IO2

e-Powertrain Engineer Skill Card

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1 TABLE OF CONTENTS

INTRODUCTION

1.1 OBJECTIVE

The objective of this deliverable is to provide an introduction to described Job Role within the applied skills definition model.

1.2 PURPOSE OF THE DELIVERABLE

The purpose of this deliverable is to define skills definitions of the Functional Safety Engineer job role within the EuroSPI/ASA skills definition model.

1.3 SCOPE OF THE DELIVERABLE

The deliverable contains

- Description of the content of the Job Role
- Description of used Skill Sets and skills definitions, coverage of Qualification Schemas

2 EUROSPI SKILLS DEFINITION MODEL

A skills definition contains the following items (see Picture 1):

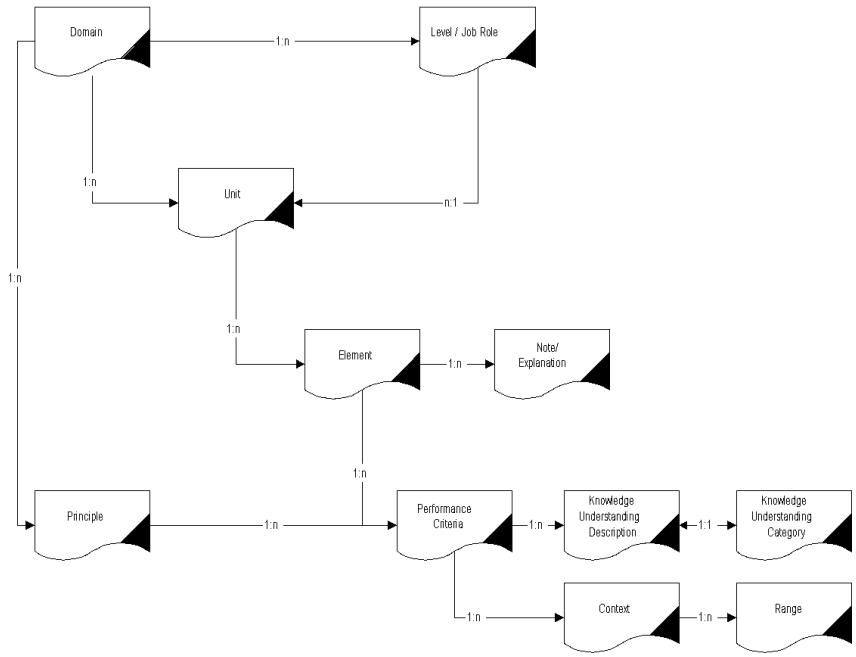

Figure 1 The Skill Definition Model (1:n = one to many relationship)

Context: A category of ranges; it represents some terminology used in a performance criterion that consists of different context, conditions or circumstances. A participant must be able to prove competence in all the different circumstances covered by the context.

Domain: An occupational category, e.g. childcare, first level management or software engineering.

Element: Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.

Evidence: Proof of competence.

Knowledge and understanding category: A category of knowledge and understanding descriptions.

Knowledge and understanding description: A description of certain knowledge and understanding. To be judged competent in a unit a participant must prove to have and to be able to apply all the knowledge and understanding attached to it.

NVQ (UK based): The National Vocational Qualification standard of England, Wales and N. Ireland.

Performance criterion: Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent. A performance criterion may have relevant contexts.

Principle: A statement of good intentions; it underpins all competent domain practice.

Range: Description of a specific circumstance and condition of a performance criterion statement.

Qualification: The requirements for an individual to enter, or progress within a certain occupation.

Job Role: A certain profession that covers part of the domain knowledge. E.g. domain = Functional Safety, job role = Functional Safety Manager.

Unit: A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the UK qualification standard hierarchy and each unit consists of a number of elements.

The above structure was originally proposed by the DTI (Department of Trade and Industry) in the UK for the NVQ (National Vocational Qualification) standards. These models have been re-used and slightly modified by other countries when they started employing skill cards [1], [2]. ISCN (developer of the platform) was partner in the first EU projects (CREDIT, 1998 to 2001) that have set up such new qualification strategies.

This model has been extended and mapped to other qualification programs:

- Erasmus+: A **Performance Criterion** is also an **LO (Learning Objetive)**
- ESCO: A Performance Criterion can be a skill or a knowledge. This way we get lements of skills that contains skills or knowledge (what ESCO proposes).

3 SKILLS DEFINITION FOR THE JOB ROLE "E-POWERTRAIN ENGINEER"

3.1 THE SKILLS DESCRIPTIONS

Domain Acronym: Engineering

Domain title: Powertrain

Domain Description:

Job Role Acronym: ECEPE

Job Role Title: e-Powertrain Engineer

Description: The Skill card comprises the following thematic learning units, and learning elements

U.1 Introduction

- U1.E1 Motivation and challenges
- U1.E2 Product life cycle
- U1.E3 Product homologation and standards
- U1.E4 Embedded automotive systems
- U1.E5 e-Powertrain Architecture

U.2 System engineering (Function-based-Development)

- U2.E1 Function Based Development
- U2.E2 Functional Safety Aspects
- U2.E3 Cyber Security aspects

U.3 Propulsion systems

- U3.E1 e-Motor
- U3.E2 Power electronics, inverters
- U3.E3 Motor control unit
- U3.E4 Hybrid control systems
- U3.E5 Energy transformation systems
- U3.E6 Transmission systems

U.4 Energy Storage Systems

- U4.E1 Battery systems
- U4.E2 Battery management systems
- U4.E3 Fuel cells

U.5 Life Cycle Management

- U5.E1 Product life cycle
- U5.E2 Life Cycle Management and Business Models

3.2 UNIT ECEPE.U1 INTRODUCTION

Acronym: ECEPE.U1

Title: Introduction

Description:

The unit introduces the e-powertrain domain. It investigates the main challenges and drivers-of-change in the automotive sector and the rationale behind electric powertrains. Different solutions such as the full electric vehicle, plug-in hybrid and hybrid are being described. The unit introduces also the product lifecycle phases from raw materials, via the development processes of embedded automotive systems (including the V-Cycle), production to the disposal.

3.2.1 Unit ECEPE.U1 – Element 1: Motivation and challenges

Acronym: ECEPE.U1.E1

Element Title: Motivation and challenges

Element Note:

This element gives an overview about Grant societal changes and drivers-of-change on the automotive domain. Further, the environmental impact of vehicles with electric powertrain and conventional propulsion systems is described.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U1.E1.PC1	The student knows about the environmental impact of the automotive domain.
ECEPE.U1.E1.PC2	The student can define drivers-of-change and grant societal challenges the automotive industry is facing.
ECEPE.U1.E1.PC3	The student knows challenges and changes the automotive domain is currently undergoing.
ECEPE.U1.E1.PC4	The student can describe the different environmental impacts of different propulsion systems.

Table 1 Performance Criteria for the Element ECEPE.U1.E1

3.2.2 Unit ECEPE.U1 – Element 2: Product life cycle

Acronym: ECEPE.U1.E2

Element Title: Product Life Cycle (Introduction)

Element Note:

This element gives an overview about the product lifecycle phases from raw materials, via the development processes (including the V-Cycle), production to the disposal. Furthermore the importance of services in Life Cycle activities are taught.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U1.E2.PC1	The student can demonstrate knowledge about the product Life Cycle Management, second life and differences for specific parts of the powertrain.
ECEPE.U1.E2.PC2	The student can demonstrate knowledge about the V-Cycle development approach.

Table 2 Performance Criteria for the Element ECEPE.U1.E2

3.2.3 Unit ECEPE.U1 – Element 3: Product homologation and standards

Acronym: ECEPE.U1.E3

Element Title: Product homologation and standards

Element Note:

This element gives knowledge about existing standards and regulations related by electric vehicles and their powertrain components.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U1.E3.PC1	The student knows about different major standardization organizations.

ECEPE.U1.E3.PC2	The student knows about different major categories of electric vehicle and electric powertrain standards.
ECEPE.U1.E3.PC3	The student knows about the regulations and procedures of approval of vehicles with electric powertrain.

Table 3 Performance Criteria for the Element ECEPE.U1.E3

3.2.4 Unit ECEPE.U1 – Element 4: Embedded automotive systems

Acronym: ECEPE.U1.E4

Element Title: Embedded automotive systems

Element Note:

This element gives an overview on embedded automotive systems architectures and combined controller structures. The element describes the difference between consumer electronic components and automotive components and describes the constrains of embedded automotive systems

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U1.E4.PC1	The student knows the difference between consumer electronic component constraints and automotive embedded system constraints.
ECEPE.U1.E4.PC2	The student can identify typical operation conditions, environmental constraints and other key usage aspects of embedded automotive systems.
ECEPE.U1.E4.PC3	The student understands the key concepts of embedded automotive system architectures.
ECEPE.U1.E4.PC4	The student can describe typical combined controller types and important architectural approaches.
ECEPE.U1.E4.PC5	The student can describe real-time and embedded automotive system specifics.

Table 4 Performance Criteria for the Element ECEPE.U1.E4

3.2.5 Unit ECEPE.U1 – Element 5: ePowertrain Architecture

Acronym: ECEPE.U1.E5

Element Title: ePowertrain Architecture

Element Note:

This element explains different system architectures of an e-powertrain, including full electric car, hybrid, range extender model, and fuel cell. For each type the system architecture is described with different control units, mechatronic functions per control unit, interfaces on vehicle level, and interfaces to the electric engine. The element also discusses the main vehicle level functions and the interdependency of the control units connected by bus signals.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U1.E5.PC1	The student can describe the main elements of a system architecture of a full electric powertrain.
ECEPE.U1.E5.PC2	The student can describe the main elements of a system architecture of a hybrid powertrain.
ECEPE.U1.E5.PC3	The student can describe the main elements of a system architecture of a range extender based powertrain.
ECEPE.U1.E5.PC4	The student can describe the main elements of a system architecture of a fuel cell based powertrain.

Table 5 Performance Criteria for the Element ECEPE.U1.E5

3.3 UNIT ECEPE.U2 SYSTEM ENGINEERING (FUNCTION-BASED-DEVELOPMENT)

Acronym: ECEPE.U2

Title: System Engineering

Description:

The unit introduces system architecture thinking in context of an e-powertrain with an understanding of system functional design, system-wide feature thinking for functional safety, and cyber-security related development. It highlights the main components of an e-powertrain, the approaches and rationales behind dependable (safety & security) engineering concepts for electric powertrains. Different concepts, such as signal flow concepts, effect chain between components, and risk management in complex system design are being described.

3.3.1 Unit ECEPE.U2 – Element 1: Function Based Development

Acronym: ECEPE.U2.E1

Element Title: Function Based Development

Element Note:

This element explains the system architecture of an e-powertrain with an understanding of system functional design. The system architecture incudes different control units, software based mechatronic functions, interfaces on vehicle level, and interfaces to the electric engine. The ePowertrain architecture also includes a list of functions which are described as an effect chain between vehicle, motor control unit, inverter, battery management system, and electric engine.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U2.E1.PC1	The student can explain the functionality of the involved electronic control units.
ECEPE.U2.E1.PC2	The student can describe the functional control flow in an e-powertrain architecture and how the vehicle interfaces the system.
ECEPE.U2.E1.PC3	The student can apply the system architecture and draw effect chains (vehicle level functions) in the system architecture.
ECEPE.U2.E1.PC4	The student is able to write system requirements which can be forwarded to software, hardware, electrics development teams.

Table 6 Performance Criteria for the Element ECEPE.U2.E1

3.3.2 Unit ECEPE.U2 – Element 2: Functional Safety Aspects

Acronym: ECEPE.U2.E2

Element Title: Functional Safety Aspects

Element Note:

This element gives an overview about typical ASIL (Automotive Safety Integrity Level) classifications and safety goals related with ISO 26262 which affect the functional design of an e-powertrain.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U2.E2.PC1	The student knows about typical Automotive Safety Integrity Level (ASIL) ratings of battery systems and their related safety goals.
ECEPE.U2.E2.PC2	The student can define typical ISO 26262 related safety measures taken into account in case of battery management systems.
ECEPE.U2.E2.PC3	The student knows about typical ASIL ratings of electric control systems and engines in cars and their related safety goals.
ECEPE.U2.E2.PC4	The student can define typical ISO 26262 related safety measures taken into account in case of battery management systems.
ECEPE.U2.E2.PC5	The student is able to do his own HARA (Hazard and Risk Analysis) based on ISO 26262 and derive safety goals, and safety measures.

Table 5 Performance Criteria for the Element ECEPE.U2.E2

3.3.3 Unit ECEPE.U2 – Element 3: Cyber Security Aspects

Acronym: ECEPE.U2.E3

Element Title: Cyber Security Aspects

Element Note:

This element gives an overview on cyber-security aspects of automotive systems. The element describes basic design approaches for cyber-security related design, threat and attack surface thinking approaches and differences of security in general vs. automotive cyber-security

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U2.E3.PC1	The student understands the specific features of automotive cyber-security.
ECEPE.U2.E3.PC2	The student is able to identify potential threats and attack surfaces of automotive systems.
ECEPE.U2.E3.PC3	The student knows about the security-by-design approach.
ECEPE.U2.E3.PC4	The student can identify cyber-security related automotive systems.
ECEPE.U2.E3.PC5	The student is able to identify security relevant assets and map required cyber-security approaches to protect the assets.

Table 8 Performance Criteria for the Element ECEPE.U2.E3

3.4 U.3 PROPULSION SYSTEMS

Acronym: ECEPE.U3

Title: Propulsion Systems

Description:

This unit gives an overview about the division of electric motors, their principles, behaviour and control methods as well as overview about the division of car/vehicle inverters and Power electronics (PE) components. The motor control to manage the phase currents of the electric motor is done by a special Software called Field Oriented Controller (FOC) Software. Defined Software tool setups are used to explain the motor control software. An overview on block structures, properties, control methods and strategies of hybrid control systems is presented.

3.4.1 Unit ECEPE.U3 – Element 1: eMotor

Acronym: ECEPE.U3.E1

Element Title: eMotor

Element Note:

This element gives an overview about the division of electric motors, their principle, behaviour and control characteristics. There are described as examples of emotor real integration information, selected important components, connection standards, cooling, protections and so on.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U3.E1.PC1	The student knows about different types and general/basic properties of electric motors for automotive powertrain area.
ECEPE.U3.E1.PC2	The student can describe electric motor types and exact principle for car powertrain system. Especially AC-PMSM, AM --- DC-BLDC, DC.
ECEPE.U3.E1.PC3	The student knows powertrain emotors real behaviour and can draw a describe control characteristics.
ECEPE.U3.E1.PC4	The student has enough knowledge to describe/define specific malfunctions of emotors.
ECEPE.U3.E1.PC5	The student is able to describe examples of emotor real integration, can described important selected components, connection standards, cooling, protections and so on.

Table 9 Performance Criteria for the Element ECEPE.U3.E1

3.4.2 Unit ECEPE.U3 – Element 2: Power electronics, inverters

Acronym: ECEPE.U3.E2

Element Title: Power electronics, inverters

Element Note:

This element gives an overview about the division of car/vehicle inverters and Power electronics (PE) components, their principle, behaviour and control methods (e.g. scalar control, two-value current control, rectangular control, vector control, direct torque control). Student knows examples of an inverter car integrations.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U3.E2.PC1	The student knows what does mean “Power electronics” – power part and control part of a converter generally. Student knows types description and division of inverters in automotive area.

ECEPE.U3.E2.PC2	The student can describe types and properties (behaviour, VA characteristics) of main PE components - capacitors, semiconductors and drivers.
ECEPE.U3.E2.PC3	The student can describe basic principle of vehicle inverters, their power part structure and control methods.
ECEPE.U3.E2.PC4	The student is able to describe/define specific malfunctions of inverters in automotive area (not industrial inverters).
ECEPE.U3.E2.PC5	The student is able to describe examples of invertors car integrations.

Table 10 Performance Criteria for the Element ECEPE.U3.E2

3.4.3 Unit ECEPE.U3 – Element 3: Motor control unit

Acronym: ECEPE.U3.E3

Element Title: Motor control unit

Element Note:

The motor control to manage the phase currents of the electric motor is done by a special software called Field Oriented Controller (FOC) Software. This

- Controls the phase currents
- I usually based on a ready to use software development kit
- Includes an embedded driver software plus measurement of sensors (to read back the rotor position, rotor speed etc.)
- Most large supplier adapt their own version of a FOC module

There are defined software tool setups (see references) which can be used to explain the motor control software.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U3.E3.PC1	The student can explain the functionality of a Field Oriented Controller (FOC) and what algorithms are implemented in general.
ECEPE.U3.E3.PC2	The student can apply on a lab motor the FOC and switch to specific states.

ECEPE.U3.E3.PC3	The student is able to understand the differences between the FOC models, e.g. one using an estimation model and the other using a set of sensors to read back and control.
ECEPE.U3.E3.PC4	The student knows how to calibrate and adapt a FOC module to fit with a specific motor.

Table 11 Performance Criteria for the Element ECEPE.U3.E3

3.4.4 Unit ECEPE.U3 – Element 4: Hybrid control systems

Acronym: ECEPE.U3.E4

Element Title: Hybrid control systems

Element Note:

This element gives an overview about block structures, properties, control methods and strategies of hybrid control systems. The description will focus mainly on HW resources, block diagrams describing functionalities. There are mentioned specific information about hybrid control systems and their HW properties, communication means, general information about cooperation and their specific applications.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U3.E4.PC1	The student knows the meaning of the term “hybrid drive” and can draw and exactly describe the block structure/scheme of an ECU-converter-emotor-ICE (Internal Combustion Engine).
ECEPE.U3.E4.PC2	The student can describe types and properties of specific hybrid control systems – for example inputs/outputs definition, structure, connections and blocks description, communication means.
ECEPE.U3.E4.PC3	The student knows basic control and regulation strategies and is able to describe the cooperation of all-important nodes: charger - battery system – converter – emotor – motor control unit.
ECEPE.U3.E4.PC4	The student is able to describe/define specific malfunctions of hybrid control systems in automotive area (not industrial inverters).

ECEPE.U3.E4.PC5	The student can describe examples of hybrid control systems integrations.

Table 12 Performance Criteria for the Element ECEPE.U3.E4

3.4.5 Unit ECEPE.U3 – Element 5: Energy transformation systems

Acronym: ECEPE.U3.E5

Element Title: Energy transformation systems

Element Note:

This element deals with energy transformation system used in Hybrid Electric Vehicles and Range Extended Electric Vehicles. Also, regenerative braking and Kinetic Energy Storage System (KERS) are considered.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U3.E5.PC1	The student knows about internal combustion engine and electric generator characteristics.
ECEPE.U3.E5.PC2	The student knows about the driving condition and the requirements about e-powertrain with a range extender.
ECEPE.U3.E5.PC3	The student knows about operating modes of traction drives and traction/braking characteristics.
ECEPE.U3.E5.PC4	The student is able to explain the principles of the regenerative braking.
ECEPE.U3.E5.PC5	The student knows about types and elements of KERS systems.

Table 13 Performance Criteria for the Element ECEPE.U3.E5

3.4.6 Unit ECEPE.U3 – Element 6: Transmission systems

Acronym: ECEPE.U3.E6

Element Title: Transmission systems

Element Note:

This element deals with transmission types, their structure and components and HW and SW transmission control system architecture.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U3.E6.PC1	The student knows about the purpose and the main types of transmissions for conventional vehicles.
ECEPE.U3.E6.PC2	The student knows about the modifications made to transmissions installed in hybrid electric vehicles.
ECEPE.U3.E6.PC3	The student is able to compile structural, calculation and kinematic schemes of various types of drives and converters and to analyse planetary gear sets.
ECEPE.U3.E6.PC4	The student knows about the components of transmission control system and their function.

Table 14 Performance Criteria for the Element ECEPE.U3.E6

3.5 U.4 ENERGY STORAGE SYSTEMS

Acronym: ECEPE.U4

Title: Energy Storage Systems

Description:

The unit 4 "Energy Storage Systems" gives an overview of battery systems, battery management systems and fuel cells systems. Differences between the traction battery in a car with electric drive (EV) and traction battery for hybrid vehicle (EHV) as well as the differences in the properties of both on-board power supply networks are being discussed. Issues, solutions of systems, circuit solutions for measuring and evaluating the isolation condition, BMS hardware and software components and fuels cell systems principles are the main topics covered.

3.5.1 Unit ECEPE.U4 – Element 1: Battery systems

Acronym: ECEPE.U4.E1

Element Title: Battery systems

Element Note:

This element gives an overview about the division of battery types and their properties suitable for on-board accumulators and traction batteries (their properties, principle, behaviour and loading

characteristics, on-board system structure and others). Student knows examples of battery integrations and their dysfunctions. The student will gain knowledge about the reasons for the use of ultracapacitors.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U4.E1.PC1	The student knows the concept of types and reasons for the integration of electricity sources in cars.
ECEPE.U4.E1.PC2	The student can describe the division of battery types and their properties suitable for on-board accumulators and traction batteries.
ECEPE.U4.E1.PC3	The student is able to explain the differences between the traction battery in a car with electric drive (EV) and traction battery for hybrid vehicle (EHV) as well as the differences in the properties of both on-board power supply networks.
ECEPE.U4.E1.PC4	The student is able to describe the connection of on-board systems with a link to the traction battery and on-board battery (e.g. charger, traction battery, on-board battery, inverter, motor).
ECEPE.U4.E1.PC5	The student is aware of the most common issues with traction batteries and can knows the reasons for their occurrence.
ECEPE.U4.E1.PC6	The student knows the design solution of the integration of on-board accumulators and traction batteries for EV and EHV.
ECEPE.U4.E1.PC7	The student knows the circuit solutions for measuring and evaluating the isolation condition and is aware of the relevant standards about electric safety (ECE R100, CSN 33 0010) as well as their application in different countries.
ECEPE.U4.E1.PC8	The student knows the properties of the ultracapacitor and can present the circuit solutions of the concept of ultracapacitor batteries (one module consisting of ultracapacitors + converters.)

ECEPE.U4.E1.PC9	The student can describe the operating states and energy flows within the connections: battery-ultracapacitor module-inverter-motor

Table 15 Performance Criteria for the Element ECEPE.U4.E1

3.5.2 Unit ECEPE.U4 – Element 2: Battery Management Systems

Acronym: ECEPE.U4.E2

Element Title: Battery Management Systems

Element Note:

This element gives an overview on battery management systems hardware, software and High Voltage (HV) safety related components. The element describes the specifics of continuously powered HV systems, the BMS HW, BMS SW functions and safety related system components (such as fuses, sensors and relays).

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U4.E2.PC1	The student is able to describe functions and usage of Battery Management Systems (BMS).
ECEPE.U4.E2.PC2	The student is able to define components, specifics and constraints for a BMS.
ECEPE.U4.E2.PC3	The student knows about the HW features a BMS is required to implement.
ECEPE.U4.E2.PC4	The student can define necessary SW functionalities a BMS needs to implement.
ECEPE.U4.E2.PC5	The student is able to describe/define specific malfunctions of BMS and safety functions.

Table 14 Performance Criteria for the Element ECEPE.U4.E2

3.5.3 Unit ECEPE.U4 – Element 3: Fuel cells

Acronym: ECEPE.U4.E3

Element Title: Fuel cells

Element Note:

This element deals with fuel cells principle of operation, their advantages and disadvantages and their combining with battery/supercapacitor.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U4.E3.PC1	The student knows about the principle of operation and characteristics of fuel cells.
ECEPE.U4.E3.PC2	The student knows about the different types of fuel cells.
ECEPE.U4.E3.PC3	The student knows about the advantages and disadvantages of fuel cells.
ECEPE.U4.E3.PC4	The student knows about combining the fuel cell with battery/ ultracapacitor.

Table 16 Performance Criteria for the Element ECEPE.U4.E3

3.6 U.5 LIFE CYCLE MANAGEMENT

Acronym: ECEPE.U5

Title: Life Cycle Management

Description:

The unit 5 “Life Cycle Management” gives an overview about Life Cycle related topics like the Product Life Cycle or Life Cycle Management. Students gain insight into different topics as the different phases of Life Cycle Mangement and how to apply them on practical topics. Furthermore business models are also involved in the taught subjects.

3.6.1 Unit ECEPE.U5 – Element 1: Product life cycle

Acronym: ECEPE.U5.E1

Element Title: Product life cycle

Element Note:

This element gives a detailed overview on different Life Cycle phases and furthermore the impact of sustainability. These topics are taught with a view to electric powertrain components to stress the importance of sustainability in this area of engineering.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
ECEPE.U5.E1.PC1	The student can demonstrate knowledge in the importance of the design, usage and end of life phase in Life Cycle.
ECEPE.U5.E2.PC2	The student can define the impact and interdependencies of phases, the cost and revenue related impacts of phases and furthermore the importance of service in the usage phase are topics to be taught.
ECEPE.U5.E2.PC3	The student is able to present knowledge about the basics of sustainability in relation to Life Cycle Management. Therefore, they can deliver knowledge in social and ecological Life Cycle Assessments.
ECEPE.U5.E2.PC4	The student can deliver knowledge in social and ecological Life Cycle Assessments.

Table 17 Performance Criteria for the Element ECEPE.U5.E1

3.6.2 Unit ECEPE.U5 – Element 2: Life Cycle Management and Business Models

Acronym: ECEPE.U5.E2

Element Title: Life Cycle Management

Element Note:

This element gives an overview about Life Cycle Costing and Life Cycle Data Management. The element includes detailed Life Cycle Costing calculation systems and their difficulties and furthermore the collection of product data and the efficient management of them. Furthermore this element gives an overview about Life Cycle Service Business models.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate

ECEPE.U5.E2.PC1	The student can present knowledge in the Life Cycle calculation system and the difficulties of the system.
ECEPE.U5.E2.PC2	The student knows how to analyse and handle financial risks with regards to components from the automotive sector.
ECEPE.U5.E2.PC3	The student is able to present knowledge in the topics Product Data Management (cloud based computing), Product Information Management and Life Cycle Management which contains the management and publication of product data over its Life Cycle.
ECEPE.U5.E2.PC4	The student can present knowledge about why services may fail. Furthermore the difference between expectations and perceived service, the Service GAP Model and service and their value proposition can be explained by the student.

Table 18 Performance Criteria for the Element ECEPE.U5.E2

REFERENCES

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5 ANNEX A EUROSPI CERTIFICATION DESCRIPTION

5.1 EUROSPI CERTIFICATES AND SERVICES GMBH DESCRIPTION

he EuroSPI² conference series (and book series) has been formed 1994 as a leading conference in the area of System, Software, Services Process and Product Improvement and innovation with contributions from leading industry and leading research. SOQRATES as working group of leading German and Austrian industry started in 2003 and is moderated by the chair of EuroSPI since 2003 and the working group contributes to the thematic workshops organized at EuroSPI, to define state of the art in system design, safety and cybersecurity, assessments, quality management, agile processes, standards, etc. The EuroSPI academy started in 2020 (based on the EU Blueprint project DRIVES concept of a learning compass for European automotive industry) and within a year has many hundred trained, and on DRIVES learning portal we have more than 2000 MOOC trainees. The exam systems originally developed to support ECQA are now adapted and integrated to support Europe wide certification and exams systems under the EuroSPI Certificates & Services GesmbH. We now bundle this to a European initiative under one umbrella and move all teams and services behind this aggregated bundled European strategy.

EuroSPI² use proven in use exam systems and cooperates with DRIVES and ASA and supports the skills sets defined in the DRIVES learning systems.


EUROSPI² European System, Software & Service Process Improvement & Innovation

Certificate
of Electric Powertrain Competencies

Lars Aymann

has passed the
Certified Electric Powertrain Engineer
examination for the accredited units and course elements

Eligible for recertification: November 2023

EUROSPI²
Issued by
EuroSPI Certificates and Services GmbH
Online, 2nd November 2021

ECEPE

See above an example ECEPE certificate.

Access to a Vast Pool of Knowledge

- EuroSPI (www.eurospi.net) has a program committee of experts from 28 countries.
- EuroSPI has key notes from leading car makers and Ter 1 like VW, Porsche, KTM Motorsport, BOSCH, ZF, MAGNA etc.
- EuroSPI has a book series in SPRINGER which was downloaded above 500000 times, and was awarded a prize by SPRINGER online
- EuroSPI has a working group SOQRATES (soqrates.eurospi.net) with leading Ter 1 in Germany and Austria
- EuroSPI has a working group for IT enabled automotive job roles in the ASA (Automotive Skills Alliance)

Background of EuroSPI Certification:

1) 29 years of European system software services improvement

EuroSPI brings together an established community of experts from leading industry and research, who jointly contribute to an annual conference.

2) EuroSPI certificates are recognised by the Automotive Skills Alliance (ASA) in the EU

EuroSPI certificates are issued by EuroSPI Certificates & Services GmbH (www.eurospi.net) in cooperation with DRIVES and the Automotive Skills Alliance (ASA). The ASA was founded by the EU Blueprint Project Drives and ALBATTS with support from the European Automobile Manufacturers' Association (ACEA).

3) EuroSPI Academy with hundreds of attendees

EuroSPI runs the DRIVES Learn Compass Portal, where more than two thousand engineers from the leading automotive industry are attending MOOCs. EuroSPI has been running the EuroSPI Academy since November 2020 attracting hundreds of trainees within one year.

4) Proven-in-use exam system with more than 12,000 exams

EuroSPI employs a proven-in-use exam system , that has been used for over twelve thousand exams with different certifiers and will be used exclusively by EuroSPI Certificates and Services in the future.

5) EuroSPI offers networking options towards European cooperation

EuroSPI organizes annual workshops on thematic topics (e.g. safety, cybersecurity etc.), to which leading researchers and industries are contributing. Training course participants and examinees are granted a 20% price reduction.

Download as PDF

6) Worldwide dissemination (>500000)

EuroSPI has established collaborations with publishers and launched a renowned book series at SPRINGER CCIS with more than half a million downloads. The CCIS editorial team includes experts from Europe, the USA, China, Japan, Russia, India, and South America.

7) Best practices elaboration in European working groups

The knowledge taught in the EuroSPI Academy courses was developed in working parties (e.g. SOQRATES) including leading industry in the electronics and automotive domains.

8) Top-level infrastructure for EuroSPI Academy courses

EuroSPI Academy courses are set up within state-of-the-art learning portals, using exercise materials, templates, and tools to support learning by doing.

9) Number #1 assessment tool Capability Adviser

EuroSPI owns, sells, and uses the Capability Adviser tool, which enables (online) team assessment for different norms (e.g., Automotive SPICE, ASPICE etc.) and can be configured for in-house standards. Leading Tier 1 and Tier 2 automotive companies are using the Capability Adviser.

10) Assessments of experts' skills supported by the EuroSPI exam system

EuroSPI has an advanced exam system, using team roles, such as Assessor and Exam Participant to support assessors who evaluate expert skills based on provided evidences in different domains (e.g. functional safety, cybersecurity etc.). Where high risk is involved a simple multiple-choice test is not sufficient.

5.2 EUROSPI SELF ASSESSMENT AND EXAM SYSTEM

The EuroSPI exam system has been used by a former certification body ECQA (EuroSPI Certification and Qualification Association) and was developed by ISCN. In 2021 the exam system has been reconfigured to support in future the ASA (Automotive Skills Alliance) and ECEPE.

The guidelines have been adapted for ECEPE.

See the two guidelines developed:

- How-to-Guide-Exam-Participant-Multiple-Choice-Based-Exam.docx
- How-to-Guide-Exam-Participant-Self-Assessment-Exam-Preparation.docx

5.2.1 EUROSPI – ECEPE REGISTRATION AND SKILLS BROWSING SYSTEM

Skills browsing allows you to see the hierarchy of skills required grouped into units (areas of skills), elements (specific knowledge required) and performance criteria (abilities of the learner achieved in the training).

Test questions have been designed per performance criteria and the test is generated with a random generator per element.

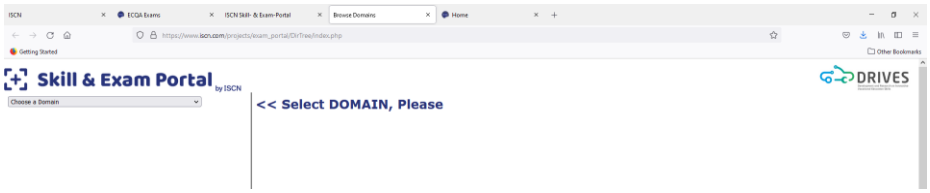

Figure 2: Skills Tree Main Page

First select a job role, then the units are displayed. Then select a unit and the elements are displayed. And finally, you select an element and the performance criteria are displayed.

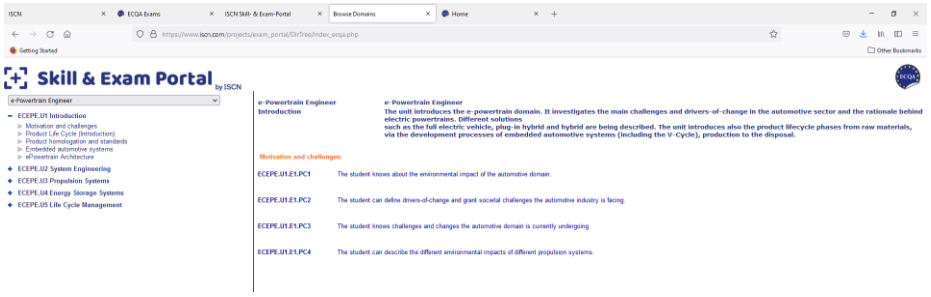

Figure 3: Skills tree after selection of a job role and selecting an element

Exam Registration or Login

Login: If you have already registered for this or another job role exam before in the ISCN exam system and you want to participate in an exam you know already your credentials and you can login. In this case do not register again since the system will make you a separate user account again.

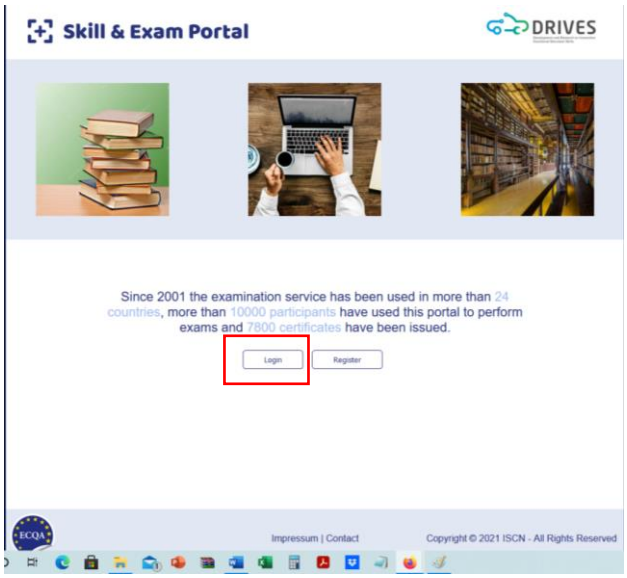

Figure 4: Login

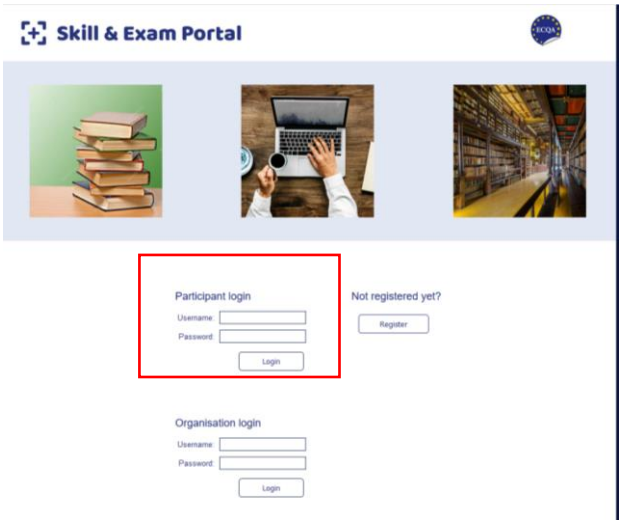

Figure 5: Participant Login

Register: If you want to register for a new job role and exam (even if you have an account already for another job role) you select REGISTER. Register will guide you through a number of dialogues t select the job role, and to select the exam organisation, and to enter more details required to issue an exam result and certificate at the end.

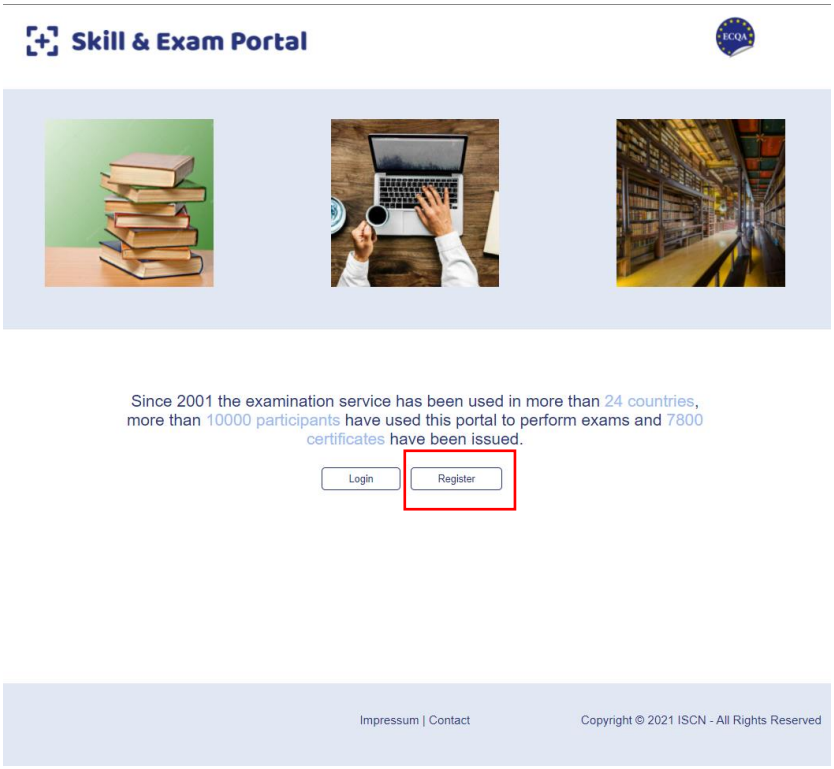

Figure 6: Register

Steps to register

1. Call REGISTER (Figure 6)
2. Step 1: Choose Job Role / Domain (Figure 6)
3. Step 2 - Choose Exam Organisation (Figure 7)
4. Step 3 – Registration (Figure 8)

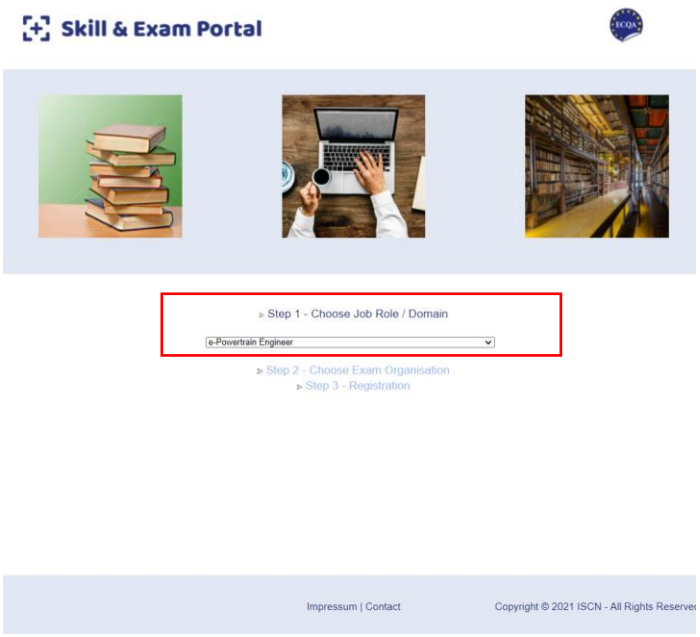

Figure 7: Step 1: Choose Job Role / Domain

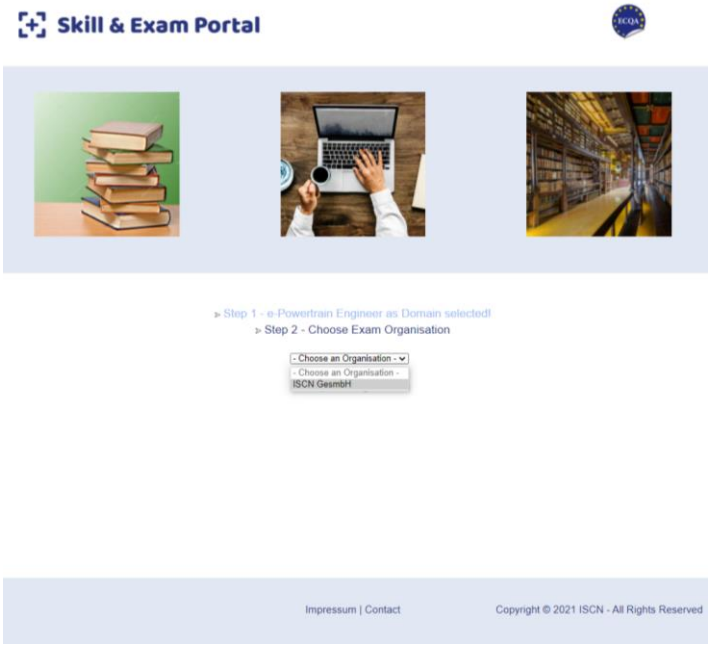

Figure 8: Step 2 - Choose Exam Organisation

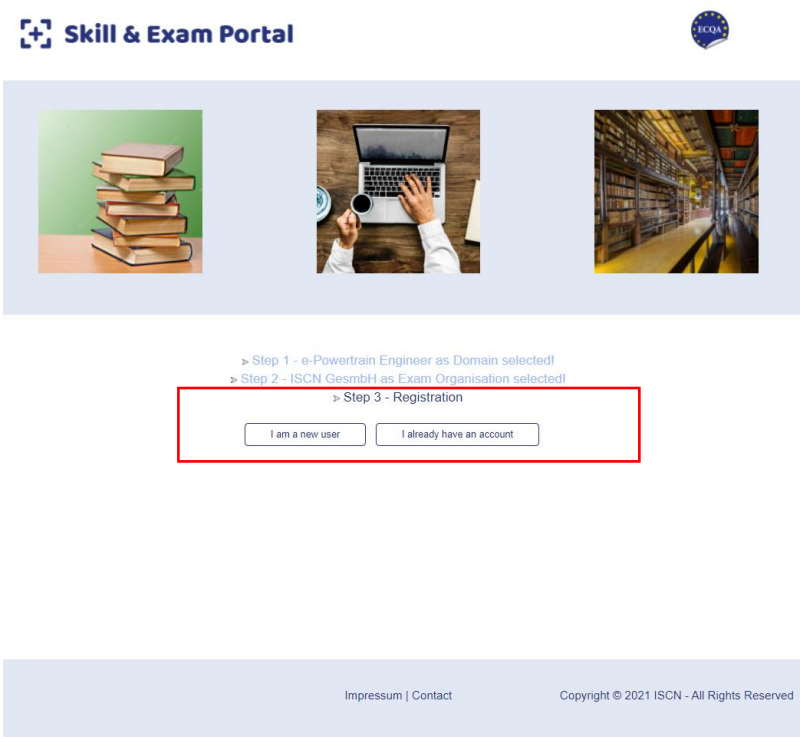

Figure 9: Step 3 – Registration

I am a new user. If it is the first time you create an account for a job role in the exam system you must enter your personal details. To issue a certificate (following the guidelines outlined by standards for personal certification (e.g. ISO 17024) certificates can only be issued to identifiable persons (see Figure 9).

I already have an account. If you already have an account from a previous exam or by registering for another job role at an earlier stage you can use the login details of your account. This way the new job role and exam is also linked to the already existing account (see Figure 10).

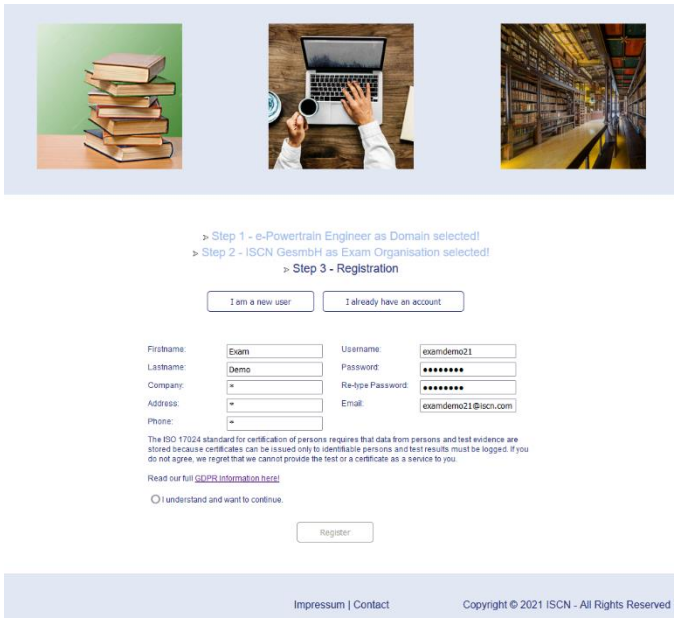

Figure 10: Entering data in case of "I am a new user" and REGISTER

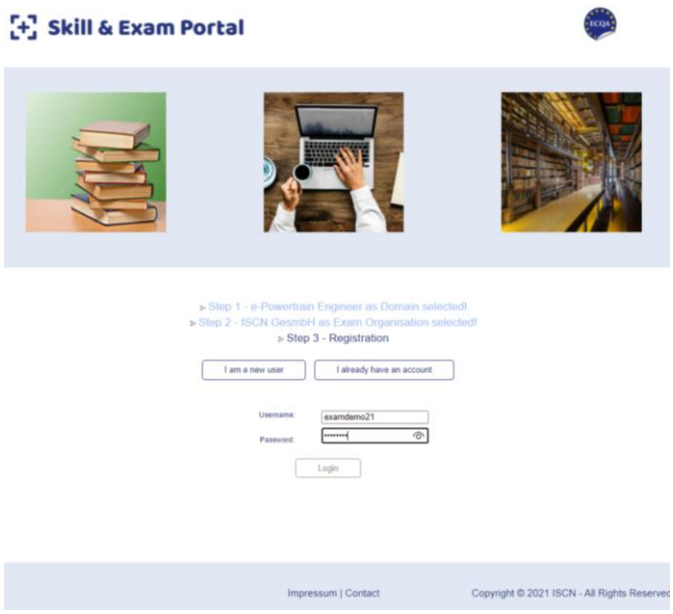

Figure 11: Entering data in case of "I already have an account" and REGISTER when you select REGISTER your personal skills account with a skills browsing function opens.

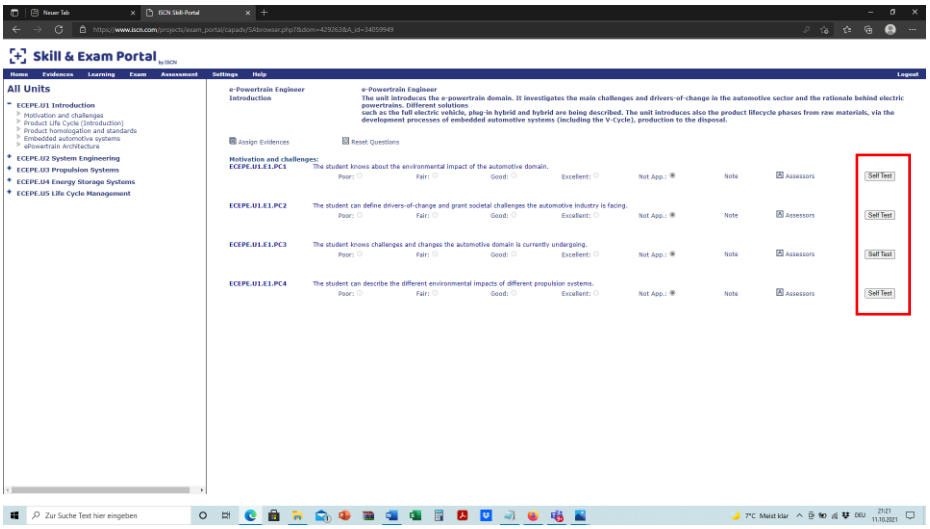

Figure 12: Your private skills account in the exam portal

Attention: If you logout and later come back to d the exam or further skills browsing, you only need to login (Figure 3).

5.2.2 EUROSPI – ECEPE SELF ASSESSMENT SYSTEM

Self Assessment. Once you accessed your skills account with the skills browsing function, you can open a specific element and see the list of performance criteria for the element (Figure 12).
Beside each performance criteria you can see a SELF TEST button. When you open the SELF TEST a set of multiple choice questions is offered (Figure 13).

Multiple Choice Questions. Each multiple choice question can have one or many correct answers. If a multiple choice question has n answers from which m < n answers are correct then each correct answer is 1/m worth. If you find all correct answers you get m * 1/m = 1 point. If you tick a wrong answer then you lose all points of that question and get 0 points.

The self assessment tool automatically calculates the scores of all multiple choice questions of a specific performance criteria and sets a rating of poor (0%), fair (33%), good (66%), excellent (100%) for the performance criteria (Figure 14).

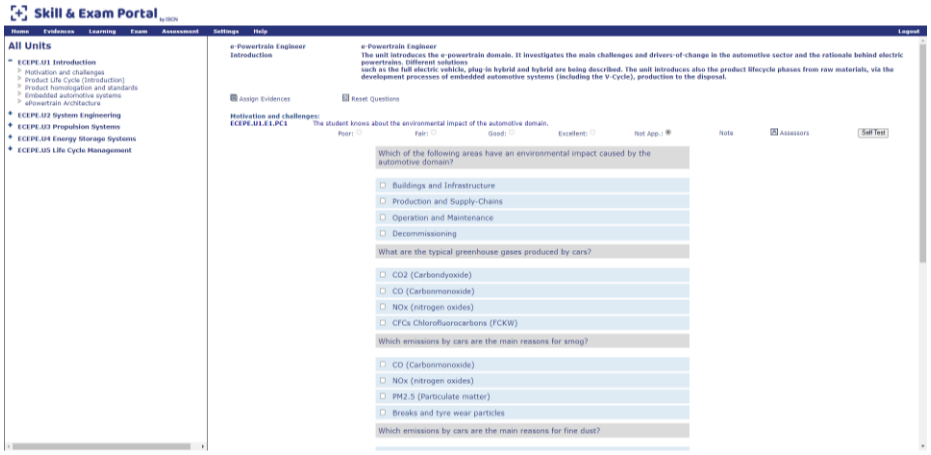

Figure 13: SELF TEST – Multiple Choice for a Performance Criteria

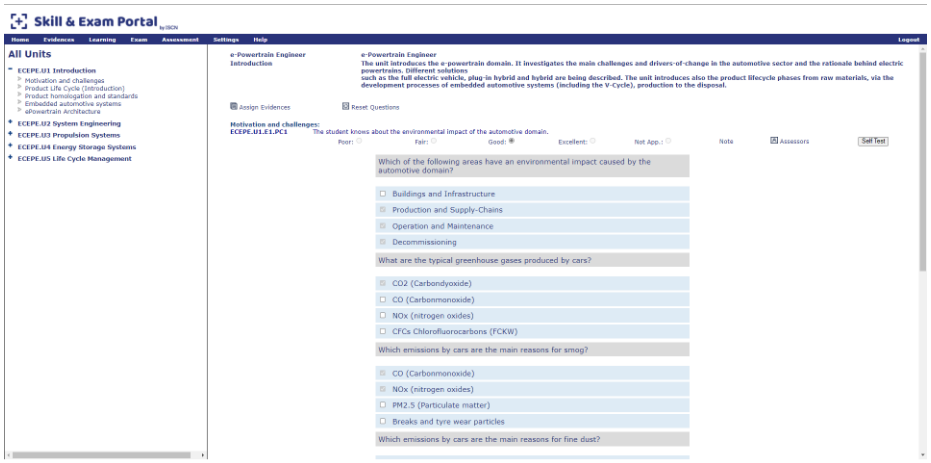

Figure 14: SELF TEST – Multiple Choice for a Performance Criteria

Reset the Self Assessment. When you select an answer the answer is locked. You can reset and repeat the self assessment by using the ach multiple choice question can reset the entire self test (Figure 14).

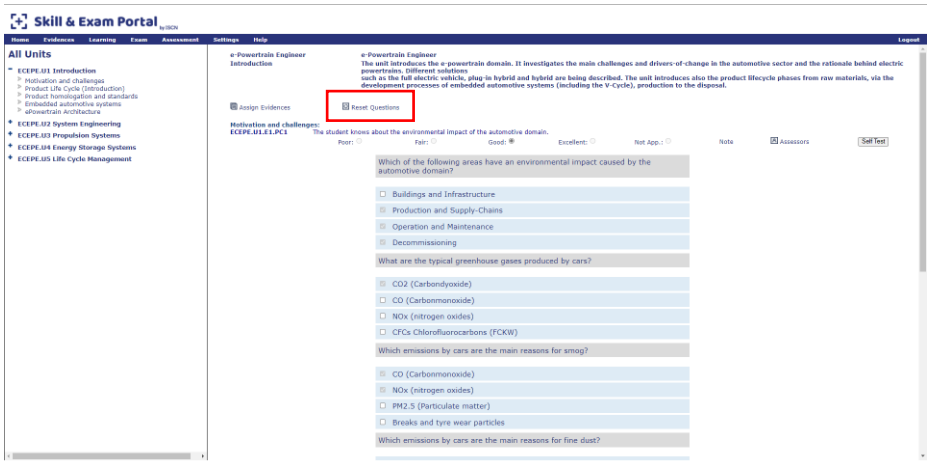

Figure 15: Reset SELF TEST

Skills Profile per Element. Your achievements in the self-test can be displayed in form of a skills profile per element. The ratings of the performance criteria are aggregated to a rating of a skills element. You pass the element when you achieved a minimum of 67%.

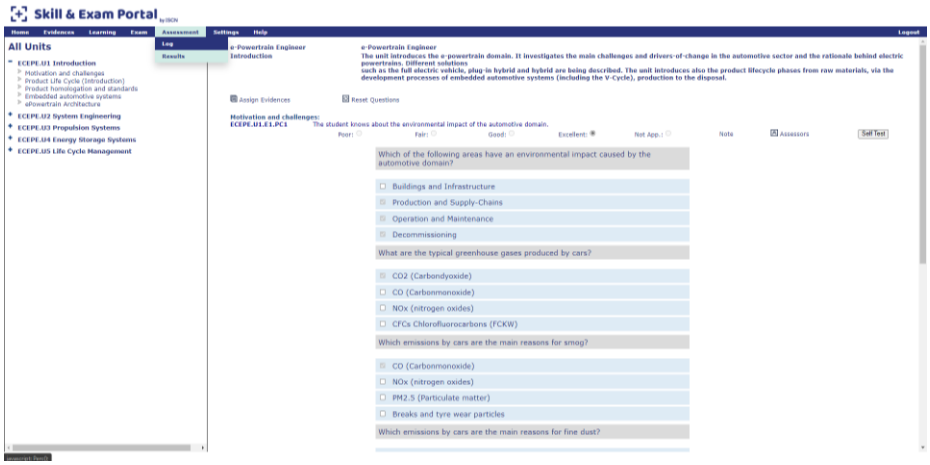

Figure 16: Main Menu ASSESSMENTS - RESULTS

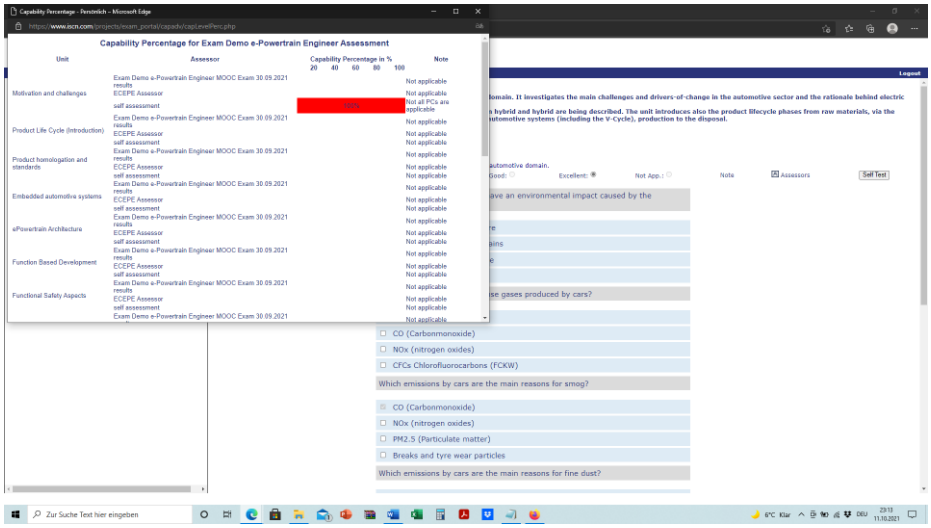

Figure 17: SKILLS PROFILE – Self Assessment

To prepare for the exam you should repeat the self-test until you achieve minimum 67% in each of the skills elements.

5.2.3 EUROSPI – ECEPE EXAM SYSTEM

Opening the exam. Exams are opened by the exam body. Only after the exam has been opened the student can see the exam. To open the exam you use the main menu EXAM and select PERFORM.

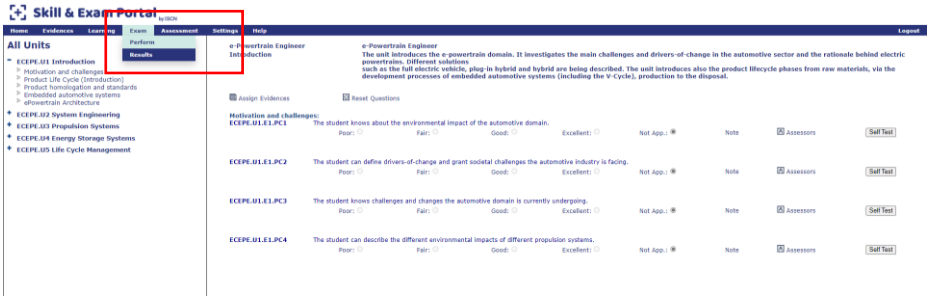

Figure 17: Opening the exam

Exam Performance. Exams are generated randomly, i.e. every participant gets a different set of exam questions generated from a pool of exam questions. The student can answer the multiple-choice questions. Every answer click is stored. You can correct your selections as long as the exam is open.

If you have a bad connection and lose the connection during the exam and you reconnect and login again the exam is still available and all answers were stored. The software checks that you are connected and displays a warning if scores were not stored due to connection to server issues.

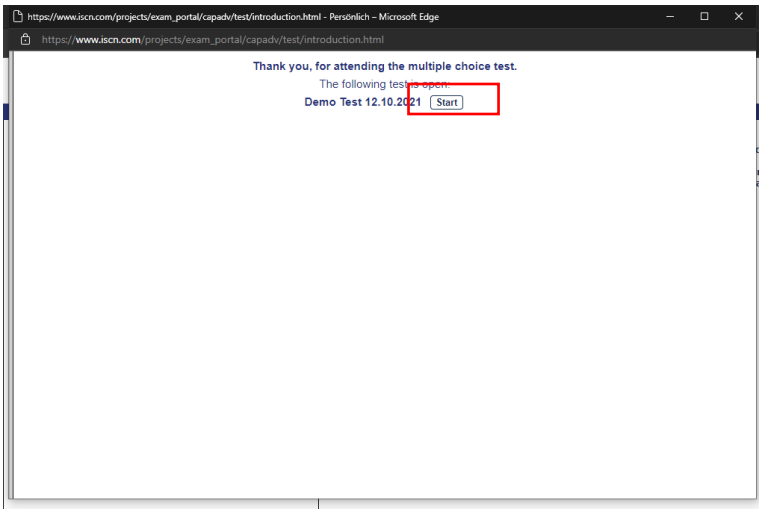

Figure 18: Starting the Exam

Once you started you see your test and you have a defined number of minutes (usually 90 minutes) to answer the questions.

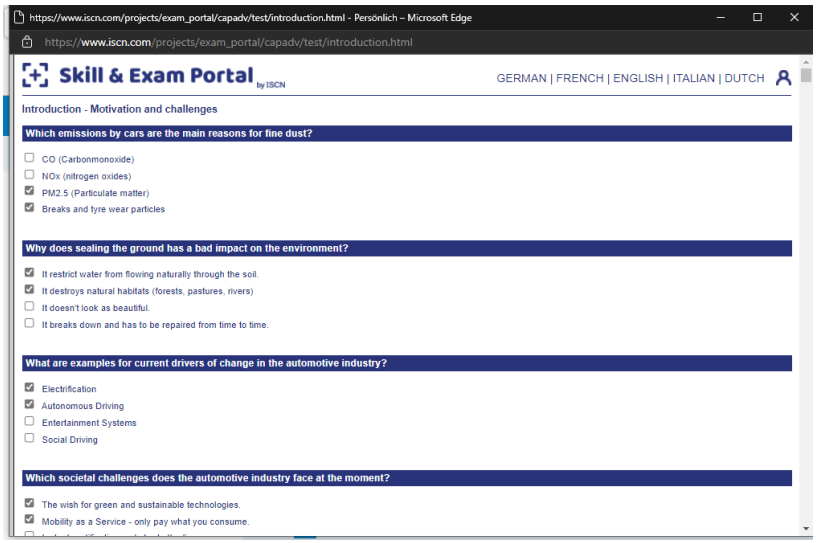

Figure 19: Answering the questions

Multiple Choice Questions. Each multiple choice question can have one or many correct answers. If a multiple choice question has n answers from which m < n answers are correct then each correct answer is 1/m worth. If you find all correct answers you get m * 1/m = 1 point. If you tick a wrong answer then you lose all points of that question and get 0 points.

The multiple choice questions are assigned to elements and for each element 67% of the pints need to be achieved.

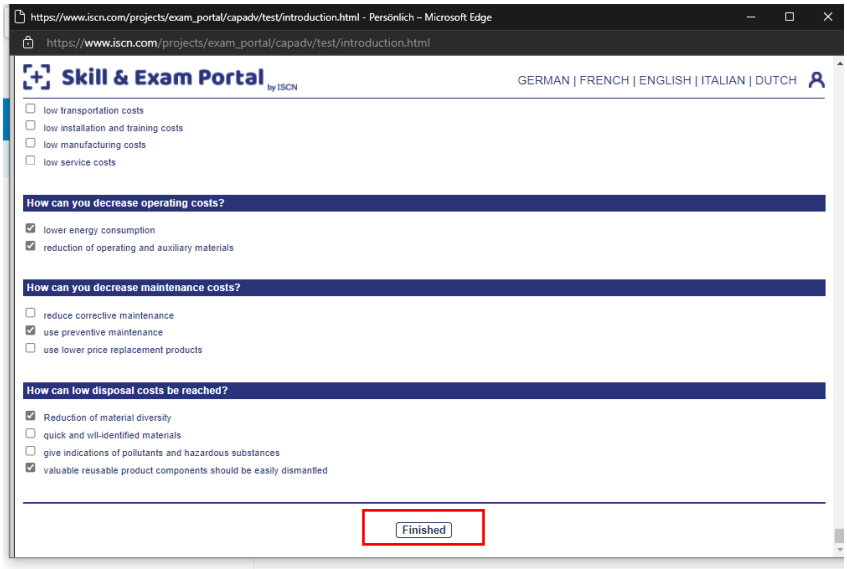

Figure 20: Finishing the Exam

Closing the exam. Only after the exam organisation closes the exam your scores will not be saved any more. As long as the exam organisation did not close the exam you still can login and continue with the exam yourself.

After the exam organisation closed the exam you can see your results.

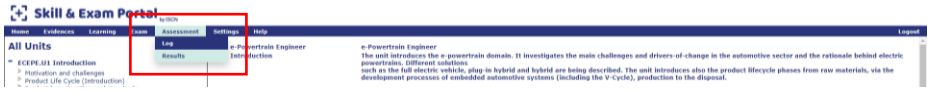

Figure 16: Exam Results

5.3 EUROSPI SKILLS DEFINITION MODEL

The EuroSPI skills definition model, used for Job Role definition, is described in chapter 2 of this document.

This model has also a mapping to the EQF model and the ESCO model which was created in an EU Blueprint project DRIVES.

5.3.1 EUROSPI – CERTIFICATE TYPES

In the standard test and examination procedures for levels of certificates are offered:

- Course Attendance Certificate
  - Received after course attendance by the training body if no test is done
- Course / Test Certificate
  - Test in a test system (European pool of test questions)
  - 67% satisfaction per element
  - Received from the EuroSPI Certificates and Services GmbH
- Renewal of certificate every 2 years
  - Attendees visit an update course
  - Attendees perform a mandatory exercise
  - Received from the EuroSPI Certificates and Services GmbH

The certificates show credited elements in comparison to all required.

6 ANNEX B EUROSPI COVERAGE OF QUALIFICATION SCHEMAS

6.1.1 MAPPING BASED ON NVQ QUALIFICATION LEVELS

Qualification / training levels: Five levels of qualification / training are defined by European legislation and this structure can be used for comparability of vocational qualifications from the different European countries.

- Level 1: semi-skilled assistant performing simple work
- Level 2: basic employee performing complex routines and standard procedures
- Level 3: skilled professional with responsibility for others and performing independent implementation of procedures
- Level 4: middle management & specialist performing tactical an strategic thinking
- Level 5: professional / university level

In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

6.1.2 MAPPING BASED ON EUROPEAN QUALIFICATION FRAMEWORK (EQF) LEARNING LEVELS

- Six level taxonomy:

Level 0: I never heard of it

1. Knowledge (I can define it):
2. Comprehension (I can explain how it works)
3. Application (I have limited experience using it in simple situations)
4. Analysis (I have extensive experience using it in complex situations)
5. Synthesis (I can adapt it to other uses)
6. Evaluation (I am recognized as an expert by my peers)

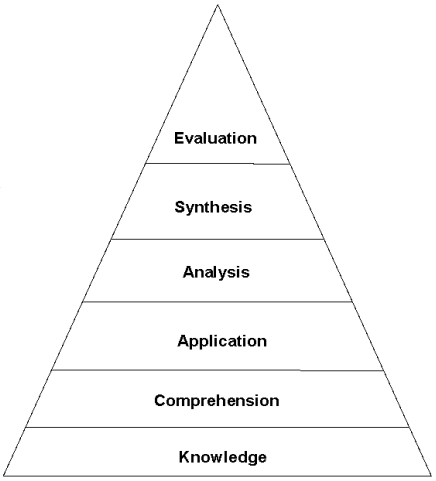

Figure 3 Blooms Learning levels

Level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	Six Sigma Yellow Belt
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Six Sigma Green Belt
Level 7	• Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields	Six Sigma Black Belt

Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Six Sigma Master Black Belt

Figure 4 EQF Learning levels

7 ANNEX C EUROSPI LEGAL BACKGROUND FOR CERTIFICATION

7.1.1 ISO/IEC 17024 STANDARD FOR PERSONNEL CERTIFICATION PROGRAMMES

The ISO/IEC 17024 standard describes standard processes for the examination and certification of people. Some of the basic principles described include:

- Standard exam procedure
- Standard certification procedure
- Identification of persons receiving the certificate
- Independence of examiner and trainer
- Certification system that allows to log the exam to keep a record/proof that the examinee passed the exam
- Mapping of processes towards ISO 17024

7.1.2 EUROSPI AND ISO/IEC 17024 STANDARD

- You can see in chapter 5 a standard exam system with a standard workflow and standard test processes applied
- When developing these standards the ISO 17024 guideline has been used as the reference model
- EuroSPI established a mapping onto the ISO 17024 norm and published that in form of a self declaration.

7.1.3 LIASION WITH INSTITUTIONS

EuroSPI established cooperation with national universities who teach job roles with ECTS. The same job roles are offered with ECVET on the market by training bodies.

The job role of ECEPE has been integrated into existing lectures at TU Graz, TU Ostrava, and the EuroSPI academy which is shared between industry and universities, and which is supported / cooperating with the ASA (Automotive Skills Alliance).

8 ANNEX D ECQA RELATED REFERENCES

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