Interpretation and Reference on Criteria of Engineering Education Accreditation

CEEAA

No. 30, Xueyuan Road, Haidian District

Beijing 100083

Phone: 86-10-66093183

Email: ceeaa@cast.org.cn

Website: http://www.ceeaa.org.cn

Interpretation and Reference on Criteria of Engineering Education Accreditation

To better understand the accreditation criteria and ensure the substantial equivalence internationally, the China Engineering Education Accreditation Association (CEEAA) has formulated the *Interpretation and Reference on Criteria of Engineering Education Accreditation* for reference in the engineering education accreditation. The instructions of this document are as follows.

1. Purpose and Role

This document is intended only as a supporting reference to help evaluators and programs understand the accreditation criteria for better self-study and review. Please note that this document is not a substitute for the *Engineering Education Accreditation Criteria*, it does not include rigid requirements that must be implemented by the program to be accredited, and does not serve as an absolute guideline for evaluators to determine the review results.

The program should carry out self-study according to the actual situation on the basis of understanding the requirements of the *Engineering Education Accreditation Criteria*. Evaluators should judge the program’s attainment of the criteria according to the *Engineering Education Accreditation Criteria*.

2. Main Contents

This document intuitively expresses the connotation of the outcome-based concept and accreditation criteria, and highlights the accreditation requirements of outcome-based educational program and the prerequisite of getting accredited.

This document sets the level of "problem solving" for student training at "complex engineering problems" to ensure that the substantial equivalency requirements of the Washington Accord are met.

This document gives a reference explanation of accreditation criteria, including connotation explanation of each criteria item, the focus of program self-study and evaluator review, and the problems in understanding and application of the criteria.

3. Revision Principles

CEEAA will update this document in a timely manner according to the needs of accreditation work. For example, according to the further development of the accreditation work and the deepening understanding of the accreditation criteria, CEEAA will refine, supplement or optimize this document, to ensure that the interpretation and description are in line with the accreditation requirements.

1. Students

1.1 The program must have policies and procedures to attract outstanding students

【Connotation interpretation】

The "outstanding students" should include both "quality" and "quantity". "Quality" means that the student meets the program expectations. The "quantity" indicates the adequacy of the student scource. The "outstanding students" is a relative concept, which is influenced by the institution, industry and social background, and is expressed differently in different programs.

The "policies and procedures" focus on the requirements of the institution and the measures taken by the program, usually including the analysis of the quality of students, the analysis of the advantages of the program, the enrollment promotion, the scholarships, grants and loans specific to the program, and the analysis of the recognition of the program by the students. The policies and procedures should be stable and continuous, with personnel and conditions to ensure implementation and enforcement. In addition, the implementation effect of the policies and procedures should be analyzed and evaluated to promote its improvement.

【Program self-study and evaluator’s review focus】

1. Policies and regulations related to program admissions, including the responsibilities assigned to the program and the system of program autonomy, etc., especially the responsibility assumed by the program to improve the quality of students and the specific measures to implement the responsibility, and the analysis and evaluation of the effectiveness of the policies and procedures.

2. The expectations of the program on student source, as well as the analysis of the status and development trend of the student in the past three years, including the status of the students on campus, the awareness and recognition of the program by the students and their willingness to study, etc.

3. Mechanisms to ensure the proper and effective conduct of the relevant work, and supporting documents for the implementation.

【Common problems】

1. Just list the institution-level admission regulations, the responsibility of program for attracting the outstanding students is not clear.

2. Just list the grades of the entrance examinations of new students or the academic performance of the program, did not analyze the changes in the student source and take measures accordingly.

3. Did not investigate and analyze the recognition of the program by the students enrolled, and no measures was taken in response to the results of the analysis. Did not pay enough attention to student attrition.

1.2 The program must have enforced policies and procedures on learning advising, career planning, employment guidance and psychology counseling for students

【Connotation interpretation】

Program should carry out student learning advising, career planning, employment guidance and psychological counseling, help students attain graduation outcomes and achieve student development. Among the various guidance activities, student learning advising is the focus.

Teachers of the program should play a major role in developing students' competence and provide study advising in conjunction with course teaching. Study advising should achieve the following three goals:

First, to help students understand the graduate outcomes and know how to attain them;

Second, to help students understand the relationship between the curriculum and graduate outcomes, to enable students understanding the role of course learning in attaining relevant graduate outcomes;

Third, to timely assistant students in their course learning and professional competencies development.

【Program self-study and evaluator’s review focus】

1. The program explains the educational program to students; helps students understand the educational objective, graduate outcomes, curriculum and their interrelationships.

2. The requirements and policy support of the program for teachers to carry out student learning advising. The responsibilities and specific requirements (content, frequency, methods, coverage, etc.) of teachers in student learning advising are clearly defined, as well as the policy support for learning advising (working conditions equipped, workload recognition, etc.). There is evidence that teachers know the work requirements and can effectively implement them.

3. The relevance of student learning advising to graduate outcomes. Teachers have explained the course syllabus clearly to students and explained how the course learning outcomes relate to graduate outcomes. There is evidence that students can evaluate the teaching activities and their own learning outcomes with reference to course learning outcomes or graduate outcomes.

4. The career planning, employment guidance and psychological counseling for students are guaranteed by regulations, personnel and conditions, and the

guidance is relevant to the graduate outcomes.

【Common problems】

1. The student learning advising is not focused on graduate outcomes, and students are not aware of graduate outcomes and course learning outcomes.

2. The student learning advising, career planning, employment guidance and psychological counseling are not connected with each other, or even interfered with each other.

1.3 The program must track and evaluate student’s outcomes throughout the learning process, and to ensure and document that students achieve the graduate outcomes through formative evaluation

【Connotation interpretation】

The program should track and evaluate the learning outcomes of each student, provide support and assistance for their academic development, and ensure that students attain graduate outcomes when graduate.

The formative evaluation is a process evaluation activity in the teaching process of the program to understand each student's learning situation and provide timely assistance to students, which is mainly reflected in the following two aspects.

First, in the process of course learning, teachers can take effective ways to track each student's learning status and students can timely feedback the self-learning questions. Teachers can dynamic adjust teaching strategies and provide assistance to students based on the tracking/feedback information.

Second, the policies and procedures which are designed and taken by the program to assess, precautionary and support students' learing outcomes at all stages of their undergraduate studies, to enable students to attain graduate outcomes.

【Program self-study and evaluator’s review focus】

1. The policies and procedures for follow-up and evaluation of each student's learning outcomes, including methods of follow-up and evaluation, and persons responsible for them.

2. The policies and procedures for precautionary and support for students with learning difficulties.

3. The policies and procedures for formative evaluation around course learning outcomes in course teaching, including requirements for teachers, condition support, and supervision and inspection.

4. The evidence and effectiveness of formative evaluation in program core courses in the last three years.

【Common problems】

1. Inadequate follow-up and assessment measures for individual student. Teachers play no role in formative assessment.

2. The precautionary mechanism is not well-established, and the support measures accompanying the precautionary mechanism are not taken seriously by the program.

3. Just simply tracking the grade of students' course exam results, formative evaluation content of the course learning process is insufficient, and the role of evaluation results are limited.

1.4 The program must have specific requirements and processes for awarding appropriate academic credits of transfer students

【Connotation interpretation】

The focus is on the basis and procedures for the validation of transfer students' original credits. The reason for the basis and procedures is that the teaching activities corresponding to "credits" are responsible for supporting the attainment of the specified graduate outcomes. The teaching activities of different institutions and programs are distinctive and different.

A student earning credit for a course indicates that the student has educated for the attainment of the relevant graduate outcomes through the course. Therefore, the program must judge whether the credit earned outside the program is equivalent or covers the program graduate outcomes to determine whether the student should be given the credit or not.

The program should establish regulations to clarify the basis for giving appropriate academic credits of transfer students, the responsible person and the procedures for implementation, and to ensure that the results are documented.

【Program self-study and evaluator's review focus】

1. Regulations of academic credits validation, including the basis, procedures and responsible persons for giving credits.

2. The basis for giving credits ensures the equivalence of the graduate outcomes support.

3. The processes and responsible persons of giving credits are reasonable, and there is evidence to proof the credit validation regulations are strictly

enforced.

4. The cases of giving credits of transfer students in last three years can proof the processes are reasonable.

【Common problems】

1. Does not accurately understand the meaning of this criteria item, and introduces the regulations for transferring students of institution and program, not the regulations and process for giving appropriate academic credits of transfer students. The principles of giving credit do not reflect the ideas of OBE.

2. The principle of original credits validation is unclear and does not reflect the requirement of equivalence in supporting the attainment of graduate outcomes.

3. The basic rules for validating original credits are inappropriate, only the equivalence of credits, the same or similar course titles, or even the equivalence of credit hour length.

4. The procedure of credit validation is not clear and lack of a determination process in supporting the equivalency in attainment of graduate outcomes.

2. Educational objectives

2.1 The program must have published educational objectives consistent with the mission of the institution and the needs of social and economic development

【Connotation interpretation】

The educational objectives are the general description of the career and professional achievements that the graduates can achieve about 5 years after graduation. The program must fully consider the internal and external needs when formulating the educational objectives, including the role of the institution, the features of the program, the needs of the society and the expectations of the stakeholders, and can reflect the social development requirements for the competence of professional engineers in this field. The program should make stakeholders understand and participate in the process of developing the educational objectives through various means, and reach a consensus on the content of the educational objectives.

The program should have clear public channels to publish and explain its educational objectives so that stakeholders know and understand the meaning of the educational objectives.

【Program self-study and evaluator’s review focus】

1. The educational program expresses the educational objectives completely, and explains the professional field, professional characteristics and professional abilities that students will achieve about 5 years after graduation. The educational program reflects the education policy of the comprehensive development of all-round ability.

2. The explanation of the educational objectives is reasonable, and interprets the relationship between the educational objectives, the institution orientation and the internal and external needs of society.

3. Effective investigation and reasonable prediction should be conducted in the process of developing the educational objectives, including internal survey for faculty and administrators and external survey for relevant industry, enterprise, alumni and other stakeholders. The analysis and prediction are reasonable and valid.

4. There are clear public channels for the educational objectives, and the

descriptions of the educational objectives in different channels should be consistent to help stakeholders understand the meaning of the educational objectives.

【Common problems】

1. The educational objectives cannot reflect the institution’s orientation and features of the program.

2. The expression of the educational objectives is not clear in the professional competence, does not reflect the competencies required of professional engineers and are not consistence with graduate outcomes.

3. The program cannot explain the relationship between educational objectives, the institution orientation and social needs reasonably.

4. The development of educational objectives lacks sufficient and effective survey and analysis of internal and external needs.

5. The channels for disclosure of educational objectives are not clear, the expressions of educational objectives in different channels are inconsistence, and the interpretation of connotations is unclear.

2.2 The program must periodically review the educational objectives to ensure they remain consistent with the institutional mission and social & economic development. The review process must involve experts from industry or enterprises

【Connotation interpretation】

The assessment on the consistency of educational objectives with the institutional mission and social & economic development is the basis for revising the educational objectives. Consistency means that the educational objectives are consistent with the internal and external requirement such as the institution orientation, program characteristics, social needs and expectations of stakeholders.

The program should periodically review the consistency of educational objectives with the institutional mission and social & economic development, understand and analyze the changes of internal and external demands, and revise the educational objectives according to the changes.

The evaluation and revision of educational objectives should involve experts from industry or enterprises to ensure that the evaluation and revision can better reflect the needs of talents from industry and enterprises, so that the students training is more in line with the needs of industry and enterprises.

【Program self-study and evaluator's review focus】

1. The program has established the mechanism to periodically review the consistency of educational objectives with the institutional mission and social & economic development and revise it, including the review cycle, review content, work procedures, responsible persons, organizational structure, work requirements, etc. The procedure has participation of industry and enterprise experts.

2. The program understands the connotation of consistency of educational objectives, has conducted targeted internal and external survey according to the need of assessment on the consistency of educational objectives with the institutional mission and social & economic development. The content of survey is related to the internal and external needs such as institution orientation, program characteristics, social needs and expectations of stakeholders. The survey involves faculty, students and their parents, alumni, industry and other stakeholders.

The program has effectively analyzed the survey results to assess the consistency of educational objectives with the institutional mission and social & economic development and revised the educational objectives based on the assessment results.

【Common problems】

1. The content, methods and requirements of the assessment on the consistency of educational objectives with the institutional mission and social & economic development are not clear. The review is carried out arbitrarily; the survey and analysis are implemented temporarily for the accreditation and is not sustainable.

2. Lack of effective design of survey content and scope for various groups of people. The survey content does not reflect the internal and external needs. The analysis of survey results is not sufficient, and the results are simple and rough.

3. The original materials are not standardized and not organized in a timely manner. The original materials are insufficient for supporting the self-study.

4. Confusing the concept of the assessment on the consistency of educational objectives with the institutional mission and social & economic development with the assessment on the attainment of educational objective.

5. The results of the assessment on the consistency of educational objectives with the institutional mission and social & economic development are not used for its revision.

3. Graduate outcomes

The program must have clear documented, published and assessable graduate outcomes. The documented graduate outcomes prepare graduates to attain the program educational objectives.

【Interpretation】

The criteria put forward the requirements of "clear, published, assessable, consistent and coverage" for graduate outcomes of the program.

"Clear" means that program should clearly describe the graduate outcomes and accurately express the connotation.

"Published" means that the graduate outcomes should be published as an important part of the educational objectives through stable channels, and make sure that teachers and students have a relatively consistent understanding.

"Assessable" means that undergraduates will get the competencies and attributes of graduate outcomes through studying on campus (implementable), and the attainment of competencies and attributes can be assessed through the learning outcomes and performance of students (evaluable).

"Consistent" means that the description of the competencies and attributes of graduate outcomes can reflect the support of the educational objectives.

"Coverage" means that the graduate outcomes of the program are fully cover all the graduate outcomes in the *Engineering Education Accreditation Criteria*, with special attention to the requirements for the ability of students to solve complex engineering problems.

The main task of undergraduate engineering education is to develop the ability of solving complex engineering problems, and the 12 graduate outcomes proposed in these criteria reflect the core elements of that ability. The program must ensure the substantial equivalence of the graduate outcomes to these criteria.

Complex engineering problems must have the following characteristic as (1) and some or all of the characteristics as (2) - (7):

(1) Cannot be resolved without in-depth engineering knowledge;

(2) Involve wide-ranging or conflicting technical and non-technical issues (such as ethical, sustainability, legal, political, economic, societal) and consideration of future requirements;

(3) Have no obvious solution and require abstract thinking, creativity and originality in analysis to formulate suitable solutions;

(4) Involve infrequently encountered issues or novel problems;

(5) The factors involved in the problem may not be fully included in the criteria and norm of the program;

(6) Involve collaboration across engineering disciplines, other fields, and/or diverse groups of stakeholders with various needs;

(7) Address comprehensive problems with many components or sub-problems that may require a systematic approach.

Graduate outcomes are the competencies that undergraduates should have when they graduate and receive degree. The following interpretation of each graduate outcome item reflects the core elements of competencies and cognitive process of undergraduates from the perspective of education, and provides a guiding basis for program to optimize curriculum.

If the program graduate outcomes do not reflect the connotation of the criteria, even if the program copies the general criteria in Engineering Education Accreditation Criteria, it may not prove the "coverage". If the program graduate outcomes cannot be implemented and assessed, even if the attainment assessment is conducted, the results are not admissible as evidence.

3.1 Engineering knowledge: Apply knowledge of mathematics, natural science, engineering fundamentals and engineering specialization to solve complex engineering problems

【Connotation interpretation】

This criteria item requires undergraduates to understand and apply engineering knowledge, it includes two aspects: First, students understand the knowledge of mathematics, natural science, computing and engineering fundamentals and engineering specialization (including relevant social sciences applicable to the discipline) to solve complex engineering problems; Second, students must be able to apply such knowledge to solve complex engineering problems. The former is a requirement for knowledge structure, and the latter is a requirement for knowledge application.

The program can understand this criteria item from the following:

1. A systematic, theory-based understanding of the mathematics, natural science, computing and engineering fundamentals that apply to the engineering problems in the engineering discipline;

2. Ability to analyze data required in the field and to build mathematical models for specific objects and solve them using computing;

3. Ability to apply relevant engineering expertise and mathematical analysis methods to the derivation and analysis of professional engineering problems;

4. Ability to use systematic thinking skills to compare and synthesize engineering knowledge for solutions to professional engineering problems and reflect advanced technology in the field.

This requirements of this criteria item can be attained through the study and application of knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialization.

3.2 Problem analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using basic principles of mathematics, natural sciences and engineering sciences

【Connotation interpretation】

This criteria item require the ability of problem analysis as the following two aspects: First, students should think about problems based on first principles of scientific; Second, students should master the method of problem analysis. The former is the development of thinking skills, and the latter is the teaching of methodology.

The program can understand this criteria item from the following:

Students are able to apply relevant scientific principles to identify and analyze the key links of complex engineering problems;

1. Students are able to correctly formulate complex engineering problems based on relevant scientific principles and mathematical modeling methods;

2. Students recognizes that there are multiple options for solving problems and will seek alternative solutions through literature research;

3. Students are able to analyze the influencing factors of the engineering activities process with holistic considerations for sustainable development.

The requirements of this criteria item can be attained by the study and application of mathematics, natural science, and engineering science principles. Teaching process should pay attention to the methodology of problem analysis and develop the scientific thinking and independent thinking ability of students.

3.3 Design/development of solutions: Design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate societal, public health and safety, legal, cultural and environmental considerations

【Connotation interpretation】

This criteria item requires students to understand the basic methods and techniques for engineering-oriented design and whole-life product development, and to be able to complete the design of components and systems for specific needs.

The program can understand this criteria item from the following:

1. Students master the basic methods and techniques of the whole-life of engineering design and product development, understand the various factors that influence the design objectives and technical solutions;

2. Students are able to complete the design of systems, components or processes to meet idendified needs;

3. Students are able to design systems or processes design creatively;

4. Students are able to design solutions for complex engineering problems with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations.

The requirements of this criteria item can be attained by understanding and application of engineering design, public health and safety, environmental protection and relevant social science, as well as engineering design practice.

3.4 Investigation: Conduct investigations of complex problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

【Connotation interpretation】

This criteria item requires students to be able to conduct investigations of complex engineering problems by investigation, design, implementation, and generalization. Awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

The program can understand this criteria item from the following:

1. Students are able to investigate and analyze complex problems using scientific principles, through literature research or related methods;

2. Students are able to select methods of investigations and design experimental protocol based on the characteristics of the objects of specific engineering problem;

3. Students are able to construct experimental systems according to the experimental protocols, conduct experiments safely, and collect experimental data correctly;

4. Students are able to analyze and interpret experimental results and synthesize information to get valid conclusions.

The requirements of this criteria item can be attained by the study and application of knowledge related to the analysis, screening and research of academic literature in the discipline.

3.5 Modern tool usage: Create, select and apply appropriate techniques, resources, modern engineering and IT tools for complex engineering problems, including prediction and modeling of complex engineering problems, with an understanding of the limitations

【Connotation interpretation】

This criteria item requires students to create, select and apply modern tools. Modern tools include techniques, resources, and modern engineering and IT tools (including prediction and modelling to complex engineering problems).

The program can understand this criteria item from the following:

1. Students have the knowledge of the principles and using methods of modern engineering and IT tools, and recognize the limitations.

2. Students are able to select, apply, and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools to complex engineering problems.

3. Students are able to use tools creatively to support detailed analysis and modelling applicable to the discipline.

The requirements of this criteria item can be attained by the study and application of knowledge of data analysis, statistics, information technology, and engineering practice.

3.6 Engineer and society: Apply reasoning informed by the 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

【Connotation interpretation】

This criteria item requires students to have the knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety.

The program can understand this criteria item from the following:

1. Students understand efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

2. Students understand the influence of different social cultures on engineering activities, including analyzing and assessing societal, health, safety, legal and cultural implications of engineering practice and the impact of these constraints on project implementation, and able to assume corresponding responsibilities.

The requirements of this criteria item can be attained by understanding knowledge of the natural sciences and relevant social sciences applicable to the discipline, and engineering design & operations in a practice area.

3.7 Environment and sustainability: Understand and evaluate the sustainability and impact of professional engineering work in solving complex engineering problems in societal and environmental contexts

【Connotation interpretation】

This criteria item requires that students must develop an awareness of sustainable development and be able to focus on, understand, and evaluate environmental protection, social harmony, and economic sustainability, ecological sustainability, and social sustainability in the engineering practice.

The program can understand this criteria item from the following:

1. Students understand the Sustainable Development Goals (SDG17, see the attachment "Connotation of Keywords").

2. Students are able to think about the sustainability of professional engineeirng practices from the perspective of environmental and social sustainability, and to evaluate the possible damage and potential hazards to humans and the environment during the product cycle.

The requirements of this criteria item can be attained through the study and application of knowledge related to ecological environment and sustainable economic and social development.

3.8 Professional ethics: Have humanities and social science qualities, social responsibility, apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice

【Connotation interpretation】

This criteria item requires students to understand humanities and social sciences, professional ethics, responsibilities, and norms of engineering practice. In engineering practice, the students are able to consciously fulfill the engineer's social responsibility for the safety, healty and well-being of the public, and understand and accommodate diverse social needs.

This criteria item requires the students to:

1. understand the relationship between individuals and society ;

2. abide by ethics, commit to professional ethics and norms of engineering practice, and adhere to relevant national and internatinal laws and regulations ;

3. be able to consciously fulfill engineers' social responsibility for public safety, health and well-being, and understand and accommodate diverse social needs and inclusion in engineering practice.

The requirements of this criteria item can be attained by the study and application of knowledge of humanities and arts, engineering ethics, law and professional norms. The training of engineering professional ethics should be implemented to the cultivation of students' basic attributes, such as honesty , fairness, integrity and abidance by the rules.

3.9 Individual and team work: Function effectively as an individual, team member and principal in a multi-disciplinary team

【Connotation interpretation】

This criteria item requires students to be able to take on a variety of roles in a multidisciplinary setting. The emphasis on “multi-disciplinary background” is due to the fact that the development and implementation of engineering projects usually involve knowledge and personnel from different disciplines. Even if an engineering innovation and product development project is undertaken by one discipline or one person, the subsequent pilot testing (testing before the product is put into production), production, marketing and service need to work together in diverse and inclusive team, so students need to have the ability to work in teams with multi-disciplinary backgrounds.

This criteria item requires the students to:

1. be able to communicate and collaborate effectively and inclusively with other team members in multi-disciplinary, diverse and inclusive teams and in face-to-face, remote and distributed settings;

2. be able to undertake tasks independently in a team, work cooperatively and complete engineering practice tasks;

3. be able to organize, coordinate and lead the work of the team.

The requirements of this criteria item can be attained by inter-disciplinary team tasks such as engineering project design, engineering practice, and cooperative learning activities.

3.10 Communication: 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. Have a particular international perspective, communicate and exchange in the cross-cultural context

【Connotation interpretation】

This criteria item sets requirements for students' ability to communicate effectively and inclusively on professional issues, as well as their international perspective and ability to communicate across cultures,taking into account cultural, language and learning differences.

This criteria item requires the students to:

1. be able to express their views accurately on professional issues orally, in manuscripts and diagrams, respond to queries, and understand and tolerate the differences in communication with peers in the field and the public;

2. understand international development trends and research hotspots in the professinoal field, and understand and repect the differences and diversity of different languages and cultures in the world;

3. be able to communicate cross-culturally, both verbally and in writing.

The requirements of this criteria item can be attained by relevant theoretical and practical teaching, academic exchange activities, and symposium activities.

3.11 Project management: Understand and master engineering management principles and economic decision-making methods, and apply them in a multi-disciplinary environment

【Connotation interpretation】

The “engineering management principle” mentioned in this criteria item refers to the process management in accordance with the whole cycle and process of the design and implementation of engineering projects or products, including multi-task coordination, time schedule control, related resources scheduling, human resources allocation, etc., which involves the intersection of differnet disciplines. The “economic decision method” refers to the method of analyzing and deciding the cost of the whole cycle and process of the design and implementation of an engineering project or product.

This criteria item requires students to:

1. master the management and economic decision-making methods involved in engineering projects ;

2. understand the cost components of the whole cycle and process of the projects and products, and understand the engineering management and economic decision-making issues involved ;

3. be able to apply engineering management and economic decision-making methods in the design and development of solutions in a multidisciplinary environment (including simulation environments).

The requirements of this criteria item can be attained by the study and application of knowledge involving engineering management and economic decision-making.

3.12 Lifelong learning: Recognize the need for, have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

【Connotation interpretation】

This criteria item emphasizes the ability of life-long learning because students' future career development will face the challenges of new technologies, new industries, new business models and new modes, and the cross-fertilization between disciplines and programs will become the new trend of social and technological progress, so students must establish the awareness of life-long learning and have the ability to think and act on lifelong learning.

This criteria item requires students to :

1. be able to recognize the need for self-motivated and life-long learning in the context of the broadest context of technological change ;

2. be able to learn independently, including the ability to understand technical issues, summarize, ask questions, think critically and creatively;

3. be able to accept and respond to the new and emerging technologies, challenges, new things and new issues.

The requirements of this criteria item can be attained by teaching processes with inspirational and guiding effects.

【Program self-study and evaluator's review focus】

1. Graduate outcomes: the rationality of the formulation and connotation of the graduate outcomes of the program, the channels through which the graduate outcomes are made public, and the knowledge and understanding of the graduate outcomes by the faculty and students.

2. Criteria coverage: the substantial coverage of the 12 criteria items of the graduate outcomes, i.e., whether the 12 criteria items are fully covered, whether the requirements of the graduate outcomes are lower than that of the 12 criteria items, and whether the understanding is accurate.

3. Objective support: the explanation and description of the graduate outcomes to support the educational objective. Whether the graduate outcomes clearly express the competency characteristics of the students in the program and whether the described competencies can support the graduates' professional competencies of the educational objective.

4. Measurability: the reasons that each graduate outcome can be implemented and evaluated. Whether the competencies and attributes described in the graduate outcomes can be judged to be attained by the learing outcomes and performance of the students (evaluable), and whether the attainment can be evaluated by appropriate assessment methods.

【Common problems】

1. There is no reasonable working mechanism to ensure the development of graduate outcomes, and teachers' participation is low or no participation at all, making it difficult to implement graduate outcomes effectively.

2. Directly copying the 12 criteria items without deep understanding of the connotation of the criteria, and graduate outcomes do not reflect the requirements of the criteria.

3. The formulation of the graduate outcomes does not sufficiently support the educational objectives, resulting in the unclear relationship between graduate outcomes and the orientation and characteristics of educational objectives.

4. The description of competencies in the graduate outcomes lacks measurability. The main manifestations are:

(1) inaccurate orientation of competencies, which are difficult to attain through teaching at the undergraduate level;

(2) the logical relationship of competency formation is unclear and cannot be connected with teaching processes;

(3) the competencies are not clearly described, or inappropriate adjectives are used, making it difficult to evaluate accurately.

4. Continuous improvement

4.1 The program must establish regulations and mechanism to monitor teaching quality. There must be clear quality standards of main teaching process. The program must periodically evaluate curriculum and its quality. The program must establish regular, appropriate, documented process and mechanism to assess and evaluate the extent to which the graduate outcomes are being attained.

【Connotation interpretation】

This criteria item focuses on the establishment of two mechanisms, namely the teaching quality monitor mechanism and the evaluation mechanism of graduate outcome attainment. The core of these two mechanisms is outcome-based course quality evaluation. The outcome-based course quality evaluation means that the evaluation should focus on the effectiveness of student learning, and that the course content, teaching methods and assessment must match the graduate outcomes supported by the course.

Since the attainment of graduate outcomes requires the support of teaching activities (hereinafter generally referred to as courses), course quality evaluation is the core of quality monitoring and the basis for the evaluation of graduate outcome attainment. The object of course quality evaluation includes various theoretical and practical courses, and the purpose of evaluation is to objectively determine the attainment of course learning outcomes related to the graduate outcomes. On the basis of course quality evaluation, a combination of qualitative and quantitative methods can be used to evaluate the attainment of graduate outcomes.

The evaluation mechanism of graduate outcome attainment is an important assurance mechanism to test and judge whether the export quality of student training meets the expectations (i.e. graduate outcomes), and is also the basic premise of continuous improvement of the program. The evaluation of graduate outcome attainment is realized by collecting and identifying the most representative evaluation data of learning outcomes that best characterize the connotation of graduate outcomes, and making qualitative or quantitative statistical analysis and result interpretation of these data. Based on the evaluation results, the strengths and weaknesses of the students' abilities can be evaluated, which provides a basis for the continuous improvement of the program.

【Program self-study and evaluator's review focus】

1. Whether the quality requirements of each teaching process are clear, whether they are associated with the graduate outcomes, and whether they are reflected in the course syllabus and relevant teaching management documents.

2. Whether the course quality evaluation mechanism is established and whether the evaluation content, basis, process, cycle and responsible person are clear.

3. Whether the organization of course quality evaluation is standardized, and whether course quality evaluation becomes a necessary part of course teaching and is organized and implemented by the professor responsible for the course. Whether the rationality of the basis and results of the course quality evaluation is checked and reviewed by a specialized organization, which is generally composed of experts familiar with the teaching of the program, and is headed by the professor responsible for the program.

4. Whether the content of the course quality evaluation focuses on the effectiveness of student learning and whether the evaluation data of core courses of the program can prove that: 1) the correspondence between the

course learning outcomes and the supported graduate outcomes is reasonable; 2) course content and teaching methods can effectively support the attainment of course learning outcomes; 3) course assessment and grading criteria can reflect the attainment of course learning outcomes.

5. Evaluation mechanism of the graduate outcome attainment of the program. Whether the mechanism is established, including whether the evaluation method, basis, process, cycle and responsible person are clear.

6. Whether the program uses appropriate methods to conduct evaluations based on the different characteristics of each graduate outcome. Whether the evaluation methods are reasonable, operable, and cover all students.

7. Whether the records of the evaluation of the graduate outcome attainment already carried out by the program can prove that the evaluation can be carried out regularly, the evaluation basis and method are reasonable, and the evaluation results can objectively reflect the attainment of the graduate outcomes of the program.

【Common problems】

1. The teaching quality monitor mechanism does not focus on graduate outcomes. The monitor method is still based on traditional classroom auditing, which only focuses on teachers' classroom performance, and there is no clear correlation between quality monitor and graduate outcome attainment.

2. Inadequate understanding of outcome-based course quality evaluation, which does not focus on the attainment of course learning outcomes and their support of corresponding graduate outcomes. Course quality evaluation mechanisms are inadequate and poorly implemented.

3. The graduate outcomes are evaluated by a single method, mainly by the score calculation method based on course examination results.

4.2 The program must have the feedback mechanism from industry and society, including graduates and employers, to evaluate the extent to which the educational objectives are being attained.

【Connotation interpretation】

The program should systematically carry out tracking of graduates and surveys of relevant stakeholders such as employers and industrial organizations with respect to the educational objectives, and analyze and evaluate the attainment of the educational objectives based on the information obtained from the tracking and surveys to form an overall judgement on the attainment of the educational objectives.

This criteria item emphasizes the regular analysis of the attainment of educational objectives, i.e., through the establishment of a feedback mechanism for graduates and a social evaluation mechanism, the proper use of direct and indirect, qualitative and quantitative methods, and the adoption of appropriate sampling methods, identifying and collecting data on the attainment of educational objectives regularly, in order to analyze the attainment of educational objectives.

【Program self-study and evaluator's review focus】

1. Whether the program has established an external evaluation mechanism for the attainment of educational objectives, and regularly conducts graduate tracking and surveys of employers, industry enterprises and other stakeholders.

2. Whether the data to be collected by the survey is reasonably designed to reflect the attainment of the educational objectives.

3. Whether the graduate tracking has sufficient coverage and is statistically significant. Whether the survey of employers and industry enterprises is

representative and consistent with the main employment of graduates.

4. Whether there is evidence that the program is able to conduct regular analysis of the attainment of educational objectives based on feedback from follow-up and surveys, and that the results of the analysis are convincing and documented.

【Common problems】

There is no mechanism to guarantee. The survey work of graduate tracking, employers and industry enterprises is random and the results are not reliable.

4.3 The results of periodical evaluation must be systematically utilized as input for program's continuous improvement actions.

【Connotation interpretation】

Based on the results of internal and external evaluations required in criteria items 4.1 and 4.2, programs should identify problems in the design of educational program and the implementation of course teaching, provide timely feedback to relevant responsible persons, and make scientific, systematic and continuous improvements to educational objectives, graduate outcomes, curriculum, courses and teaching processes, assessment and evaluation mechanisms, faculty allocation and supporting resources.

【Program self-study and evaluator's review focus】

1. Whether the program has clear measures to ensure that the results of internal and external evaluations are fed back to the relevant responsible persons in a timely manner.

2. Whether there is evidence that the results of various types of evaluations are used for continuous improvement, and whether the program follows up on the feedback and improvements.

【Common problems】

1. There is no clear feedback mechanism for evaluation results, and no stable information feedback channel is established.

2. The evaluation results are not carefully analyzed and improvements are made arbitrarily.

5 Curriculum

The curriculum must be consistent with graduate outcomes. The design of the curriculum must involve experts from the enterprises or industry.

【Connotation interpretation】

The course is the basic unit to attain the graduate outcomes, and whether the course can effectively support the attainment of the corresponding graduate outcome is the main criterion to measure whether the curriculum meets the requirements of the accreditation criteria. The core connotation of this criteria item is that the curriculum of the program should focus on the fundamental task of student training, and the curriculum can support the attainment of graduate outcomes. The so-called “support” includes two meanings. First, the curriculum can support graduate outcomes, i.e., in the curriculum mapping, each graduate outcome is supported by a suitable course and the supporting relationship can be reasonably explained. Secondly, each course can realize its role in the curriculum, i.e., the correspondence between the course learning outcomes and the relevant graduate outcomes is clearly established in the course syllabus; the course teaching content, teaching methods and assessment can effectively ensure the attainment of the course learning outcomes; the mode, content and grading criteria of the course assessment can be designed for the course learning outcomes, and the assessment results can prove the attainment of the course learning outcomes.

Reasonable curriculum design should determine the structure of the curriculum and design course content, teaching processes, basic teaching requirements and assessment based on graduate outcomes. The purpose of requiring enterprise or industry experts to participate in the curriculum design process is to ensure that the course content is updated in a timely manner and is compatible with the actual development of the industry.

It should be noted that the 12 graduate outcomes of the general criteria emphasize the training of students' ability to solve complex engineering problems, and whether the curriculum supports or not is an important criterion for the real implementation of this ability training. Therefore, the design of curriculum should consider the role of various courses in training student's ability to solve complex engineering problems, and all courses supporting graduate outcomes should take complex engineering problem solving as one of the main teaching objectives. Each category of course should have its own responsibility to support the attainment of this ability.

【Program self-study and evaluator's review focus】

1. Whether the curriculum mapping reflects a reasonable support of the curriculum for all graduate outcomes. Whether the program has a reasonable explanation for the setting of the core courses that support each graduate outcome in the mapping and whether the core courses play a high support role. Whether each graduate outcome of the program is supported by appropriate courses.

2. Whether the course syllabus can reflect the role of the course in the mapping, i.e., whether the graduate outcomes supported by the course in the syllabus are clear and reasonable, whether the course learning outcomes are related to the graduate outcomes, and whether the course content is aligned with the course learning outcomes.

3. Whether the teaching process and course assessment are designed for the course learning outcomes, i.e., whether the depth and breadth of the content match the requirements of the course learning outcomes; whether the teaching organization can effectively ensure the attainment of the objectives; whether the assessments, contents and grading criteria can effectively prove the attainment of the course learning outcomes.

4. For the ability training of solving complex engineering problems, whether the program has carried out the overall design in the curriculum, clarified the tasks undertaken by different types of courses, and reflected them in the course syllabus. For example, course on engineering foundation requisite and course on subject foundation requisite should strengthen the training of ability to identify, express and analyze complex engineering problems; The core courses should strengthen the training of analysis/design/research ability; Comprehensive practice course should reflect the training of the ability to synthesize and apply knowledge to solve practical and complex engineering problems.

5. Whether there is evidence of effective participation of industry expert in the design of the curriculum.

【Common problems】

1. The curriculum lacks a systematic design, but simply outlines the correspondence between courses and graduate outcomes in the mapping, especially lack of thinking about the support of complex engineering problem abilities and non-technical abilities.

2. The curriculum cannot effectively support all graduate outcomes, and the course syllabus cannot reflect the role of the courses in the mapping. The main manifestations are: 1) the layout of the course mapping is unreasonable, some graduate outcomes have intensive overlapping support courses, some graduate outcomes have weak support, especially the selection of the courses for non-technical ability lacks basis; 2) the setting of high support courses lacks basis and is rather arbitrary; some graduate outcomes have no high support courses, and some seem to have many high support courses, but these courses actually support only individual indicators in that graduate outcome; 3) the graduate outcomes or indicators of the course are

unreasonable and do not match with the course content and teaching methods, which cannot form effective support.

3. The description of course learning outcomes in the course syllabus is unreasonable and does not reflect the requirements for students' abilities, and lacks correspondence with graduate outcomes. The course contents and teaching methods are not designed for the course learning outcomes and cannot support the attainment of all the course learning outcomes. The assessments and contents of the course cannot cover all the objectives of the course, or process assessment contents and grading criteria are not designed for the course learning outcomes, which cannot effectively prove the attainment of the course learning outcomes.

4. The task of industry experts to participate in the design and revision of curriculum is not clear and their role is not obvious.

The curriculum must include:

5.1 Courses on mathematics and natural sciences consistent with the graduate outcomes (accounting for at least 15% of the total credits)

【Connotation interpretation】

Such course cover: 1) knowledge of mathematics, numerical analysis, data analysis, statistics, computational and information science applicable to the discipline to which the program belongs and used to support specific analysis and modeling; 2) the understanding and application of the systematic theory of natural science applicable to the discipline of this program.

This criteria item is a requirement for the settings of course on foundation requisite such as mathematics and natural science. The connotation includes three aspects, one is that the proportion of credits of such courses should not be less than 15%; second is that the curriculum should meet the requirements of complementary criteria; third is that the teaching content and effectiveness of the course should be able to support the attainment of the corresponding graduate outcomes.

【Program self-study and evaluator’s review focus】

1. Whether the subject and credit regulations for mathematics and natural science courses of the program are clear and reasonable, and whether the credits and areas of knowledge covered meet the requirements of the general and complementary criteria. Whether there is a system to ensure that all students can meet the requirements for course selection.

2. Whether the course syllabus reflects the role of such courses in the mapping, and whether the teaching process and course assessment are designed to meet the course learning outcomes.

【Common problems】

1. Only the percentage of credits is calculated, and there is a lack of analysis and evaluation of such course settings to demonstrate support for graduate outcomes.

2. Lack of clarity on the tasks undertaken by such courses in the curriculum mapping, and unrealistic requirements for such courses to undertake professional competency development.

3. The course syllabus does not meet the requirements, and the requirements for course learning outcomes, course content, teaching methods, assessment, and examination contents are not clear.

4. The program uses such courses as the basis for evaluation of graduate outcome attainment, but does not conduct evaluation of the attainment of the course learning outcomes.

5.2 Courses on engineering fundamentals, courses on subject fundamentals and subject courses (accounting for 30% of the total credits). Courses on engineering fundamentals and courses on subject fundamentals may provide training in the ability to apply mathematics and natural science in solving complex problems related to the professional discipline. Subject courses can fully assume the role of training abilities in system design and operation.

【Connotation interpretation】

Courses on engineering fundamentals cover: systematic, theory-based engineering fundamentals required by the engineering discipline to which the program belongs.

Courses on subject fundamentals cover: able to provide a theoretical framework and knowledge system for recognized practical work in the discipline to which the program belongs, and able to reflect the knowledge at the forefront of the discipline.

Subject courses cover: 1) knowledge that can support engineering design and operations in practical work, including efficient use of resources, environmental impact, whole-life cost, resource reuse, net zero carbon and similar concepts; 2) relevant knowledge from the current research literature in the discipline to which the program belongs, as well as methodologies for critical and creative thinking.

The connotation of this criteria item includes three aspects, one is that the proportion of credits of such courses should not be less than 30%; second is that the curriculum should meet the requirements of complementary criteria; third is that the teaching contents and effectiveness of the courses should be able to support their roles in the curriculum mapping. The teaching contents of courses on engineering fundamentals and courses on subject fundamentals can reflect the training of the ability to analyze and study complex engineering problems in professional fields by applying the principles of mathematics, natural science and engineering science. Subject courses can reflect the development of the ability to design systems and effectively implement solutions to complex engineering problems.

【Program self-study and evaluator’s review focus】

1. Whether the credits and knowledge areas of the courses on engineering fundamentals, courses on subject fundamentals and subject courses meet the requirements of general criteria and complementary criteria, whether the core courses play a high support role for graduate outcomes, and whether there is a system to ensure that the elective courses can support all students to attain the graduate outcomes.

2. Whether the course syllabus can reflect the role of courses on engineering fundamentals, courses on subject fundamentals and subject courses in the curriculum mapping, and whether the teaching process and course assessment are designed for the course learning outcomes.

3. With regard to solving complex engineering problems, whether the tasks undertaken by various courses are clearly defined, and whether the training of the ability to solve complex engineering problems is reflected in the course syllabus and course teaching process.

【Common problems】

1. Only the percentage of credits is calculated, and there is a lack of analysis of whether the content and effectiveness of the course can support the graduate outcomes, and thus cannot demonstrate support for the graduate outcomes.

2. The content and quantity of courses in this category are not sufficient to support the attainment of relevant graduate outcomes. For example, the

teaching contents of courses on engineering fundamentals and courses on subject fundamentals are not sufficient to train the ability to apply the principles of mathematics, natural science and engineering science to analyze and study complex engineering problems of the program. Subject courses are not suffcient to train the ability to system design and effectively implement solutions to complex engineering problems.

3. The course syllabus does not meet the requirements, and the requirements for course learning outcomes, course content, teaching methods, assessment methods and examination content are not clear.

4. Insufficient attention to student learning outcomes and lack of analysis of course learning outcomes attainment by the teachers.

5.3 Engineering practice and graduate design (thesis) (accounting for 20% of the total credits). The program has a well-established practice education system and cooperate with enterprises to educate students on practical and innovative abilities. The topics of graduate design (thesis) are oriented from the practical engineering problem to educate students engineering awareness, cooperation and abilities to systematically utilize what they have learned to solve complex engineering problems. The guidance and evaluation of graduation design (thesis) involve experts from industry or enterprises.

【Connotation interpretation】

These courses cover: the practical engineering knowledge and methods involved in the practical work of the engineering discipline to which the program belongs, and the practical process of students' comprehensive application of the knowledge they have learned to solve practical problems. Such courses should focus on the engineering practice of the discipline and the engineering awareness in complex engineering problems.

This criteria item is a requirement for the practice-teaching process. The program should establish a well-established practice-teaching system, including comprehensive experimental projects, practice, exercise, course design and other engineering practices and graduate design (thesis) that all students participate in, with quality control standards and management system. The proportion of practice-teaching process credits is not less than 20%, and the content of practical training meets the requirements of complementary criteria. The process implementation status and actual effect of practice and exercise should be able to support their role in the curriculum mapping and reflect the training of students' practical ability and innovation ability. The topic chosen for the graduate design (thesis) should be combined with the actual engineering problems of the program, which can reflect the training of students' engineering consciousness, collaborative spirit and the ability to comprehensively apply the knowledge learned to solve practical problems. There are experts from enterprises or industries involved in the guidance and assessment of the graduate design (thesis).

【Program self-study and evaluator's review focus】

1. Whether the credits and contents of engineering practice courses and graduate design meet the requirements of the general criteria and complementary criteria.

2. Whether the practice-teaching system conforms with the characteristics of the program, whether the contents of practice, internship and design can support students to master the knowledge and ability required for engineering design and engineering practice of the program, whether practice-teaching is carried out in cooperation with enterprises to strengthen students' engineeirng awareness and practical/innovative ability training, whether each student has sufficient training opportunities, and whether their performance is objectively evaluated.

3. Whether the course syllabus can reflect the role of engineering practice courses and graduate design (thesis) in the curriculum mapping, whether the teaching process and course assessment are designed for the course learning outcomes, whether there are clear and reasonable grading critera for evaluating students' learning outcomes and performance, and whether the "passing standard" reflects the prerequisite of getting accredited that the couse learning outcomes are basically attained.

4. For solving complex engineering problems, whether the tasks of the practical courses are clearly defined, and whether the requirements of solving complex engineering problems are reflected in the course syllabus and course teaching process.

5. For the practice-teaching process supporting the non-technical graduate outcomes, whether clear course learning outcomes, teaching contents, teaching methods, assessment methods and grading criteria are designed for each graduate outcome, and whether they can ensure that the course learning outcomes are implemented and effectively evaluated.

6. Whether the topic chosen for the graduate design (thesis) is combined with the actual engineeirng problems of the program; whether the training process focuses on the training of students' engineering consciousness, collaboration spirit and communicatoin ability; whether the assessment methods and grading criteria reflect a reasonable evaluation of the attainment of the course learning outcomes and related graduate outcomes.

7. Whether the graduate design (thesis) guidance and assessment involves the participation of enterprise or industry experts.

【Common problems】

1. The program only calculate the percentage of credits, and there is a lack of analysis on whether the implementation status and actual effect of engineering

practice and graduate design (thesis) can support the attainment of graduate outcomes.

2. The content and quantity of practice-teaching process such as engineering practice and graduate design (thesis) are not sufficient to support the attainment of relevant graduate outcomes, especially in the training of engineering design ability, the examination and evaluation of whether students can consciously consider economic, environmental, legal, ethical and other constraints when engaging in engineering design is neglected.

3. There is a lack of judgment on the rationality of the basis for the evaluation of course learning outcomes. The practice-teaching process (such as experiments, practice and exercise, course design, social practice, etc.) lack assessment and grading criteria, and the grades have a large arbitrariness, which directly affects the rationality of the evaluation results. Specifically, the graduate design (thesis) usually supports multiple graduate outcomes, but the correspondence between its course learning outcomes and graduate outcomes is not clear, the grading criteria are not designed for the course learning outcomes, and the assessment results cannot prove the contribution of the course to the attainment of graduate outcomes.

4. There is a lack of strong evidence on how the competencies supported by extracurricular innovative or practical activities are guaranteed to be attained by all students.

5.4 Courses on humanities, social sciences and general education (accounting for at least 15% of the total credits) to enable students to consider the economic, environmental, legal, safety, health and ethical constraints in engineering practice.

【Connotation interpretation】

These courses cover: knowledge of humanities and social sciences, knowledge of professional ethics, social responsibility and norms of engineering practice, as well as engineering economics, environmental and legal aspects.

The criteria item is a requirement for general education curriculum. The connotation includes three aspects, one is that the proportion of credits of such courses should not be less than 15%; second is that the curriculum should meet the requirements of complementary criteria; third is that the content and effectiveness of the course teaching should be able to support its role of ability training in the curriculum, help students establish correct values, and enable them to consider various constraints such as economic, environmental, legal and ethical factors when engaging in engineering design.

【Program self-study and evaluator’s review focus】

1. Whether the subject and credit regulations for courses on humanities, social sciences and general education are clear and reasonable, and whether the credits and areas of knowledge covered meet the requirements of the general and complementary criteria. Whether there is a system to ensure that all students’s course selections can meet the requirements.

2. Whether the setting of such courses can meet the needs of training non-technical comprehensive abilities, help students establish correct values, enable them to understand, master and apply economic, environmental, legal, ethical and other relevant knowledge related to engineering practice, and conisder relevant constraints when engaging in engineering design.

3. Whether the course syllabus reflects the role of such courses in the curriculum mapping, and whether the teaching process and course assessment are designed for the course learning outcomes.

【Common problems】

1. The program only calculates the percentage of credits, but lacks analysis of whether the content and effectiveness of the course can support the attainment of graduate outcomes.

2. There is a lack of strong evidence on how the competencies supported by the electives are guaranteed to be attained by all students.

3. There is a lack of assessment methods and grading criteria for competency objectives, and a lack of assessment and evaluation of students' ability to consider various constraints such as economic, environmental, legal and ethical factors when engaging in engineering design. There is a large arbitrariness in the examination results, which affects the retionality of the course evaluation results.

4. Insufficient attention to student learning outcomes and lack of analysis of course learning outcomes attainment by the teachers.

6. Faculty

6.1 The faculty is sufficient and has a reasonable structure to meet the program's teaching requirements. The program must have part-time faculty members from industry or enterprises.

【Connotation interpretation】

This criteria item focuses on whether the overall situation of the faculty meets the needs of engineering program education. The so-called overall situation refers specifically to three aspects: the number of faculty members, team structure and part-time faculty. Whether the number of faculty members meets the teaching requirements is judged mainly from the number of students enrolled, courses offered and practice-teaching processes. The rationality of the faculty structure is mainly judged from the aspects of age structure, title structure, educational structure and specialty structure. There should be enterprise or industry experts participating in teaching as part-time faculty members and be able to use the advantages and characteristics of the industry background.

【Program self-study and evaluator’s review focus】

1. Whether there are detailed data and supporting materials to show that the number and structure of full-time faculty and the number and source of part-time faculty and the hiring process can meet the requiremenets of the general and complementary criteria.

2. Conduct a comprehensive analysis in terms of the number of students enrolled, courses offered, and practice-teaching processes to indicate or judge whether the number of faculty meets teaching requirements.

3. Whether the program has analyzed the characteristics, strengths and

weaknesses of the faculty structure based on the information such as age structure, title structure, educational structure, and specialty structure.

4. Whether there is evidence that part-time faculty members have undertaken specific teaching tasks and used the advantages and characteristics of their industry background in their teaching activities, and the program has conducted the necessary follow-up and evaluation of their teaching effectiveness.

【Common problems】

1. There is a lack of reasonable analysis on whether the number and structure of faculty members meet teaching requirements.

2. The introduction of teaching work undertaken by part-time faculty members is not specific enough and lacks role analysis.

6.2 Each faculty member must have proper teaching, professional practice, communication, career development and engineering research abilities. The professional background of each faculty member must meet the program's teaching needs.

【Connotation interpretation】

This criteria item focuses on the professional ability of individual faculty member, which specifically includes teacher ethics, teaching ability, professional level, engineering experience, communication ability, and career development ability. The program should give specific descriptions and requirements of the above-mentioned abilities from the perspective of ensuring teaching quality; describe the specific requirements of the program in terms of engineering experience and engineering background of the faculty members. The engineering background and engineering experience possessed by faculty members should be useful in teaching activities. In addition to participating in teaching work, the faulty members should have the ability and experience in research work and academic communication related to engineering practice.

【Program self-study and evaluator's review focus】

1. The specific requirements of the program for faculty members in terms of teacher ethics, teaching ability, professional level, engineering experience, communication ability, and career development ability; the basis and conclusion for determining whether a faculty member has met the self-defined requirements of the program.

2. The definition of engineering background and engineering experience of faculty members by the program, i.e. what kind of work experience counts as having engineering background and engineering experience; the basic requirements of engineering background and engineering experience for faculty in the program, according to which the basic engineering background of faculty is analyzed.

3. Whether the faculty's engineering background and engineering experience play a role in teaching, especially in the teaching processes with strong engineering properties.

4. Engineering practice and engineering research conducted by faculty members, as well as academic exchanges related to them.

5. Whether the professional background and engineering ability of the faulty members meet the requirements of the complementary criteria.

【Common problems】

1. The program does not have basic requirements for faculty members' various competencies, engineering backgrounds and engineering experience, and there is no corresponding threshold or basis for judgment. As a result, the

program itself cannot definitively confirm that the faculty members' various competencies and engineering backgrounds meet the accreditation criteria.

2. The program cannot show that the faculty's engineering background and engineering experience play a role in the teaching activities.

6.3 The faculty members must have sufficient time and effort devoted to undergraduate teaching and student advising and actively participate in research and reform on teaching.

【Connotation interpretation】

Teaching is the main responsibility of faulty members. The faculty members must have sufficient time and effort devoted to undergraduate teaching and student advising, and actively participate in research and teaching innovation. The program must have clear requirements and regulations for faulty members' teaching work time and participation in teaching research and reform.

【Program self-study and evaluator's review focus】

1. Systems and measures to ensure that time and effort of the faculty members are devoted to teaching and student advising.

2. Time and effort of the faculty members and basis for judgement.

3. Measures and regulations to encourage faculty members to participate in teaching research and reform; the participation of the faculty members and the results attained.

【Common problems】

The program cannot explain how it ensures that the faulty members devote time and effort to their teaching work.

6.4 The faculty members must provide student advising, counseling and service activities and accommodate adequate levels of career planning and professional education to the students.

【Connotation interpretation】

The program should not only provide the teaching environment for students enrolled, but also provide the students with all-round advising, including career planning and career education. The faculty members of the program should have significant responsibilities in student advising. Therefore, program must clearly define the scope of work, specific content and work requirements for faculty to provide advising, counseling, services, career planning, career education and other advising to students, and ensure it with regulations.

【Program self-study and evaluator's review focus】

1. The requirements of the program for various types of advising work of the faculty members, including the scope of work, specific content and work requirements, and the corresponding institutional safeguards.

2. The actual situation and relevant data on the various types of advising work provided by the faculty members to students.

【Common problems】

The requirements for advising work of the faculty members are not clear enough and lack regulations.

6.5 The faculty members must understand their responsibilities in the program's quality improvement and continuously improve their work.

【Connotation interpretation】

As the executors of teaching, the faculty members' sense of responsibility is an important factor affecting the quality of teaching, so they must clearly and consciously take responsibility for improving teaching quality. The “understand their responsibilities” mentioned in this criteria item mainly means that the faculty members should be aware of, understand and agree with their teaching responsibilities for students’ graduate outcomes, and consciously improve their teaching work and fulfill their responsibilities.

【Program self-study and evaluator’s review focus】

1. Regulations and measures to ensure that the faculty members are clear about their responsibility for quality, with a focus on systems and measures to promote faculty members’ understanding of the OBE concept and fulfillment of their responsibilities.

2. The main methods and bases for supervising and judging faculty members’ fulfillment of their responsibilities; accountability mechanisms for teaching quality issues and its implementation and effectiveness.

3. Whether the faculty members are clear about their teaching work and their responsibility for improvement, whether they understand and implement the OBE teaching philosophy in their teaching work, and consciously evaluate and improve their work.

【Common problems】

The requirements of the program for the faculty members are relatively general and lack evaluation, judgements and regulations.

7. Supporting resources

7.1 Classrooms, laboratories, practice and exercise workshops, associated equipment are adequate to satisfy teaching needs. The program must have well-established management, maintenance and update mechanism of the facilities enabling students to access. The program cooperates with enterprises to establish practice and exercise bases and provide the engineering practice platform for the student during the teaching process.

【Connotation interpretation】

The supporting resources referred to in this criteria item are mainly classrooms and related facilities, laboratories and experimental equipment, practice and exercise bases. The concern is whether the quantity, function and management of these teaching facilities can meet the teaching needs and support the attainment of students' graduate outcomes. These teaching facilities are required to: (1) meet the needs of teaching courses and practical education in terms of quantity and function; (2) have good management, maintenance and updating mechanisms to ensure the operation, update frequency and management mode to facilitate students' use. The program cooperates with enterprises to establish practice and exercise bases and provide the real engineering practice platform for the student during the teaching process. The teaching requirements, staffing, and safety management meet the complementary criteria.

【Program self-study and evaluator's review focus】

1. Whether the site and equipment of classrooms and laboratories can meet the needs of teaching courses and practical education in terms of space, quantity and function.

2. The situation of laboratories, practice and exercise bases undertaking teaching tasks, including the availability of instructors, student coverage, and the organization of experiements.

3. The establishment and implementation of laboratory management, maintenance and updating mechanisms, including staffing, daily management, safety norms, student use, equipment operation and maintenance updates.

4. The operation of off-campus cooperative practice and exercise bases, including conditions and facilities, teaching tasks, staffing, students’ benefit areas and teaching methods, and whether they help strengthen students’ engineering practice ability.

5. Whether the above contents (1)-(4) meet the requirements of the complementary criteria.

【Common problems】

1. The laboratory site, the quantity and function of laboratory equipment do not match the teaching needs, and not convenient for students to use.

2. Laboratory safety management is not standardized, and ill-established measures.

3. The selection of practice and exercise bases is unreasonable. The practice contents, conditions and facilities of the bases cannot support the teaching needs.

4. The teaching contents and methods of the practice and exercise do not make full use of enterprise resources, and students are only visiting, not participating in engineering practice.

7.2 Computer facilities, network conditions, books and documents sufficient to satisfy the needs of teaching and scientific research of the students and faculty. These resources are systematically maintained and accessible, and have a high degree of sharing.

【Connotation interpretation】

The supporting resources referred to in this criteria item are mainly public resources such as computers, networks, books and electronic materials. These public resources are required to: (1) be sufficient in quantity, rich in variety, timely updated, highly informatized, and convenient for faculty members and students to use; (2) be able to meet the learning needs of students and support them to attain relevant graduate outcomes (such as access to information, modern tools, innovative activities, self-learning and international perspective); (3) meet the teaching and research needs and support teaching reform and career development of the faculty members; (4) have standardized resource management and high degree of sharing and use efficiency.

【Program self-study and evaluator's review focus】

1. The demand for computers, networks, books and electronic materials for teaching and research.

2. The provision and management of program-related computers, networks, books and electronic materials.

3. What teaching and learning activities related to graduate outcomes teachers and students need to use public resources for, and whether public resources meet the needs.

4. Relevant management systems and measures for the resources, as well as the sharing and usage of the resources.

【Common problems】

1. Simply provide the general availability of the school's computer, network, and library resources without indicating how these resources are used by the faulty members and students of the program.

2. There is no clear indication of which teaching activities in the program have needs for these public resources and whether these needs can be met.

7.3 Financial resources must be sufficient to meet the needs of teaching.

【Connotation interpretation】

The supporting resources referred to in this criteria item are the investment of teaching funds. Requirements for the investment of teaching funds are: (1) there are investment standards and systems to ensure; (2) the total amount of daily teaching funds meets the teaching needs, including the maintenance and renewal fees of experimental equipment, the average student fees for experiment, practice and graduate design, etc.; (3) the investment of special funds contributes to the continuous improvement of the program, including teaching reform, laboratory construction and the training of the faulty members.

【Program self-study and evaluator's review focus】

1. The regulations and standards related to the budget, allocation and use of teaching funds.

2. Whether the teaching funds meet the teaching needs, especially the average student allocation and use of practice-teaching funds (experimental operation fees, practice funds and graduate design funds).

3. Special funds spent on teaching in the past three years.

【Common problems】

1. Only the quantity of teaching funds is available and there are no regulations and standards related to the budget, allocation and use of teaching funds.

2. Unclear and unstable fundings for experiment, practice and graduate design for all students.

7.4 The institution must attract and retain qualified faculty and effectively support faculty development, especially the guidance and training of young faculty.

【Connotation interpretation】

The supporting resources referred to in this criteria item are the policies, measures and effects of the institution to support the professional faculty development. Requirements for the institution are: (1) to establish institutional mechanisms and measures to attract outstanding teachers, ensure the stability of the faculty team, promote the professional development of faulty members, and help young faulty members to grow; (2) the policies, measures and systems should be effective ; (3) the policies, measures and systems should be clear and open to the public.

【Program self-study and evaluator's review focus】

1. Institutional policies and measures of institution to support faculty development.

2. Specific effects of the institution's support for the professional development of faulty members in this field and improvement of teaching ability in the past three years.

3. The specific effect of the institution's support for young faulty members of the program in teaching and engineering practice ability development in the past three years.

4. Whether the faculty members understand and recognize the above systems and measures.

【Common problems】

1. The program’s understanding of this criteria item is unclear, and the evidence and information provided are duplicated or confused with those related to the Faculty in criteria 6. Criteria 6 focuses on whether the existing faculty can meet the requirements of student training, while this criteria item refers to the policies, systems and measures of the institution and department to ensure the stability and healthy development of the faculty team, focusing not only on the system, but also on the effectiveness.

2. The information provided on whether policies and measures of the institution and department are known to faculty members and whether have a positive impact is relatively vague.

7.5 The institution must have sufficient infrastructure to meet the needs of graduate outcomes and support students' practice and innovation activities.

【Connotation interpretation】

The supporting resources referred to in this criteria item are the necessary infrastructure provided by the institution for students to attain graduate outcomes, including a suitable learning and living environment, well-established cultural and sports facilities, good platform conditions for extracurricular activities, social practice and innovative practice.

【Program self-study and evaluator’s review focus】

1. The demand for various types of infrastructure by the program to help students attain graduate outcomes.

2. Whether the institution’s infrastructure provides support for students’ extracurricular practice activities and community activities.

3. Whether the institution’s infrastructure provides support for students’ innovative practice activities.

4. Whether the institution’s infrastructure provides a suitable living and learning environment for students.

【Common problems】

Insufficient materials are provided on the actual support effects and benefits of various activities for students.

7.6 The institution must have well-established teaching management and service to support the attainment of graduate outcomes.

【Connotation interpretation】

This criteria item requires that the institution’s teaching management and services can support the continuous improvement of the teaching quality and the attainment of the graduate outcomes for all students. Management and service standards require both institutional documents and effective implementation of documents to achieve results.

【Program self-study and evaluator’s review focus】

1. Management and service organizations and functions of the institution and program such as academic affairs, students, faculty, and finance.

2. Whether the institution’s academic affairs and student management and services can support teaching and student development.

3. Whether the institution’s personnel and financial management and services can provide effective support for continuous improvement of the program.

【Common problems】

The description of the service situation and effectiveness is insufficient.

Attachment

Connotation of Keywords

1. The Sustainable Development Goals

The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The 17 Goals were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals. The 17 Goals are:

Goal 1: No poverty;

Goal 2: Zero Hunger;

Goal 3: Good health and well-being;

Goal 4: Quality education;

Goal 5: Gender equality;

Goal 6: Clean water and sanitation;

Goal 7: Affordable and clean energy;

Goal 8：Decent work and economic growth；

Goal 9: Industrialization, innovation and infrastructure;

Goal 10: Reduced inequalities;

Goal 11: Sustainable cities and communities;

Goal 12: Responsible consumption and production;

Goal 13: Climate action;

Goal 14: Life below water;

Goal 15: Life on land;

Goal 16: Peace, justice and strong institutions;

Goal 17: Partnerships for the goals.

2. Engineering design knowledge

Knowledge that supports engineering design in a practice area, including codes, standards, processes, empirical information, and knowledge reused from past designs.

3. **Engineering sciences**

Engineering sciences include engineering fundamentals that have roots in the mathematical and physical sciences, and where applicable, in other natural sciences, but extend knowledge and develop models and methods in order to lead to applications and solve problems, providing the knowledge base for engineering specializations.

4. Engineering management

Engineering management is the generic management functions of planning, organizing, leading and controlling, applied together with engineering knowledge in contexts including the management of projects, construction, operations, maintenance, quality, risk, change and business.

5. Diversity

Diversity incorporates all of the elements that make individuals unique from one another, and while there are infinite differences in humans, most of us subconsciously define diversity by a few social categories, such as gender, race, age and so forth.

6. Inclusion

Inclusion is all about understanding and respect. Making sure everybody's voices and opinions are heard and carefully considered is vital in creating a more inclusive environment where everyone feels respected.

Program Profiles of IEA Graduate Attributes & Professional Competences 2021

The following tables provides profiles of graduates of tertiary education engineering programs in *Graduate Attributes and Professional Competences* 2021. The underlined texts are the revised content.

Knowledge and Attitude Profile

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.	1) "Relevant" means "to the extent that the engineering problems in the discipline requires." 2) "Awareness" is less than "knowledge" and more than "acquaintance" or "familiarity." An example of implementation for "social sciences" may be used to distinguish "knowledge" and "awareness" usages throughout GAPC: Limit the social sciences electives to a restricted pool of courses that are relevant to the discipline. For awareness, demonstration may be a successful completion of such electives by every student. For demonstration of knowledge (if it were required), the courses would have been must courses and the HEI must have shown additional

	student work in which student displays the learning of the main subject matters. 3) This row can be thought of the row of "supporting sciences." Physics (as a natural science) supports EE and Mech Eng. Similarly, (as social sciences) Sociology and Psychology may support Computer and Industrial Eng; Economy supports all traditional engineering disciplines.
WK2：Conceptually-based mathematics, numerical <u>analysis</u>, and data analysis , statistics and formal aspects of computer and information science to support <u>detailed analysis</u> and modelling applicable to the discipline.	Data analytics, sometimes suggested, is defined as the science of analyzing raw data and hence not discipline independent. The suggested addition is "data analysis" with small letters.
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.	
WK5：Knowledge, <u>including efficient resource use, environmental impacts, whole-life cost, re -use of resources, net zero carbon, and similar concepts</u>, that supports engineering design and <u>operations</u> in a practice area.	There have been recurring views that listing components restricts the scope and the requirement is better stated in general terms leaving the choice to the curriculum designer. Here, the knowledge relevant to design, which is the main engineering activity, is the topic. Those that are explicitly listed as relevant to design are items that have overwhelmingly mentioned in our surveys.
WK6： Knowledge of engineering practice (technology) in the practice areas in the engineering discipline	
WK7：Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety <u>and sustainable development</u>.	1) The addition of "sustainable development" and the reference in a footnote to UN-SDG is to make sure that engineering programs, when they draw attention to sustainability issues in their curriculum, do it in the framework of UN-SDG; even if their discipline relates to some of those goals only tangentially. 2) An efficient implementation strongly depends on the particular discipline: difference is easy to imagine considering, for instance, chemical and computer engineering.

WK8：Engagement with selected knowledge in the current research literature of the discipline, <u>awareness of the power of critical thinking and creative approaches to evaluate emerging issues</u>.	1) Critical thinking and creative approach may not be knowledge elements and they may be counted perhaps more as "attitudes." They are difficult to teach but the curriculum can help the students to acquire them. 2) "Awareness" is less than "knowledge" and more than "acquaintance" or "familiarity." 3) Examples of implementation: i) encourage unique solutions in every assignment, promote them. ii) Give an award to the "most creative capstone design" every year, iii) Include an assessment item for critical thinking and creativity in every major student work. (It may help the sceptics to know that college professors regularly have to judge the "creativity" of every student they write a recommendation letter for.)
<u>WK9：Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive</u>	1) As a disposition or attitude, ethics (professional or not) and inclusion are in the same category. They need to be implemented in an analogous manner in the curricula (case studies, behavioral scenarios, etc.). 2) The need for diversity is required at the level of "awareness," not knowledge, because the instruments of teaching during education are more limited than, say, at the workplace.

attitudes.	

Graduate Attribute Profiles

WA1 Engineering Knowledge：Apply knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialization as specified in WK1 to WK4 respectively to develop solutions to complex engineering problems.	1) The deletion of "education" in the row-title, is to avoid the impression that this attribute prescribes a curriculum. 2) It is true that each component of "knowledge" would require inclusion of a number of full semester-courses in the 4-year curriculum (usually, many in the first two years). Some Engineering Accreditation Criteria (EAC) stipulate that there must be 30 semester-credit hours (approximately corresponding to a total of 10 courses) to satisfy mathematics and natural sciences together. 3) Similarly, some EAC require 45 semester-credit hours of courses to satisfy computing and engineering fundamentals knowledge requirement. 4) The addition "computing" here (the "Knowledge row!") is different from "Tool Usage" below in row 5 and refers to "computing fundamentals." This includes "algorithms, numerical analysis, basic optimization approaches," whichever is appropriate to the discipline.

WA2 Problem Analysis：Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences with holistic considerations for sustainable development. (WK1 to WK4)	1) The word "research" that occur here should not be interpreted in excess. It only requires that the students learn how to get equipped with the accumulated knowledge in the textbook-literature relevant to a particular problem. 2)The component of sustainability considerations can partly be acquired by its implementation in the capstone design experience, as indicated in the next row. This is not, however, sufficient. The sustainable development outcomes must be considered also at problem definition and problem analysis stages. To be able to do this, students must be first made aware of what these considerations are and learn how to identify those that are relevant to a particular problem under analysis.
WA3 Design/development of solutions： **Design creative solutions for complex engineering problems and design systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource,**	1) Whether a solution is a design solution is distinguished by the problem it solves: i) the problem is incompletely defined, not amenable to a deductive resolution, and requires an innovative or creative approach. ii) the problem admits differing and equally acceptable solutions. 2) Many EAC require a capstone design course (usually, a two-semester long) that is placed in the last year and specify that the design problem solved must require skills and knowledge acquired in the earlier years of the curriculum. 3) The "appropriate considerations" here are not the design specs, which may be already present in the problem definition. This refers to the circumstantial requirements that arise

cultural, societal, and environmental considerations as required (WK5).	from the interaction of the proposed solution with environment and society. 4) Some HEI's present a list of possible considerations as an integral part of the capstone design project, in order to guarantee that the solution takes an appropriate subset of these into account. It may be a good practice to include a reference to UN-SDG in this list or directly form a list based on it.
WA4 Investigation：Conduct <u>investigations</u> of <u>complex engineering</u> problems using research methods <u>including research-based knowledge</u>, design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions (WK8).	1) Many EACs give a detailed definition of a "complex problem" (GAPC does this via all five tables). The main task is to draw its boundaries so that it stands apart from the kind of problems that are in a technologist or technician domain. 2) The "research methods" here consists of learning how to find out what is already known about a particular problem (anything more than this would be unrealistic for a four-year curriculum) 3) The teaching of "design of experiments" is obviously dependent on the engineering discipline: "finding bugs in a code" in computer engineering, "measuring elasticity" in mechanical engineering, "determining the bandwidth by measurement" in electrical engineering, and so on. The word "design" necessitates that a student (or a group of students), alone, devises which experiment would be suitable. 4) Design of experiments, analysis and interpretation of data, synthesis of information are all methods of investigation that can be implemented as parts of suitable courses,

	not in separate courses.
WA5 Tool Usage：Create, select and apply, <u>and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems</u> (<u>WK2</u> and WK6).	1) The attribute is to be able to select and apply the appropriate tool from among those that the recent (modern) technology offers; and, to be able to create one when selection is not possible because none of the existing tools answers the present need. 2) The implementation not only requires to confront the student with problems that need selection of a tool but also with some that necessitate the creation of a new tool. To expect a creation that is comprehensive (a new software!) is not realistic; adding a feature to an existing software, synthesis of two separately available tools, an alteration of an existing model (from linear to nonlinear, from time-invariant to slowly time-varying, from polynomial to exponential etc.) would be examples that can be introduced in a four-year curriculum.
WA6 The Engineer and the World: When solving complex engineering problems, analyze and evaluate sustainable development impacts to: society, the economy, sustainability, health and safety, <u>legal frameworks, and the environment (WK1, WK5, and</u>	1)This attribute can partly be acquired by its implementation in the capstone design experience, as was indicated above. This is not, however, sufficient. The sustainable development outcomes must be considered also at problem definition and problem analysis stages. (This is the reason why a separate row must be devoted to it.) 2) How a foundation for this attribute may be included in a curriculum is indicated by rows 1, 5, and 7 of Knowledge Profile.

WK7).	3) An awareness of social sciences is one requirement to the attainment of this attribute. An example implementation in the curriculum may be to limit the social sciences electives to a restricted pool of courses that are relevant to the discipline. (Sociology and Psychology may support Computer and Industrial Engineering; Economy supports all traditional engineering disciplines, and so on). 4) In some disciplines, it may be necessary to devote a full 3-semester-credit course for a particular aspect in this row. (For instance, health and safety in chemical engineering and so on.) Otherwise, the observance of these aspects in each major student work on analysis and design may be sufficient.
WA7 Ethics：Apply ethical principles and **commit to professional ethics and norms of engineering practice and adhere to relevant national <u>and international laws</u>. <u>Demonstrate an understanding of the need for diversity and inclusion (WK9)</u>.**	1) This row is about understanding and practicing ethics. The additions are detailing what aspects ethics encompasses. D&I, as an "attitude" is very much a part of ethics. Team work is an instance where D&I is important. Communication is another. 2) If a devoted course to ethics is not feasible, then the best way to implement this attribute in the curriculum would be to design, as parts of some appropriate courses, a number of case studies. 3) An example of implementation for the demonstration of D&I as an "attitude" may be to design one or two (of these) case studies on "workplace ethics problem on non-discrimination."

	4) Professional ethics is not only "not to cheat on specs of a product," it is more comprehensive and includes all aspects indicated in this row. These aspects are still listed though, for emphasis.
WA8 Individual and Collaborative Team work：Function effectively as an individual, and as a member or leader in diverse and <u>inclusive</u> teams and in multi-disciplinary, face-to -face, <u>remote and distributed settings</u> <u>(WK9)</u>.	1) The addition "collaborative" in the row-title is to indicate that a group of students with or without a leader but with different skills get together to complete a project. Many think that "team" alone does not imply these. 2) The word "inclusive" in the attribute draws attention that teams must learn to function with individuals of different backgrounds and different levels of learnings, etc. One implementation in the curriculum is to form any lab or project team among students randomly, as a principle. 3) The teamwork attribute, especially multidisciplinary one, is a major challenge of implementation in any engineering discipline, not only to realize but even to sustain after having started. This is, however, one attribute almost every employer of engineers puts at the top of the "must be list." 4) The "remote and distributed settings" component has clearly gained significance in the last year. It is agreed, however, that it is not a result of this temporary state and will continue to be the primary setting for any group to work together. Students must hence learn to be comfortable with it. An implementation example may be to (additionally)

	request that a meeting or presentation by a student is also transmitted to an audience and its effectiveness is evaluated.
WA9 Communication：Communicate effectively and inclusively 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, taking into account cultural, language, and learning differences.	1) This attribute has many important components, some of which have been explicitly mentioned in the previous version, like "give and receive clear instructions." The choice depends on a list of priorities that is shaped by specific scenarios in mind. The present priorities are on "reports and documentation" and "language and learning differences." 2) The implementation would require that every student not only writes a comprehensive report, makes a formal presentation, and faces a diverse audience at least once during the education period but that all these activities are evaluated by instructor(s) using appropriate performance criteria, with feedback to the student, and with "repeat" a viable option.
WA10 Project Management and Finance：Apply 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, and to manage	Many EACs implement this attribute with the inclusion of a must or elective course, although this is neither sufficient nor necessary. The correct solution of implementation strongly depends on the engineering discipline as well as the program educational objectives. One possible solution may be to design the capstone design experience as a major collaborative project, which requires management and has economic dimensions.

projects and in multidisciplinary environments.	
WA11 Lifelong learning：Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change (WK8).	1) The row-title now refers to both continuity and aspects of learning. 2) Critical thinking can be understood as an "active, logical, and questioning process of accepting facts or beliefs." 3) An example implementation for (i) and (ii): Students attend (and can submit its proof) to one or two lessons or seminars in which they listen to the importance of engaging with a professional and intellectual community, learning from knowledge and standards, and how this contributes to adaptability and advancement during an engineering career. 4) It may be difficult to teach critical thinking. But, it can be learned. An example implementation in the curriculum may be adding an item among the evaluation criteria of any comprehensive student work to assess whether the student applied a questioning and logical process while making assumptions and decisions.

Complex Engineering Problems

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 and/or conflicting technical, non-technical issues (such as ethical, sustainability, legal, political, economic, societal) and consideration of future requirements.
Depth of analysis required	**WP3**： Have no obvious solution and require abstract thinking, creativity and originality in analysis to formulate suitable models.
Familiarity of issues	**WP4**：Involve infrequently encountered issues or novel problems.
Extent of applicable codes	**WP5**：Address problems not encompassed by standards and codes of practice for professional engineering.
Extent of stakeholder involvement and conflicting	**WP6**：Involve collaboration across engineering disciplines, other fields, and /or diverse groups of

requirements	stakeholders with widely varying needs.
Interdependence	**WP7**：Address high level problems with many components or sub-problems that may require a systems approach.