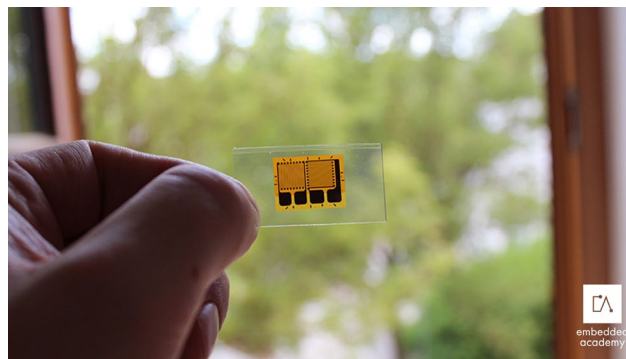


# E-Learning for Measurement Technology Engineer with Focus Strain Gauges

July 2024

The combination of courses is perfect for getting into measurement technology using strain gauges for vibration measurement



## Courses within the e-learning package

The "**Measurement Technology Engineer with Focus Strain Gauges**" e-learning package is a comprehensive program that equips learners with essential knowledge and skills in the field of electronics and electrical engineering, noise, vibration, and harshness as well as measurement technology using strain gauges. This package covers a wide range of topics to provide a well-rounded understanding of the subject.

You can acquire the knowhow by a set of technical e-learning courses which we structured into 2 parts:

1. Electronics and electrical engineering
  - a. electronics and electrical fundamentals,
  - b. bridge circuits
  - c. electrical machines,
  - d. control of electrical machines
2. Technology Know-how containing
  - a. noise, vibration, and harshness NVH,
  - b. measurement technology using strain gauges.

## 1. Electronics, electrical engineering

This second part is dedicated to electronics and electrical engineering and technology know-how which is the knowledge foundation for e-mobility.



Electronics  
and Electrical  
Fundamentals



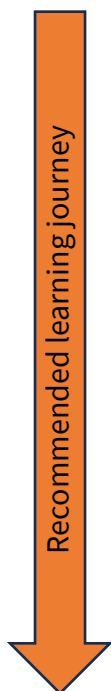
Bridge Circuits



Electrical  
Machines



Control of  
Electrical  
Machines



**Electronics and electrical fundamentals** encompassing topics like electronics and magnetism, circuitry, alternating current circuits, and the basics of power electronics.

**Bridge Circuits** begins with a basic introduction, followed by a detailed discussion of the Wheatstone bridge, including its various configurations and specific application for measuring resistance changes. It also explains how to correctly integrate bridge circuits into a measurement system and how to interpret the resulting data. The final part of the course discusses applications of bridge circuits in power electronics and power engineering.

The course on **electrical machines** is starting with the general basics and then is going into details for different machine types. Those are permanent magnet synchronous machines, synchronous machines, induction machines, DC and brushless DC machines.

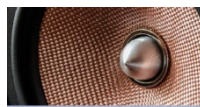
**Control of electrical machines** is bringing together power electronics, electrical machines, and embedded software. You will learn about field-oriented control as well as control design.

## 2. Technology Know-how

The technology part is providing information on strain gauges, how to measure strain and detailed know-how on noise, vibration, and harshness.



Measurement  
Technology



Noise, Vibration  
and Harshness  
for Vehicles

**Measurement Technology using strain gauges** introduces you to strain and vibration measurement.

Last but not least, you will learn about **noise, vibration, and harshness NVH for vehicles**. This includes the general aspects like physical description of sound, psychoacoustics, noise contribution and propagation as well as sound design in the vehicle context.

## Delivery Content

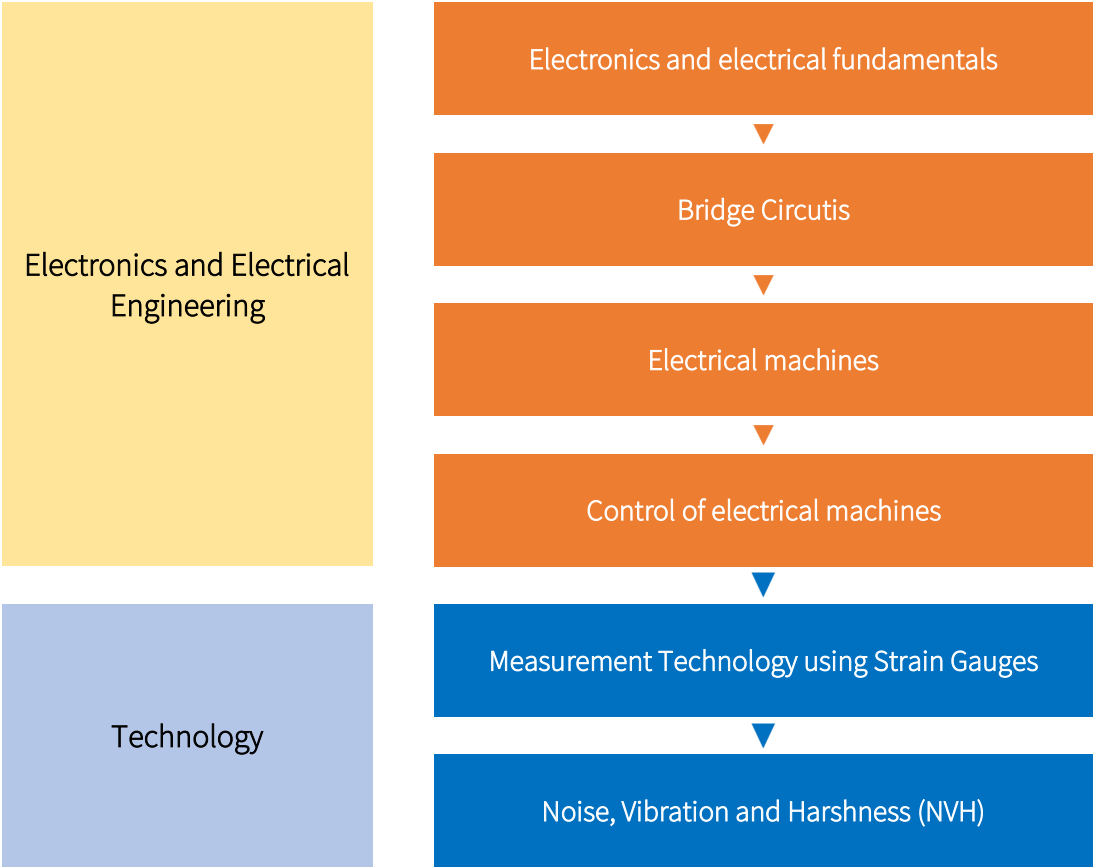
### Access

- for one user
- to all e-learning courses
- for the purchased time period

of the Embedded Academy.

### Recommended Learning Journey

The Embedded Software Developer learning package is composed of 7 e-learning courses. We recommend the following order for learning.



## E-Learning Content

### 1) Electronics and Electrical Fundamentals

- Language: English
- Course objective: The aim of this course is to provide a basic technical understanding of all relevant topics in the area of electricity.
- Course content: The first e-learning unit of this course is called “**Electronics and Magnetism**”. It covers the relationship between current, voltage and resistance, which is expressed by Ohm’s law. In addition, electric and magnetic fields are contrasted and different types of magnets are considered.

The second e-learning unit deals with the **important components of a circuit**, the capacitor and the coil, as well as the resulting phenomena and physical laws, the Lorentz Force, the Hall Effect and the principle of induction.

Furthermore, **direct current and alternating current** are analyzed. For the analysis of circuits, Kirchhoff’s Laws and the circuit types parallel circuit and series circuit are explained. With regard to alternating current, the Star connection and the Delta connection are considered. The topic of **AC circuits** is covered in greater detail. Therefore, the complex numbers are explained in order to then discuss the complex voltage and the complex current. Furthermore, this chapter covers the impedance and the Root Mean Square.

The last part of the e-learning contains an introduction to **power electronics**, which is based on semiconductor elements. In addition to teaching technical basics, it explains how various components can be constructed using semiconductors. Here, special attention is paid to the diode and the MOSFET. The user is therefore familiarized with the concept of the p-n-junction.

- Duration: 3 hours, 10 minutes
- Study time: 15 hours, 50 minutes
- Further insights:  
<https://embedded-academy.com/en/courses/electronics-and-electrical-fundamentals/>

### 2) Bridge Circuits

- Language: English, German
- Course objective: The course focuses on the most important bridge circuits currently used in industry. The aim is to know, understand and be able to use the circuits.
- Course content: In this e-learning course you will learn about the basics of bridge circuits first. We are covering the voltage divider, the fundamental circuit, bridge voltage, and the variants of bridge circuits as well as their use. In the following part further explanation on balanced and unbalanced bridge circuits is provided.

- Duration: 30 minutes
- Study time: 2 hours, 30 minutes
- Further insights:  
<https://embedded-academy.com/de/Kurse/brueckenschaltungen/>

### 3) Electrical Machines

- Language: English
- Course objective: The aim of this course is to introduce the learner to electrical machines and provide information about important machine types.
- Course content: The first e-learning of this course gives an **introduction** into the basics of electrical machines where some general information is presented. Afterwards, four e-learnings offer an overview on different machine types: Permanent Magnet Synchronous Machine (**PSM**), Synchronous Machine (**SM**), Induction Machine (**IM**) and **DC & Brushless DC Machines**.

The e-learning on **control design** focusses first on the procedure of control parameterization. This includes topics such as decoupling, pre-control, simplification of the mathematical description, and control optimization methods. This is followed by the cascaded control, where we also discuss current control vs. torque control, field-weakening control, anti-shuffle control and speed control.

- Duration: 1 hour, 45 minutes
- Study time: 8 hours, 45 minutes
- Further insights: <https://embedded-academy.com/en/courses/electrical-machines/>

### 4) Control of Electrical Machines

- Language: English
- Course objective: The objective of this course is to impart knowledge on the control of electrical machines.
- Course content: In the e-learning on **field-oriented control**, we look at some basic physical concepts (torque, electromagnetic force) and consider them in relation to the DC motor. This also includes torque control. Discussing field-oriented control then allows us to understand how to incorporate this concept into electric control. We then move on to actually focus on electrical machines as controlled systems as well as the inverter as a control actuator. A short outlook on other machine types is also included.
- Duration: 3 hours
- Study time: 15 hours
- Further insights:  
<https://embedded-academy.com/en/courses/control-of-electrical-machines/>

## 5) Measurement Technology Using Strain Gauges – Basic Course

- Language: English, German
- Course objective: The aim of this basic course is to be able to perform a measurement with strain gauges. This course forms the basis for the advanced course.
- Course content: The e-learning course starts with an **introduction** to the subject, which enables newcomers and career changers to get to know all the important terms and contexts. It then covers the **basic physics** relevant to understanding how a strain gauge works as well as how to measure with it.

This is followed by a detailed discussion of the Wheatstone bridge, which is important for making measurements with strain gauges. This is followed by a discussion of how strain gauges must be positioned in order to measure certain physical quantities and the types of designs that result. At the end, it is explained how to install electrical foil strain gauges.

- Duration: 1 hour, 5 minutes
- Study time: 5 hours, 25 minutes
- Further insights: <https://embedded-academy.com/en/courses/strain-gauges-en/>

## 6) Noise, Vibration and Harshness (NVH) for Vehicles

- Language: English
- Course objective: The aim of this course is to introduce you to the basics of Noise, Vibration and Harshness which are relevant in the context of electric vehicles.
- Course content: In this course, we will focus on basics of NVH relevant for the electrified powertrain. We will explain the physical description of sound, the relation between sound pressure, sound intensity and SPL as well as look at psychoacoustics and some aspects of sound design as well as noise propagation.
- Duration: 30 minutes
- Study time: 2 hours, 30 minutes
- Further insights:  
<https://embedded-academy.com/en/courses/noise-vibration-and-harshness-nvh-for-vehicles/>