WORLD FORUM of Universities of Resources on SUSTAINABILITY

Development of Education Standards

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Development of Education Standards

Content

- Washington Accord (Professional Engineers)
- ABET (BSc all Engineering disciplines)
- ABET Mining Engineering (Master)
- Our Tasks

Development of Education Standards

IEA

INTERNATIONAL ENGINEERING ALLIANCE

Washington Accord	**International Professional Engineers Agreement**
Sydney Accord	**International Engineering Technologists Agreement**
Dublin Accord	**APEC Engineer Agreement**

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Educational Accords

The **Washington Accord**, Sydney Accord and Dublin Accord are three multi-lateral agreements between **groups of jurisdictional agencies responsible for accreditation** or recognition of tertiary-level engineering qualifications within their jurisdictions who have chosen to work collectively to assist the **mobility of engineering practitioners** (i.e. professional engineers, engineering technologists and engineering technicians) holding suitable qualifications.

Membership (called being a signatory) is voluntary, but the signatories are committed to development and recognition of **good practice in engineering education**.

The activities of the Accord signatories (for example in developing exemplars of the graduates' profiles from certain types of qualification) are intended to assist growing **globalisation** of mutual recognition of engineering qualifications.

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Washington Accord

Washington Accord Signatories
Signed in 1989 by:
Accreditation Board for Engineering and Technology Canadian Council of Professional Engineers Engineering Council United Kingdom Institution of Engineers Australia Institution of Engineers, Ireland Institution of Professional Engineers New Zealand
Signed in 1995 by:
Hong Kong Institution of Engineers
Signed in 1999 by:
Engineering Council of South Africa
Signed in 2005 by:
Japan Accreditation Board for Engineering Education
Signed in 2006 by:
Institution of Engineers Singapore
Signed in 2007 by:
Chinese Taipei: Institute of Engineering Education Taiwan Accreditation Board for Engineering Education of Korea
Signed in 2009 by:
Board of Engineers Malaysia
Signed in 2011 by:
MUDEK- Association for Evaluation and Accreditation of Engineering Programmes
Signed in 2012 by:
AEER – Association for Engineering Education of Russia
Signed in 2014 by:
National Board of Accreditation India (NBA) (applies only to programmes accredited by NBA offered by education providers accepted by NBA as Tier 1 institutions). Institution of Engineers Sri Lanka

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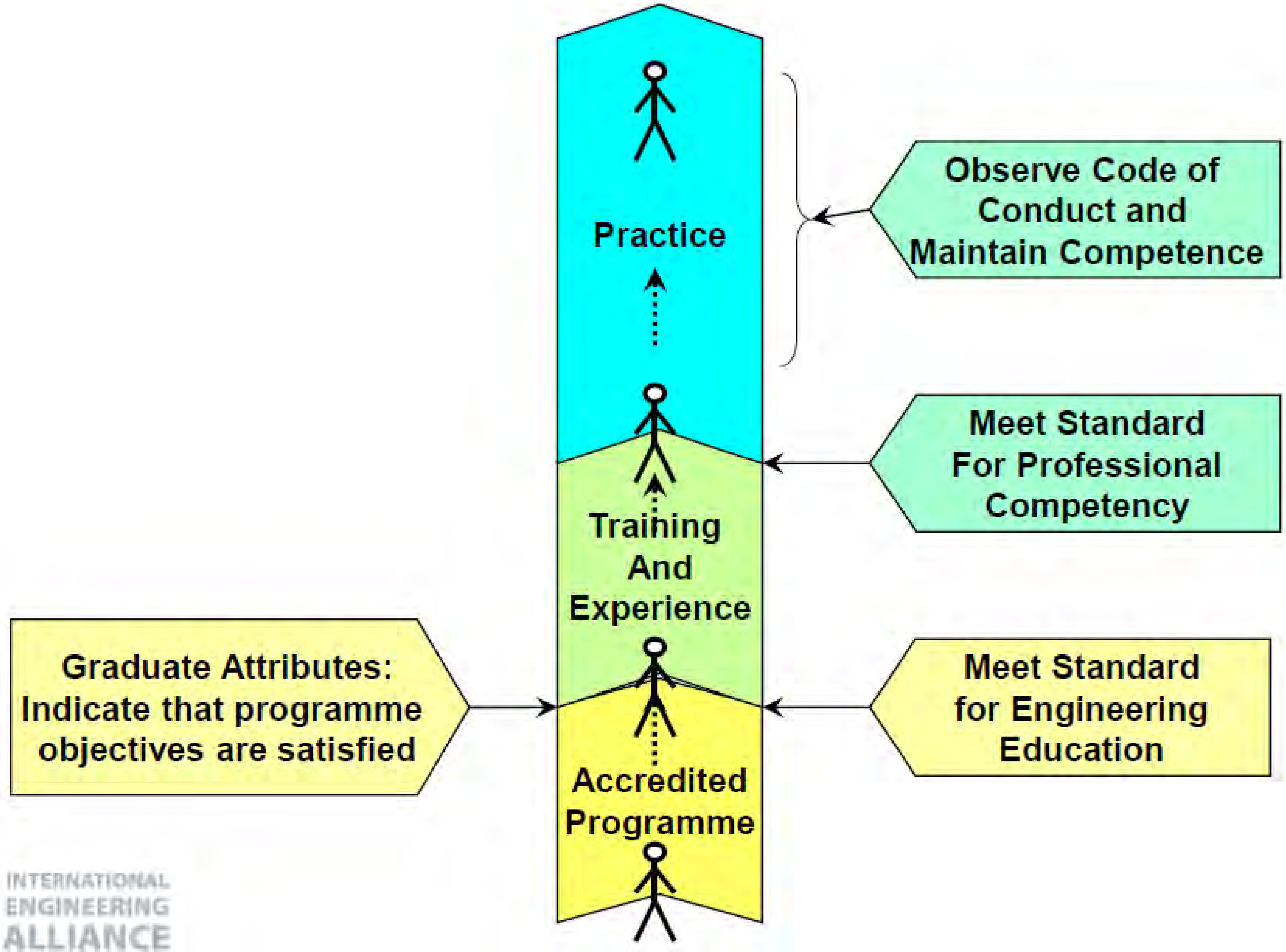
Context: Engineering Professional Lifecycle



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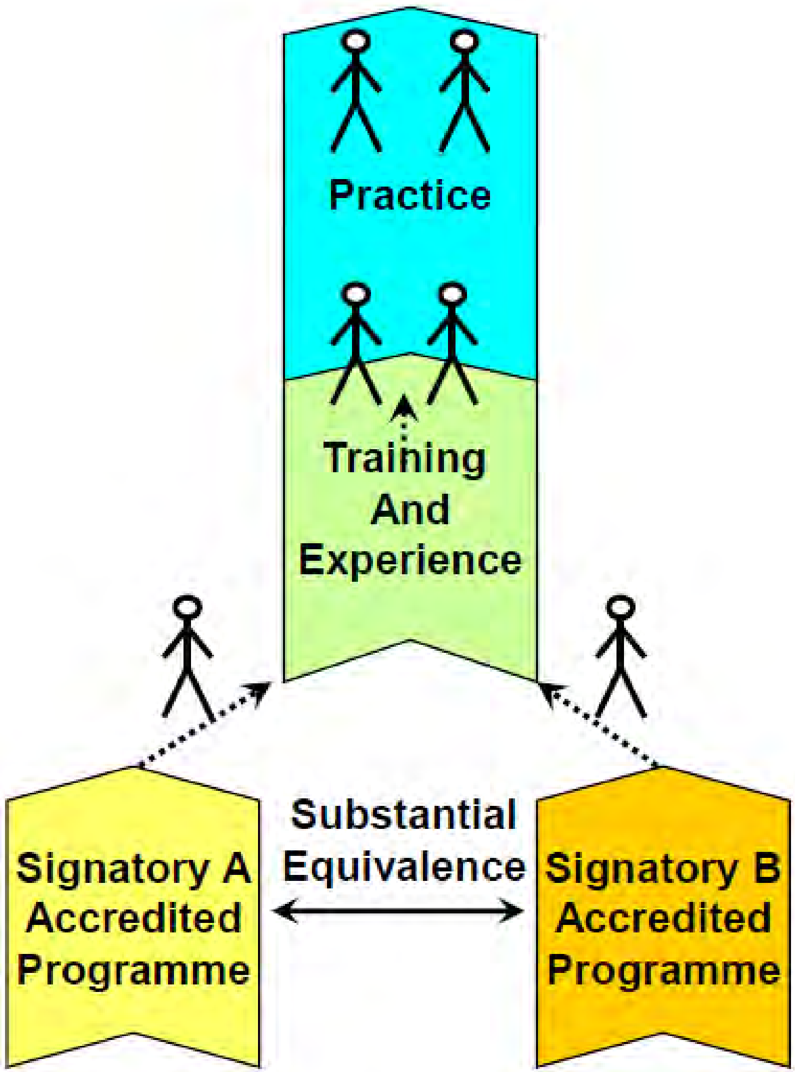
Substantial Equivalence



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Substantial Equivalence

Each educational level accord is based on the **principle of *substantial equivalence*,** that is, programmes are not expected to have identical outcomes and content but rather produce graduates who could enter employment and be fit to undertake a programme of training and experiential learning leading to professional competence and registration.

The **graduate attributes** provide a point of reference for bodies to describe the outcomes of substantially equivalent qualification. The graduate attributes do not, in themselves, constitute an "international standard" for accredited qualifications but **provide a widely accepted common reference** for bodies to describe the outcomes of substantially equivalent qualifications.

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WP Problem Solving I

Attribute	Complex Engineering Problems have characteristic WP1 and some or all of WP2 to WP7:
Depth of Knowledge Required	WP1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a fundamentals-based, first principles analytical approach
Range of conflicting requirements	WP2: Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	WP3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	WP4: Involve infrequently encountered issues
Extent of applicable codes	WP5: Are outside problems encompassed by standards and codes of practice for professional

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WP Problem Solving II

	technical, engineering and other issues
Depth of analysis required	WP3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	WP4: Involve infrequently encountered issues
Extent of applicable codes	WP5: Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	WP6: Involve diverse groups of stakeholders with widely varying needs
Interdependence	WP 7: Are high level problems including many component parts or sub-problems
In addition, in the context of the Professional Competencies	
Consequences	EP1: Have significant consequences in a range of contexts
Judgement	EP2: Require judgement in decision making

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Range of Engineering Activities (EA)

Attribute	Complex Activities
Preamble	Complex activities means (engineering) activities or projects that have some or all of the following characteristics:
Range of resources	EA1: Involve the use of diverse resources (and for this purpose resources includes people, money, equipment, materials, information and technologies)
Level of interactions	EA2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues,
Innovation	EA3: Involve creative use of engineering principles and research-based knowledge in novel ways.
Consequences to society and the environment	EA4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	EA5: Can extend beyond previous experiences by applying principles-based approaches

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Knowledge Profile I

WK1: A systematic, theory-based understanding of the **natural sciences** applicable to the discipline

WK2: Conceptually-based **mathematics**, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline

WK3: A systematic, theory-based formulation of **engineering fundamentals** required in the engineering discipline

WK4: Engineering specialist knowledge that provides **theoretical frameworks and bodies** of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

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Knowledge Profile II

WK5: Knowledge that supports **engineering design** in a practice area

WK6: Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline

WK7: Comprehension of the role of **engineering in society** and identified issues in engineering practice in the discipline: **ethics** and the professional **responsibility** of an engineer to public **safety**; the impacts of engineering activity: **economic, social, cultural, environmental and sustainability**

WK8: Engagement with selected knowledge in the **research literature** of the discipline

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Attribute Profiles I

Differentiating Characteristic	… for Washington Accord Graduate
Engineering Knowledge	WA1: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to the solution of complex engineering problems.
Problem Analysis Complexity of analysis	WA2: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (WK1 to WK4)
Design/ development of solutions: Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified	WA3: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (WK5)
Investigation: Breadth and depth of investigation	WA4: Conduct investigations of complex problems

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Attribute Profiles II

	mathematics, natural sciences and engineering sciences. (WK1 to WK4)
Design/ development of solutions: Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified	WA3: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (WK5)
Investigation: Breadth and depth of investigation and experimentation	WA4: Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
Modern Tool Usage: Level of understanding of the appropriateness of the tool	WA5: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. (WK6)
The Engineer and Society: Level of knowledge and responsibility	WA6: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex

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Attribute Profiles III

	research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
Modern Tool Usage: Level of understanding of the appropriateness of the tool	WA5: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. (WK6)
The Engineer and Society: Level of knowledge and responsibility	WA6: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (WK7)
Environment and Sustainability: Type of solutions.	WA7: Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (WK7)
Ethics: Understanding and level of practice	WA8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (WK7)
Individual and Team work: Role in and diversity of	WA9: Function effectively as an individual, and as

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Attribute Profiles IV

	and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (WK7)
Environment and Sustainability: Type of solutions.	WA7: Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (WK7)
Ethics: Understanding and level of practice	WA8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (WK7)
Individual and Team work: Role in and diversity of team	WA9: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
Communication: Level of communication according to type of activities performed	WA10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as

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Attribute Profiles V

Communication: Level of communication according to type of activities performed	WA10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project Management and Finance: Level of management required for differing types of activity	WA11: Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
Lifelong learning: Preparation for and depth of continuing learning.	WA12: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change, achieved in 4 to 5 years of study, depending on the level of students at entry.

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Professional Competency Profiles I

Differentiating Characteristic	Professional Engineer
Comprehend and apply universal knowledge: Breadth and depth of education and type of knowledge	EC1: Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice
Comprehend and apply local knowledge: Type of local knowledge	EC2: Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction in which he/she practices.
Problem analysis: Complexity of analysis	EC3: Define, investigate and analyse complex problems
Design and development of solutions: Nature of the problem and uniqueness of the solution	EC4: Design or develop solutions to complex problems
Evaluation: Type of activity	EC5: Evaluate the outcomes and impacts of complex activities

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Professional Competency Profiles II

Problem analysis: Complexity of analysis	EC3: Define, investigate and analyse complex problems
Design and development of solutions: Nature of the problem and uniqueness of the solution	EC4: Design or develop solutions to complex problems
Evaluation: Type of activity	EC5: Evaluate the outcomes and impacts of complex activities
Protection of society: Types of activity and responsibility to public	EC6: Recognise the reasonably foreseeable social, cultural and environmental effects of complex activities generally, and have regard to the need for sustainability; recognise that the protection of society is the highest priority
Legal and regulatory	EC7: Meet all legal and regulatory requirements and protect public health and safety in the course of his or her activities
Ethics	EC8: Conduct his or her activities ethically
Manage engineering activities: Types of activity	EC9: Manage part or all of one or more complex activities
Communication	EC10: Communicate clearly with others in the course of his or her activities

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Professional Competency Profiles III

	and protect public health and safety in the course of his or her activities
Ethics	EC8: Conduct his or her activities ethically
Manage engineering activities: Types of activity	EC9: Manage part or all of one or more complex activities
Communication	EC10: Communicate clearly with others in the course of his or her activities
Lifelong learning: Preparation for and depth of continuing learning.	EC11: Undertake CPD activities sufficient to maintain and extend his or her competence
Judgement: Level of developed knowledge, and ability and judgement in relation to type of activity	EC12: Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of his or her complex activities
Responsibility for decisions: Type of activity for which responsibility is taken	EC12: Be responsible for making decisions on part or all of complex activities

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Engineering Accreditation Commission

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E-mail: accreditation@abet.org
Website: www.abet.org

Seven societies founded ABET's predecessor, the Engineers' Council for Professional Development, in 1932. Today, ABET has 33 member societies representing many disciplines.

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Engineering Accreditation Commission

Criterion 1. Students

Student performance must be evaluated. Student progress must be monitored to foster success in attaining student outcomes, thereby enabling graduates to attain program educational objectives. Students must be advised regarding curriculum and career matters.

The program must have and enforce policies for accepting both new and transfer students, awarding appropriate academic credit for courses taken at other institutions, and awarding appropriate academic credit for work in lieu of courses taken at the institution. The program must have and enforce procedures to ensure and document that students who graduate meet all graduation requirements.

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Engineering Accreditation Commission

Criterion 2. Program Educational Objectives

The program must have published program educational objectives that are consistent with the **mission** of the institution, the needs of the program's various constituencies, and these criteria.

There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria.

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Engineering Accreditation Commission

Criterion 3. Student Outcomes I

The program must have documented student outcomes that prepare graduates to attain the program educational objectives.
Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) an ability to apply knowledge of **mathematics, science, and engineering**

(b) an ability to design and conduct **experiments**, as well as to **analyze** and **interpret data**

(c) an ability to **design a system**, component, or process to meet desired needs **within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability**

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Criterion 3. Student Outcomes II

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and **ethical responsibility**

(g) an ability to communicate effectively

(h) **the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context**

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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Criterion 4. Continuous Improvement

The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program.

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Criterion 5. Curriculum I

The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program and institution. The professional component must include:

(a) **one year of a combination of college level mathematics and basic sciences** (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences.

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Engineering Accreditation Commission

Criterion 5. Curriculum II

(b) **one and one-half years of engineering topics**, consisting of engineering sciences and engineering design appropriate to the student's field of study.

The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application.

These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

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Engineering Accreditation Commission

Criterion 5. Curriculum III

(c) a general education component that complements the technical content of the curriculum and is **consistent** with the program and institution objectives.

Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints.

One year is the lesser of 32 semester hours (or equivalent) or one-fourth of the total credits required for graduation.

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Engineering Accreditation Commission

Criterion 6. Faculty

The program must demonstrate that the **faculty members are of sufficient number** and they have the competencies to cover all of the curricular areas of the program.

There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.

The program faculty must have appropriate **qualifications** and must have and demonstrate sufficient **authority** to ensure the proper guidance of the program and to develop and implement processes for the evaluation, assessment, and continuing **improvement** of the program. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching effectiveness and experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and licensure as Professional Engineers.

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Engineering Accreditation Commission

Criterion 7. Facilities

Classrooms, offices, laboratories, and associated equipment must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning. Modern tools, equipment, computing resources, and laboratories appropriate to the program must be available, accessible, and systematically maintained and upgraded to enable students to attain the student outcomes and to support program needs. Students must be provided appropriate guidance regarding the use of the tools, equipment, computing resources, and laboratories available to the program.

The **library services and the computing and information infrastructure** must be adequate to support the scholarly and professional activities of the students and faculty.

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Engineering Accreditation Commission

Criterion 8. Institutional Support

Institutional support and leadership must be adequate to **ensure the quality** and continuity of the program.

Resources including institutional services, financial support, and staff (both administrative and technical) provided to the program must be adequate to meet program needs. The resources available to the program must be sufficient to attract, retain, and provide for the continued professional development of a qualified faculty. The resources available to the program must be sufficient to acquire, maintain, and operate infrastructures, facilities, and equipment appropriate for the program, and to provide an environment in which student outcomes can be attained.

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2 Criteria for Mining Programs (Master) I

Program Criteria for Mining and Similarly Named Engineering Programs (Master)
Lead Society: Society for Mining, Metallurgy, and Exploration

1. Curriculum

The program must prepare graduates to apply **mathematics** through differential equations, calculus-based physics, general chemistry, and probability and statistics as applied to mining engineering problem applications;

to have **fundamental knowledge** in the geological sciences including characterization of mineral deposits, physical geology, structural or engineering geology, and mineral and rock identification and properties;

to be **proficient in** statics, dynamics, strength of materials, fluid mechanics, thermodynamics, and electrical circuits;

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2 Criterea for Mining Prorams (Master) II

Program Criteria for Mining and Similarly Named Engineering Programs (Master)
Lead Society: Society for Mining, Metallurgy, and Exploration

1. Curriculum

to be **proficient in engineering topics** related to both surface and underground mining, including: mining methods, planning and design, ground control and rock mechanics, health and safety, environmental issues, and ventilation;

to be proficient in **additional engineering topics** such as rock fragmentation, materials handling, mineral or coal processing, mine surveying, and valuation and resource/reserve estimation as appropriate to the program objectives.

The **laboratory experience** must prepare graduates to be proficient in geologic concepts, rock mechanics, mine ventilation, and other topics appropriate to the program objectives.

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2 Criterea for Mining Prorams (Master) III

Program Criteria for Mining and Similarly Named Engineering Programs (Master)
Lead Society: Society for Mining, Metallurgy, and Exploration

2. Faculty

Evidence must be provided that the program faculty understand professional engineering practice and maintain currency in their respective professional areas.

Program faculty must have responsibility and authority to define, revise, implement, and achieve program objectives.

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Tasks for WFURS

Contribute to the Attributes Profiles

for different programs

WA6 Ethics
WA7 Engineer and Society
WA8 Environment and Sustainability

Own Brand/ Label