical treatment processes

Having completed this module, the students have an overview of the structure and function of the human body, so that they are able to integrate technical devices to support medical treatment. Further, they understand medical assistance systems as mechatronic systems and have gained basic knowledge of selected equipment technology for the therapy or replacement of organ systems.

### Modes of teaching and learning

5 SWS lecture, 1 SWS tutorial, and self-study

### Prerequisites

- Competences that can be acquired in basic modules on physics
- Competences that can be acquired in modules such as MT-12 08 01 Fundamentals of Electrical Engineering and MT-12 05 01 Electronic Systems Design

### Usability

This module is an elective module of the group “applications” within the *Diplom* programme in Mechatronics. It lays the foundation for the module MT-A12-V Biomedical Engineering, Advanced.

### Requirements for the award of ECTS credit points

The credit points are awarded if the module assessment is passed. The module assessment is an oral exam (30 min.).

### ECTS credit points and grades

7 ECTS credit points

The module grade is the grade for the oral exam.

### Frequency

Annually, in the summer semester

### Workload

210 hours

### Duration

1 semester
<table>
<thead>
<tr>
<th>Module number</th>
<th>Module name</th>
<th>Lecturer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-A12-V</td>
<td>Biomedical Engineering, Advanced <em>(Biomedizintechnik Vertiefung)</em></td>
<td>Prof. Dr.-Ing. H. Malberg</td>
</tr>
</tbody>
</table>

**Contents and objectives**

Content:
- Range of tasks of biomedical engineering and related product groups
- Electrophysiology of biological arousal
- Electrical diagnosis of nerve and skeletal muscle
- DC and low voltage electrotherapy
- RF electrotherapy
- Surgery robots

Having completed this module, the students
1. are familiar with the basic laws of biological arousal and are able to derive electrodiagnostic / electrotherapeutic processes and to apply technical equipment accordingly
2. are familiar with fundamentals and device-related approaches for the robot-assisted surgery and are able to design new systems
3. are able to support the use of technical equipment in hospitals (operation and parameter selection).

**Modes of teaching and learning**

2 SWS lecture, 2 SWS tutorial, 2 SWS lab course, and self-study

**Prerequisites**

Competences that can be acquired in modules such as MT-A12-G Biomedical Engineering

**Usability**

This module is an elective module of the group “applications” within the *Diplom* programme in Mechatronics.

**Requirements for the award of ECTS credit points**

The credit points are awarded if the module assessment is passed. The module assessment consists of:
1. a written exam (K1, 120 min.) on the objectives 1 and 2
2. three lab course reports (written, PL2, objective 3)

**ECTS credit points and grades**

7 ECTS credit points

The module grade is calculated as follows:

\[ M = 0.7 \times K1 + 0.3 \times PL2 \]

**Frequency**

Annually, in the winter semester

**Workload**

210 hours

**Duration**

1 semester
<table>
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<th>Lecturer in charge</th>
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<tbody>
<tr>
<td>MT-A13-G</td>
<td>Sensors and Measuring Systems, Basics <em>(Sensoren und Messsysteme Grundlagen)</em></td>
<td>Prof. Dr.-Ing. habil. J. Czarske</td>
</tr>
</tbody>
</table>

**Contents and objectives**
The students are familiar with the fundamental principles as well as master the practical implementation of sensors and measuring systems. They

1. master the fundamental principles of measurement systems technology. They are familiar with process measurement technology as well as signal and image processing. They are able to apply the learned methods for industrial measurement systems, especially in automation engineering.

2. are able to assess the properties of real sensors (3S: sensitivity, selectivity, stability). They are familiar with sensors for thermal values and for the measurement of mechanical values in particular.

3. are able to describe mechatronic laser measurement systems and to apply these in manufacturing, surface engineering, process control and medical engineering. These include, e.g. interferometric and confocal measurement principles.

**Modes of teaching and learning**
4 SWS lecture, 2 SWS tutorial, and self-study

**Prerequisites**
Competences in physics
Competences that can be acquired in modules such as MT-12 09 01 Systems Theory, MT-12 01 02 Automation Engineering and Measurement and MT-12 08 25 Measurement and Sensor Techniques/Actuators

**Usability**
This module is an elective module of the group “applications” within the Diplom programme in Mechatronics. It lays the foundation for the module MT-A13-V Sensors and Measuring Systems, Advanced.

**Requirements for the award of ECTS credit points**
The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. a written exam (K1, 90 min.) on objective 1
2. an oral exam (PL2, 25 min.) on objective 2
3. an oral exam (PL3, 25 min.) on objective 3

**ECTS credit points and grades**
7 ECTS credit points
The module grade is calculated as follows:

\[ M = 0.4 \times K1 + 0.3 \times PL2 + 0.3 \times PL3 \]

**Frequency**
Annually, starting in the summer semester

**Workload**
210 hours

**Duration**
2 semesters
<table>
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<tr>
<td>MT-A13-V</td>
<td>Sensors and Measuring Systems, Advanced <em>(Sensoren und Messsysteme Vertiefung)</em></td>
<td>Prof. Dr.-Ing. habil. J. Czarske</td>
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</table>

### Contents and objectives
The students are familiar with the principles as well as master the practical implementation of sensors and measuring systems, especially for process, manufacturing, medical and fluid engineering. They

1. are familiar with the fundamental principles of laser sensors for the study of fluid flows. These include, e.g. camera based measurement methods, multi-dimensional velocity measurement methods (e.g. by means of an electronic Doppler frequency measurement) and measurement methods for particles.

2. are be able to apply sensors on the basis of different physical effects for applications, such as humidity, pressure and temperature measurement.

3. are able to conduct optical measurement methods under real conditions (disturbances, parameter variations, etc.). During the project, they learn to set up process measurement techniques and to characterize their measurement properties such as the temporal and spatial resolution and measurement uncertainty.

### Modes of teaching and learning
2 SWS lecture, 3 SWS lab course, and self-study

### Prerequisites
Competences in physics
Competences that can be acquired in modules such as MT-12 09 01 Systems Theory, MT-12 01 02 Automation Engineering and Measurement, MT-12 08 25 Measurement and Sensor Techniques/Actuators and MT-A13-G Sensors and Measuring Systems, Basics

### Usability
This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

### Requirements for the award of ECTS credit points
The credit points are awarded if the module assessment is passed. The module assessment consists of:

1. an oral exam (PL1, 25 min.) on objective 1
2. a lab course (P2, objective 2)
3. a project (P3, objective 3)

### ECTS credit points and grades
7 ECTS credit points
The module grade is calculated as follows:

\[ M = 0.4 \times PL1 + 0.2 \times P2 + 0.4 \times P3 \]

### Frequency
Annually, in the winter semester

### Workload
210 hours

### Duration
1 semester
Module number | Module name | Lecturer in charge
--- | --- | ---
MT-A14-G | Electrified Mobility (Elektrifizierte Mobilität) | Prof. Dr.-Ing. B. Bäker

Contents and objectives
Content of the module: acquisition of knowledge in the area of energy management and operating strategies in mobile and stationary systems. The main focus is on:
- Fundamentals of an overall electrical energy management as a combination of mobile and stationary power generation and storage
- Methods and processes of an associated energy management
- Characterization, testing and diagnostics of electrical storage systems based on impedance spectroscopy
- Design of predictive operating strategies and online optimization (modelling, simulation of operating strategies)

Further, the students acquire knowledge in the area of diagnostics of mechatronic vehicle systems. The main focus is on:
- Fundamentals of technical diagnostics
- Methods of on and offboard diagnostics
- Standards and protocols
- Diagnostics of novel battery systems

Having completed this module, the student is able to develop, evaluate and optimize energy management systems and operating strategies. Further, the student is able to develop diagnostic capable electrical and mechatronic vehicle systems.

Modes of teaching and learning
3 SWS lecture, 2 SWS lab course, and self-study

Prerequisites
Competences that can be acquired in modules such as MT-12 08 25 Measurement and Sensor Techniques/Actuators, MT-12 01 23 Micro Computer Engineering/Embedded Controller and MT-12 08 01 Fundamentals of Electrical Engineering

Usability
This module is an elective module of the group “applications” within the Diplom programme in Mechatronics.

Requirements for the award of ECTS credit points
The credit points are awarded if the module assessment is passed. The module assessment consists of:
1. two written exams (K1 and K2, 90 min. each)
3. several lab sessions (including a test and a lab course report). All the lab sessions must be passed.

ECTS credit points and grades
7 ECTS credit points
The module grade is calculated as follows:
\[ M = \frac{1}{2} \times K1 + \frac{1}{2} \times K2 \]

Frequency
Annually, in the winter semester

Workload
210 hours

Duration
1 semester