CDIO OPTIONAL STANDARDS 3.0

The CDIO standards are a set of principles (or best practices) underlying the implementation of CDIO in an engineering programme. They define the distinguishing features of a CDIO programme, serve as guidelines for educational reform, enable benchmarking with other programmes, and provide a tool for self-evaluation to support continuous improvement.

Version history

Date	Description
26 October 2020	First version of document posted
12 July 2022	Rubric for Engineering entrepreneurship optional standard corrected

Optional Standard 1: Sustainable development

A program that identifies the ability to contribute to a sustainable development as a key competence of its graduates. The program is rich with sustainability learning experiences, developing the knowledge, skills and attitudes required to address sustainability challenges

Description

The program emphasizes environmental, social and economic sustainability in the adoption of the CDIO principles as the context for engineering education (Standard 1). Sustainability related knowledge, skills and attitudes, are explicitly addressed in program goals and learning outcomes (Standard 2). Aspects of sustainable development are integrated in several mutually supporting disciplinary courses and projects, possibly in combination with specific sustainability courses (Standard 3). Concepts of sustainability, potentials and limitations of science and technology and related roles and responsibilities of engineers, are established at an early stage of the education (Standard 4). Design-implement experiences provide students with opportunities to apply and contextualize sustainability knowledge, skills and attitudes, both in the development of new technology and in the reuse, redesign, recycling, retirement, etc., of existing technology (Standard 5). Physical and digital learning environments enable interdisciplinary and transdisciplinary collaborative learning and interaction with various external stakeholders (Standard 6). Sustainability learning experiences are integrated with the learning of disciplinary knowledge, personal and interpersonal skills, and product, process, system and service building skills (Standard 7). Active experiential and transformative learning activities develop students' key competences for sustainability (Standard 8). Enhancement of faculty competences for sustainability and related teaching competences is actively promoted (Standard 9 & 10). Approaches appropriate for assessing sustainability related learning outcomes are implemented (Standard 11). The integration of sustainable development is evaluated by students, faculty, industry and societal stakeholders, and in relation to relevant UN and other frameworks (Standard 12).

Rationale

To address the issues of sustainability is a key challenge for humanity. Engineers need to understand the implications of technology on social, economic and environmental sustainability factors, in order to develop appropriate technical solutions in collaboration with other actors in addressing societal issues.

Rubric for self-assessment

5	Sustainable development is fully integrated in accordance with the description in the optional CDIO standard for sustainable development.
4	The integration of sustainable development is pervasive, well adapted to the program context, promoting progression of knowledge, skills, and attitudes, and there is documented evidence that students have achieved the related intended learning outcomes.
3	There are explicit program goals and intended learning outcomes related to environmental, social, and economic sustainability and at least three substantial

	sustainable development learning experiences of increasing complexity including an introduction early in the program.
2	At least one substantial sustainable development learning experience is being implemented and there is a plan for extended integration of sustainable development.
1	Minor sustainable development learning experiences have been implemented and needs and opportunities for extended integration of sustainable development have been identified.
0	There are no sustainable development learning experiences in the program.

Optional Standard 2: Simulation-based mathematics

Engineering programs for which the mathematics curriculum is infused with programming, numerical modeling and simulation from the start

Description

The program emphasizes the importance of simulation-based mathematics in engineering education, research and practice. The program idea brings forward advanced simulation skills as distinctive skill of its graduates. Mathematical programming, modeling and simulation knowledge and skills are explicitly addressed in program and course goals and learning outcomes. Basic mathematics courses mix the learning of mathematical lemmas and methods with direct practice of numerical program solving, aided by mathematical software. Mathematics courses teach programming of algorithms for equation solving. Common, mutually-supporting, simulation-based assignments connect mathematics and engineering science courses. Planned learning sequences for advancing mathematical modeling and simulation skills throughout the curriculum. Design-implement experiences are designed to, in addition to develop hands-on prototyping skills, reinforce and enhance mathematical modeling and simulation concepts and competencies.

Rationale

The mathematics courses will include more authentic and complex problems. Realistic decision-making situations can be simulated. The connection to science and engineering courses can be reinforced. A better understanding of what advanced mathematics can be used for and how that it carried out strengthens student motivation.

Rubric for self-assessment

5	The course/module and program learning outcomes for mathematical programming, modelling and simulation are regularly evaluated and revised, based on feedback from students, instructors, and other stakeholders.
4	There is documented evidence that students have achieved the intended learning outcomes for mathematical programming, modelling and simulation.
3	Course and/or program learning outcomes for mathematical programming, modelling and simulation are validated with key program stakeholders, including faculty, students, alumni, and industry representatives and levels of proficiency are set for each outcome.
2	A plan to incorporate explicit statements of learning outcomes at course/module level as well as program outcomes for mathematical programming, modelling and simulation is accepted by program leaders, engineering faculty, and other stakeholders.
1	The need to create or modify learning outcomes at course/module level and program outcomes for mathematical programming, modelling and simulation are recognized and such a process has been initiated.
0	There are no explicit program learning outcomes at course/module level nor program outcomes that cover mathematical programming, modelling and simulation.

Optional Standard 3: Engineering entrepreneurship

Engineering programs that actively prepare graduates for creating technology-based business ventures, in order to produce economic and other values for society

Description

A curriculum that is permeated with entrepreneurial learning experiences, tailored to the relevant learning goals as defined in Standard 2. Entrepreneurial competence is developed through entrepreneurship learning activities (e.g. by students performing value creation projects in the community), by learning about entrepreneurship (e.g., marketing, intellectual property rights), by learning in entrepreneurial settings (e.g., student incubators or student-run companies) and learning for entrepreneurship (e.g. business model creation tools). The learning experiences are supported by appropriate learning environments, for example various kinds of maker spaces, and by staff with entrepreneurial competence. Throughout the curriculum, projects can be made increasingly authentic and realistic. They can allow students to make real-world connections and interacting with stakeholders. Some projects may involve co-creating solutions with clients or users. Valuable learning occurs not only through the hands-on activities, but also when the students reflect on their experiences, including their processes and methods, successes and setbacks. This is furthered by teacher-facilitated opportunities for reflection.

Rationale

The role of engineers has broadened from designing and implementing technical solutions to also forming business ventures based on technological innovations, thereby creating value for society. Startups are increasingly based on ideas developed by students during their studies, or on ideas and intellectual property owned by university researchers that students further develop and commercialize. The needed competences include for example opportunity identification, business planning, intellectual property rights, company financing and marketing. Entrepreneurial learning activities can be designed to address not only students' abilities in relation to venturing, but also, simultaneously, many learning outcomes that are broadly desired in all engineering programs, such as personal and interpersonal skills, and other engineering skills.

Rubric for self-assessment

5	The entrepreneurial learning experiences are regularly evaluated and revised, based on feedback from students, instructors, and other stakeholders.
4	There is documented evidence that students have achieved the intended learning outcomes of the entrepreneurial learning experiences.
3	At least two entrepreneurial learning experiences of increasing complexity are being implemented.
2	There is a plan to develop entrepreneurial learning experiences at basic and advanced level.
1	A needs analysis has been conducted to identify opportunities to include entrepreneurial experiences in the curriculum.
0	There are no entrepreneurial learning experiences in the engineering program.

Optional Standard 4: Internationalization & mobility

Programs and organizational commitment which exposes students to foreign cultures, and promotes and enables transportability of curriculum, portability of qualifications, joint awards, transparent recognition and international mobility

Description

The institution demonstrates a tangible organizational commitment to internationalization and student mobility. It enunciates the exposure, promotion, facilitation, opportunity and scholarship of an internationalized curriculum, qualifications and international mobility of students. Curricula which prepare engineers for a global environment and exposes them to a rich set of international experiences and contexts during their studies. Student learning outcomes include attributes and competencies which are recognized through international accords. Authentic cultural awareness learning experiences are embedded within the curriculum or social activities. Opportunities are made available for students to learn second and third languages. Study abroad and other international experiences (including internships, exchanges) are encouraged and recognized, for credit. Institutional cross-credit for study abroad is transparent. The institution establishes partnerships with international universities, benchmarks programs internationally and is actively involved in international engineering education scholarly activities.

Rationale

Graduate engineers increasingly need to be international in their outlook and experience, and be prepared to operate globally. Businesses progressively more compete and collaborate on a global scale, and operate across national and international borders with organizational environments being increasingly complex, dynamic and with greater interdependencies. Our challenge, as educational institutions, is to aid our students to prepare for this global environment.

Rubric for self-assessment

5	Program Internationalization and student mobility outcomes are regularly evaluated and revised, based on feedback from students, instructors, and other stakeholders.
4	There is documented evidence that students have achieved the intended learning outcomes related to an internationalized Program.
3	The plan for internationalized learning outcomes and opportunities for meaningful student mobility embedded within the Program has been implemented.
2	A plan for internationalizing the Program and opportunities for student mobility to be embedded within the Program has been approved and a process to implement the plan has been initiated
1	The need for internationalization of the Program and opportunities for student mobility is recognized and a planning process initiated.
0	There is no aspect in the Program that provides a framework for students to develop internationalized practice or key skills, nor to engage in meaningful mobility opportunities within the curriculum.