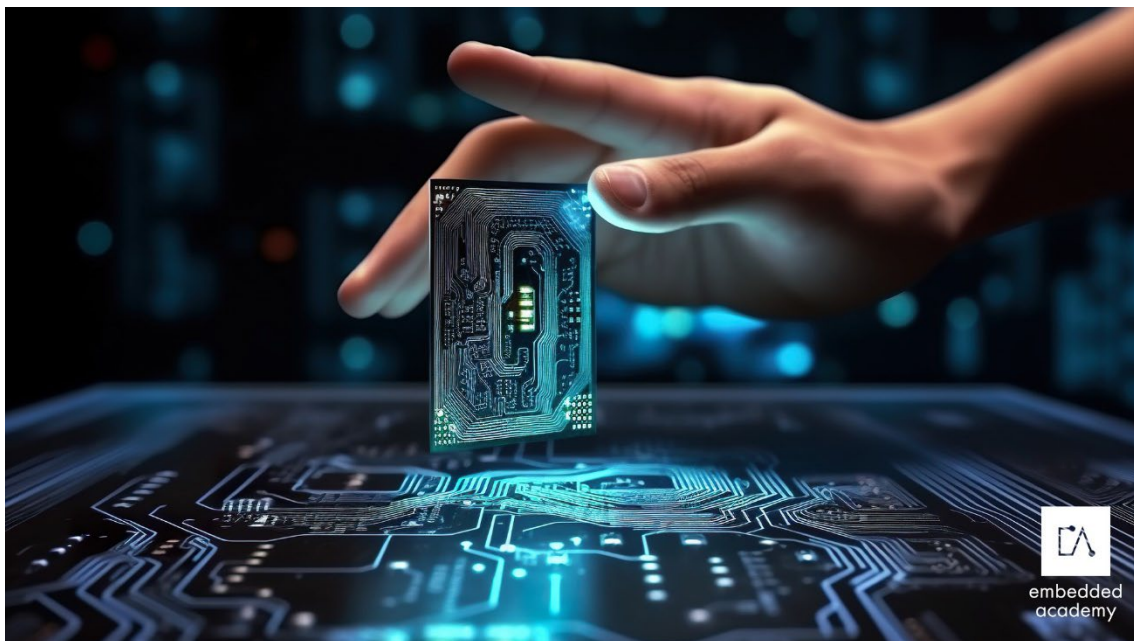




E-Learning for Embedded Software Developer with Focus Technology

June 2024

The combination of courses is perfect for getting into or learning more about Embedded Software Development with focus technology



Courses within the e-learning package

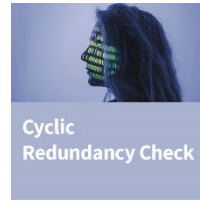
The "**Embedded Software Developer with focus technology**" e-learning package is a comprehensive program that equips learners with essential knowledge and skills in the field of embedded software development as well as technical training. This package covers a wide range of topics to provide a well-rounded understanding of the subject.

You can acquire the knowhow by a set of technical e-learning courses which we structured into 4 parts:

1. Embedded Software Development covering
 - a. fundamentals of embedded software,
 - b. serial bus systems,
 - c. cyclic redundancy check CRC,
 - d. operating system OS, and
 - e. real-time operating system RTOS.
2. Electronics and electrical engineering with courses on
 - a. electronics and electrical fundamentals,
 - b. power electronics fundamentals,
 - c. electrical machines,
 - d. control of electrical machines, and
 - e. vector control.
3. Technology Know-how containing
 - a. battery and battery systems,
 - b. noise, vibration, and harshness NVH,
 - c. measurement technology using strain gauges.
4. Information security and cybersecurity
 - a. Information security
 - b. Automotive cybersecurity



Embedded Software Development: This first part is providing you with know-how to become proficient in embedded software development.



Embedded software basics, dives into fixed-point arithmetic and floating-point arithmetic, essential for understanding numerical representation and calculations in embedded systems. ...

Serial bus systems are a critical component of embedded systems, and learners will gain insights into their architecture, protocols, and components. The OSI model is also covered, providing an understanding of layered communication systems.

The **cyclic redundancy check CRC** provides important further details which are often needed in bus communication.

Operating systems, are explored in-depth, focusing on kernel operations, multitasking, safety considerations, and common challenges in embedded OS development.

The operating system in an embedded application has real-time requirements and thus a **Real-Time Operating System** is needed. We cover different real-time requirements, time and event-based tasks and more.



2. 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



Power Electronics
Fundamentals



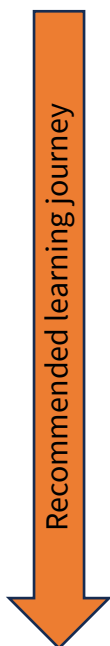
Electrical
Machines



Control of
Electrical
Machines



Vector Control



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

Power electronics fundamentals is delving into semiconductors, introduces the concepts of the half bridge which is used to control electrical machines and finally is going into thermal design and application examples.

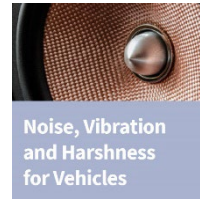
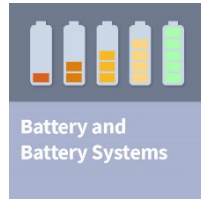
The course on **electrical machines** is starting with the general basics and then is going into details for different machine types. Those are permanent magnet synchronous machines, synchronous machines, induction machines, DC and brushless DC machines.

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.

Vector control is providing more details on this specific mathematical background which you need for field-oriented control.



3. Technology Know-how



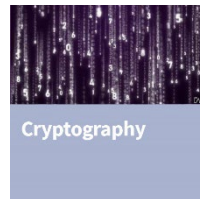
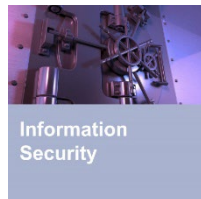
For e-mobility **battery and battery systems** are important for energy storage. First you learn all you need to know about battery cells, then battery systems are explained in detail followed by an introduction to battery management systems.

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.

4. IT-Security

In this part essential knowhow on information security and cryptography is provided.



Information security is the first e-learning course dealing with IT-security and introduces you to all the basic terms in this field.

In the realm of **cryptography**, learners will explore both classical and modern cryptography, including encryption techniques such as the Caesar Cipher, Vigenère Cipher, DES (Data Encryption Standard), AES (Advanced Encryption Standard), Diffie-Hellman Key Exchange, and RSA. This knowledge is vital for securing embedded systems and data.

This e-learning package is tailored for those aspiring to become proficient in embedded software development, whether you are a beginner or seeking to enhance your existing skills. Upon completion, you will possess the knowledge and capabilities required to excel in this dynamic and vital field of technology.

Delivery Content

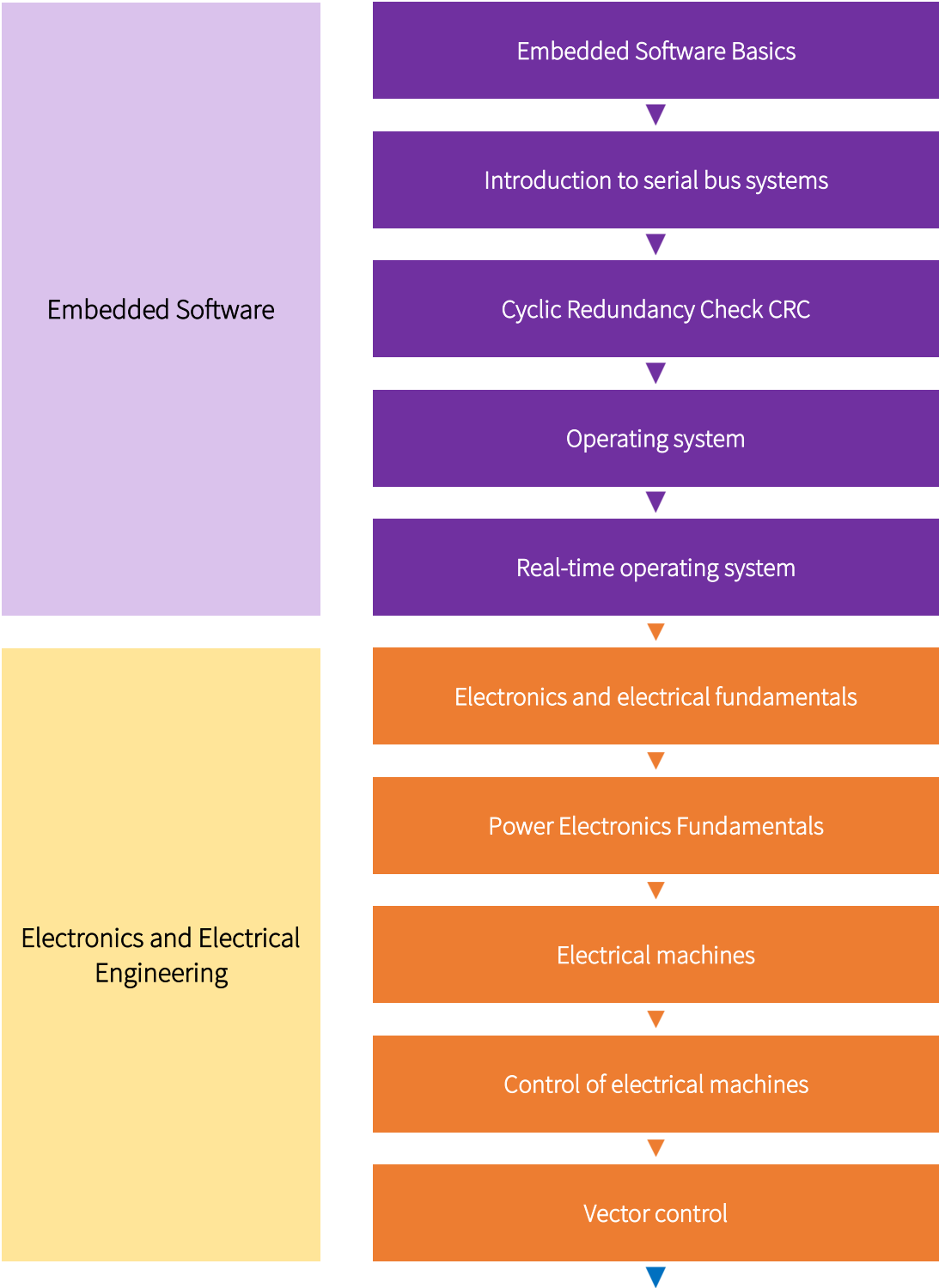
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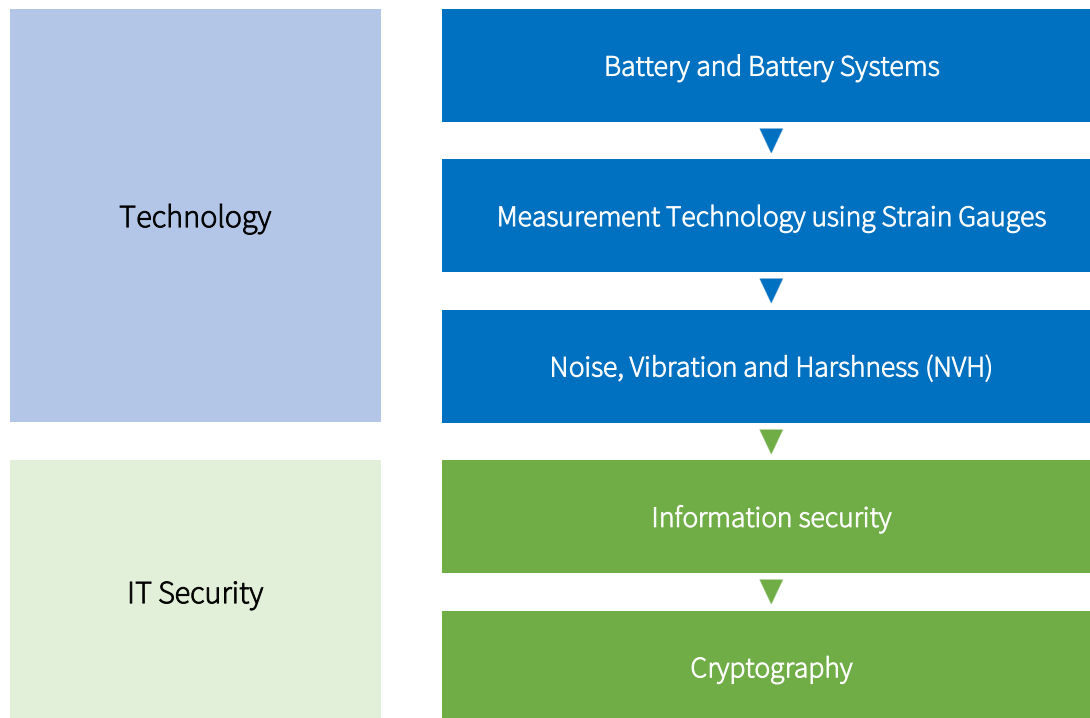
- for one user
- to all e-learning courses
- for the purchased time period

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) Embedded Software Basics

- Language: English, German
- Course objective: The aim of this course is to provide a sound basic knowledge on which other topics, such as AUTOSAR, can build.
- Course content: This course provides an e-learning on **fixed point arithmetic** and on **floating point arithmetic**. Two ways of storing binary numbers are described, and limitations and typical errors of the methods are explained. This helps to avoid beginner mistakes and enables a quick introduction to the basics of embedded software.
- Duration: 1 hours, 15 minutes
- Study time: 6 hours, 15 minutes
- Further insights: <https://embedded-academy.com/en/courses/embedded-software-basics/>

2) Introduction to Serial Bus Systems

- Language: English, German
- Course objective: The aim of this course is to introduce learners to all the important basic terms for the topic of serial bus systems.



- Course content: This course is designed to introduce you to important basic terms related to serial bus systems. Terms concerning hardware and software are explained. The focus of the first e-learning lies on very **general basic terms** that are relevant to most bus systems. For example, the terms bit rate, baud rate, latency, clock signal and router are explained, or what a protocol and a protocol stack actually are. At the beginning of the e-Learning, typical application areas of serial bus systems and their advantages over other systems are described. The second e-learning deals with the **OSI model**, which is a reference model for communication systems and protocols. Two components of this model are particularly relevant for bus systems: the so-called physical layer and the data link layer. The last two e-learning courses are based on these mentioned layers. One of them covers basic terms of the **physical layer**, the other one those of the **data link layer**.
- Duration: 2 hours, 50 minutes
- Study time: 14 hours, 10 minutes
- Further insights:
<https://embedded-academy.com/en/courses/introduction-to-serial-bus-systems-en/>

3) Cyclic Redundancy Check CRC

- Language: English, German
- Course objective: The aim of this course is to understand how to calculate various CRC checksums
- Course content: The e-learning course consists of three e-learning units: "CRC Definition," "CRC-8," and "CRC-16." In this course, you will acquire the necessary knowledge to understand the calculation of CRC checksums. The first module imparts the definition and function of the CRC checksum. The modules are organized in ascending order of CRC sums, and the calculations are always explained using examples. In the "CRC Definition" module, we uncover its significance, explore various CRC lengths, and delve into its principles, including functionality, polynomial representation, and generator polynomial. In "E-Learning CRC-8," we delve deeper into CRC-8 calculation, explaining steps with examples. Explore how the sender generates the CRC-8 checksum and how the receiver verifies message accuracy. Continuing the journey, "CRC-16" explores CRC-16 calculation through detailed examples. Learn how CRC-16 is generated and verified, addressing diverse message lengths. Whether new to CRC or seeking a deep dive, this course empowers your understanding.
- Duration: 1 hour, 20 minutes
- Study time: 6 hours, 20 minutes

- Further insights:
<https://embedded-academy.com/en/courses/cyclic-redundancy-check-crc/>

4) Operating System

- Language: English
- Course objective: The aim of this course is to provide a basic knowledge of operating systems and the various components and functions they contain.
- Course content: In this course, you learn what an operating system is. Therefore, you are familiarized with the kernel, which holds the core functionality of the operating system and you get to know the scheduler, which controls the execution of multiple tasks and allocates resources to them. This is covered in greater detail in the chapter “Multitasking”. To complete this course, safety and other advanced aspects are covered as well as the characteristics of embedded operating systems.
- Duration: 55 minutes
- Study time: 4 hours, 40 minutes
- Further insights: <https://embedded-academy.com/en/courses/operating-system/>

5) Real-Time Operating System

- Language: English
- Course objective: The aim of this course is to provide a basic knowledge of real-time operating systems. The learner will understand what a real-time operating system is and how it works.
- Course content: You will learn when real-time operating systems are needed and which requirements they have. In particular, we cover the difference between soft real-time requirements and hard real-time requirements. You will also encounter the term “timing analysis” and learn about the difference between time-based tasks and event-based tasks. At the end you will be familiarized with three scheduling algorithms, before we cover three typical problems: task starvation, deadlock and race conditions.
- Duration: 1 hour, 5 minutes
- Study time: 5 hours, 25 minutes
- Further insights:
<https://embedded-academy.com/en/courses/real-time-operating-system-en/>

6) 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/>

7) Power Electronics Fundamentals

- Language: English
- Course objective: The aim of this course is to provide a better understanding of power electronics fundamentals for engineers who are beginning to work in this field.
- Course content: In the first e-learning we clarify what **power electronics** is and where it is applied. It also includes an explanation of the electronic switch. We deal with an example of an electronic circuit, from which we derive basic components. In the e-learning “**Components of Power Electronics**” you learn about the semiconductor basics and components including MOSFETs and IGBT. The third e-learning is about the **half bridge**, that is used to control AC electrical machines and the last e-learning covers the topic of **thermal design and assembly**.
- Duration: 2 hours, 25 minutes
- Study time: 12 hours, 5 minutes
- Further insights:
<https://embedded-academy.com/en/courses/power-electronics-fundamentals/>



8) 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-learning 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/>

9) 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/>

10) Vector Control

- Language: English
- Course objective: The aim of this course is to introduce the user to the basic information on vector control. This knowledge is essential for further topics, such as Electrical Machines.



- Course content: Currently, an e-learning on the **Park and the Clarke Transformation** is available. In this e-learning, the reasons for using these transformations are discussed. By explaining the mathematical theory behind them, a solid understanding of the transformations themselves can be achieved which supports later application in practice.
- Duration: 45 minutes
- Study time: 3 hours, 45 minutes
- Further insights: <https://embedded-academy.com/en/courses/vector-control/>

11) Battery and Battery Systems

- Language: English
- Course objective: The objective of this course is to gain a better understanding of the design and control of battery systems.
- Course content: In the first e-learning, we get to know the **battery cell** itself in more detail. We learn what materials it can be made of and how it works when it is charged and discharged. At the end, we will look at the parameters that influence the battery's performance. The second e-learning is about the **battery system** of an electric vehicle, different cell types and battery safety. We take a look at the 48V battery as an example.
- Duration: 1 hour, 30 minutes
- Study time: 7 hours, 30 minutes
- Further insights: <https://embedded-academy.com/en/courses/battery-and-battery-system-fundamentals/>

12) 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
- Study time: 5 hours

- Further insights: <https://embedded-academy.com/en/courses/strain-gauges-en/>

13) 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 with are relevant in the context of electric vehicles.
- Course content: In 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/>

14) Information Security

- Language: English, German
- Course objective: The aim of this course is to provide an overview of information security so that its interrelationships and importance become clear.
- Course content: The course is divided into two topics. First, important terms of **information security** are defined and the underlying goals are explained. Furthermore, it is clarified who is affected by information security and what it is needed for.
In the second e-learning unit, the **practical implementation of information security** is explained. Here, risks and threats are presented and explained using examples. Afterwards, the **information security management system** is defined and its functioning is explained. The introduction of this system is, among other things, the task of the information security officer. Finally, direct measures are explained on the basis of the 14 reference measure objectives, using ISO 27001 as a source.
- Duration: 1 hour
- Study time: 5 hours
- Further insights: <https://embedded-academy.com/en/courses/information-security-en/>

15) Cryptography

- Language: English, German



- Course objective: The aim of this course is to understand the various encryption methods, how they are used, and which mechanisms are most useful for which application during implementation.
- Course content: The course on cryptography is divided into two parts.
First, the focus is on **classical cryptography**, presented in three e-learnings. We begin with a general introduction to the topic, which is followed by a historical overview. Thereby, we will encounter the most famous classical encryption methods: the Scytale, the Caesar Cipher, the Vigenère Cipher, the One-Time Pad and the Enigma.
The second part then moves on from this historical encryption to **modern methods**, also divided into three e-learnings. Here, using the example of Alice and Bob, A to B encryption from the sender (A) to receiver (B) is explained for the three basic types (symmetric, asymmetric, and hybrid) and further illuminated using concrete methods such as the DES, AES, RSA and the Diffie-Hellman Key Exchange.
- Duration: 4 hours
- Study time: 20 hours
- Further insights: <https://embedded-academy.com/en/courses/cryptography/>