IDEA **League**
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IDEA **League:**

Qualification Profile of the Engineer
in Electrical Engineering and Information Technology

1. Position of the Bachelor's level

The IDEA universities educate in a high-level research environment. Therefore, teaching is carried out by staff who are research active and who transmit advanced knowledge in their field. The intermediate bachelor level, reached after a 1^{st} study cycle of 3 years, is proof that fundamental knowledge and skills have been acquired allowing the pursuit of 2^{nd} cycle studies at any of the corresponding departments of the IDEA institutions and should allow students to verify that their aptitudes indeed match the specific traits of the engineering profession. They should be able to undertake work on an engineering basis in an industrial framework. 'Engineering' implies competence in design / synthesis beyond analytical skills. However, a true professional qualification for a university-level engineer is only attained at the master's level.

The IDEA League aims to produce graduates (bachelor's level profile) with the following skills and attributes.

A. General skills and attributes

The nature of university-level engineering education within the IDEA League is characterised by its scientific basis.
Students with a Bachelor diploma will

1. have a consolidated body of scientific knowledge in the underlying theoretical disciplines and the natural sciences, and be able to deploy accurately established techniques of analysis and enquiry within these fields.
2. be thoroughly familiar with common methods and paradigms of scientifically based engineering activities, i.e. to
   a) understand the role of formal models and results from the natural sciences in understanding and designing technical systems;
   b) be able to apply methods and techniques that they have acquired to review, consolidate, extend and apply their knowledge and understanding, to solve problems and to carry out projects;
   c) be able to evaluate arguments, assumptions, abstract concepts and data, in order to make judgments and to contribute to solutions of complex issues.
3. have an understanding at an introductory level of the most important research issues in their field of study and be aware of connections with other disciplines, and have the ability to describe and comment upon the implications.
4. be able to work in a team and in the context of larger projects.
5. be able to communicate information, ideas, problems, and solutions to both specialist and non-specialist audiences.
6. have awareness of possible ethical, safety, societal, environmental, aesthetic and economic implications of their discipline.
7. have the learning ability needed to undertake appropriate further training of a professional or academic nature.
8. have an appreciation of the uncertainty, ambiguity and limitations of knowledge.

B. Skills and competences specific for Electrical Engineering & Information Technology

Students from within the IDEA League are expected to acquire the following skills and knowledge before moving to the 2nd cycle at a partner institution, on a level as described in A. above (exceptions will be dealt with individually).

1. Theoretical knowledge and methods

Skills and competences that are expected concern the systematic understanding of key aspects of Electrical Engineering and Information Technology including the underlying mathematics and physics, modelling and analysis as well as synthesis methods.

Mathematics	linear algebra, calculus (including integral and differential equations) and vector calculus, complex analysis, mapping and transformations, probability and statistics, discrete mathematics.
Physics	materials science, semiconductor physics, thermodynamics, quantum mechanics, kinematics and dynamics.
Electrical engineering	basic circuits, devices, RLC components, transformers, electromechanical energy conversion, transistors, diodes and op-amps, linear passive circuits, circuit analysis, transfer functions, ac and dc analysis, transient analysis, non-linear networks, electromagnetic theory and practice, digital systems (logic circuits, combinatorial circuits, sequential circuits, finite state machines).
Information technology	algorithms and data structures, programming, software engineering, introductory computer architecture and computer systems, basic knowledge in real-time systems and distributed systems, spectral analysis, modulation, communication protocols, basic information theory, filtering, detection and estimation, feedback control, system stability.

2. Technical Practice

It is expected that students with a Bachelor diploma have a basic knowledge of the technical practice in a selected domain. This includes

a) basic practical skills in circuits, design, measurement, microprocessors and informatics as well as the corresponding state-of-the-art analysis, simulation and design tools,

b) the ability to undertake laboratory-based experiments, including the formulation of hypotheses, and to acquire the corresponding experimental data, and

c) the ability to write programs in at least one common programming language and to use complex packages (on a computer) written by others.
In addition, usually the Bachelor diploma requires a thesis or design project in teams, and as individuals.

3. System Perspective

It is expected that students with a Bachelor diploma have a basic knowledge of the methods in design, modelling and research in a selected domain. Examples for those domains are energy systems, communications, mechatronics, computers and networks, micro- and optoelectronics and automatic control.

In addition they are expected also to understand connections to other disciplines. Examples for those disciplines are mechanical engineering, physics, computer science, biology and medicine.

Students will understand systems by combining their basic knowledge in selected domains of EEIT and that of other disciplines.

4. General Education

Students will devote approximately 10% of their workload to general education subjects relevant for the engineering profession such as law, economics, management, sociology, environmental and ethical aspects, history of technology.

2. Position of Master's level

The IDEA universities educate in a high-level research environment. Therefore, teaching is carried out by staff who are research active and who transmit advanced knowledge in their field. This ensures that the graduates will have experience of being involved in real research problems and methods. This results in attributes which make the students/graduates able to engage in industry, research, development, service, consulting and management, and make them familiar with the latest developments in their field.

A. General skills and attributes

The IDEA League aims to produce graduates (master's level profile) in engineering with the following general skills and attributes.

1.Analytical and Communication Skills

The graduates will be able to apply their specific cognitive and intellectual skills in a multidisciplinary context for an externally required result. The graduates will be able

- 1.1. to take technical-scientific questions from practice, understand the problems, formulate them and then communicate them to others.
- 1.2. to analyse engineering and technology questions and formulate a solution.
- 1.3. to understand the impact of design activities on the life cycle of products.
- 1.4. to adequately report, both written and verbally in current technical language and terminology over results and work practices to persuade others about the benefits of new ideas and inventions.
- 1.5. to communicate adequately in their native language and in English.

2. Modelling, Creative and Synthesis Skills

The graduates will be creative and have acquisitive and intellectual skills to be able to work in all areas of their engineering field and cooperate with other disciplines.

The graduates will have

- 2.1. insight into the basics of natural sciences, especially physics such they can study and understand their effects, in particular their application to engineering and technology and their potential to develop innovative solutions.
- 2.2. deductive skills, learnt with studies of mathematical analysis, in order to analyse and lead to new knowledge, especially with view of new designs and engineering methodologies.
- 2.3. a lateral way of thinking and be able to use abstraction, such that they can explore new paths and to achieve new goals by generalisation.
- 2.4. representative knowledge of their engineering and technology disciplines, methods, and tools, with an emphasis on mathematical modelling and system approach. This includes the ability to design and conduct experiments, as well as to analyse and interpret data.
- 2.5. an operational understanding of system techniques, which involves transformation of market-oriented needs in specified demands, followed by an adequate system configuration through an iterative application of function analysis, synthesis, optimisation, definition, construction, judging and evaluation.

3. Engineering in Society

The professional activities of the graduates are embedded in their personal and society functioning. The graduates will

- 3.1. understand their talents and choices as well as the effects of new developments and technologies on societal processes, such that through their choices in the professional environment they can judge the impact on society.
- 3.2. promote through their actions an understanding of society for the possibilities and results of their professional activities.

3.3. have awareness of possible safety implications of their work.
3.4. be aware of their overall responsibility of their work.
3.5. be able to work in an international environment, helped by their social and cultural sensitivity and language and communication abilities, partly acquired through experience of team work and any study periods abroad.

4. *Personal Development*

By attaining the Master's in an engineering subject, the graduates will have developed the following:

4.1. independent gain and application of knowledge,
4.2. an independent and research study approach,
4.3. insight into complex decision-making processes,
4.4. insight into aspects of long-term development,
4.5. insight into the structure and functioning of companies through economic, company and legal management,
4.6. insight into the ethical aspects of the engineering profession,
4.7. work in a team and/or lead a team.

B. Skills and competences specific for Electrical Engineering & Information Technology

The domain and subject-specific skills and competences attained at master's level build upon the skills and competences at bachelor's level. The master phase of the programme provides a high level of specialisation, a research-related training and in-depth domain-specific knowledge at a professional level. Since the master phase is aimed at specialisation and offers many choices, a global list of subject-specific competences for a master cannot be provided here.

Depending on specialisation and university, many different options for gaining technical competence are available such as

a) term and master projects in small groups and as individuals,
b) practical work directly related to lectures,
c) industrial experience and practice.

The master thesis demonstrates the capability of the individual to work at a professional level contributing to research projects, i.e. to plan, conduct and report a programme of original research.

Electrical engineering and information technology is in many respects a typical system science. For example the different components of a complex system are connected and functionally combined using electronic subsystems. Students will understand systems by combining their in-depth knowledge in selected domains of EEIT and that of other disciplines. They are able to apply theoretical concepts of system identification, modelling and optimisation.