

4.7 Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. PEOs are assessable based on the attributes and accomplishments of graduates, preferably those who have worked for 3 to 5 years after graduation. Each engineering program should have published PEOs that are clear, concise, assessable and realistic within the context of the available resources. The PEOs should be consistent with the vision and mission of the department offering the program. They should be supported by a curriculum and teaching-learning processes that lead to the attainment of these objectives. Justifications should be provided for how the curriculum and the outcomes contribute to the attainment of the PEOs.

A process should be developed to assess the level of attainment of each PEO to evaluate the academic program's effectiveness. Adequate evidence and documentation on the assessment of PEO attainment should be provided. The assessment tools should be indicated, and the way in which these tools are used should be explained. PEO assessment should lead to the periodic review of PEOs. Feedback from the various program stakeholders, including employers, alumni, students and faculty, should be considered during the review.

4.8 Program Outcomes and Assessment

Program Outcomes (POs) or graduate attributes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These statements relate to the knowledge, skills and attitudes acquired by students while progressing through the program. The program must demonstrate that by the time of graduation, students have achieved an acceptable minimum level of certain knowledge, skills and behavioral traits. The BAETE specifically requires that students acquire the following graduate attributes:

(a) Engineering knowledge: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.

(b) Problem analysis: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4)

(c) Design/development of solutions: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs

with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (K5)

(d) Investigation: Conduct investigations of complex problems using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

(e) Modern tool usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. (K6)

(f) The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7)

(g) Environment and sustainability: Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7)

(h) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)

(i) Individual work and teamwork: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

(j) 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.

(k) Project management and finance: Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

(l) Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

In addition to incorporating the above-listed POs (graduate attributes), the educational institution may include additional outcomes in its learning programs. An engineering

program that aims to attain the abovementioned POs should ensure that its curriculum encompasses all the attributes of the Knowledge Profile (K1 – K8) as presented in Table 4.1 and as included in the PO statements. The ranges of Complex Problem Solving (P1 – P7) and Complex Engineering Activities (A1 – A5) that should be addressed in the program are given in Tables 4.2 and 4.3, respectively.

Table 4.1: Knowledge Profile

Attribute	
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	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
K5	Knowledge that supports engineering design in a practice area
K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

Table 4.2: Range of Complex Engineering Problem Solving

Attribute	Complex Engineering Problems have characteristic P1 and some or all of P2 to P7:
Depth of knowledge required	P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach
Range of conflicting requirements	P2: Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	P4: Involve infrequently encountered issues
Extent of applicable codes	P5: Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder	P6: Involve diverse groups of stakeholders with widely varying

involvement and conflicting requirements	needs
Interdependence	P7: Are high level problems including many component parts or sub-problems

Table 4.3: Range of Complex Engineering Activities

Attribute	Complex activities means (engineering) activities or projects that have some or all of the following characteristics:
Range of resources	A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	A2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	A3: Involve creative use of engineering principles and research-based knowledge in novel ways
Consequences for society and the environment	A4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	A5: Can extend beyond previous experiences by applying principles-based approaches

The program should describe the process involved in defining and refining the POs. The correlation between the course outcomes (COs) and POs should be demonstrated through the mapping of COs onto POs.

The way in which each attribute of the Knowledge Profile (K1 – K8) is addressed in the curriculum should be demonstrated through mapping. The program should also demonstrate how each attribute of the Range of Complex Engineering Problems (P1 – P7) and Complex Engineering Activities (A1 – A5) is incorporated in the teaching, learning and assessment.

For each course, a course file must be maintained. The course file should include the assessment of outcomes, curriculum, examination questions and answer scripts, the results of other assessments, and a summary of performance and attainment of course outcomes with suggestions or feedback for future development.

POs should be assessed using direct methods. Direct methods of assessment are accomplished through the direct examination or observation of students' knowledge or skills against measurable performance indicators or rubrics. In addition, indirect methods may also be used for PO assessment. Indirect methods of assessment are based on opinions or self-reports from different stakeholders. The way in which various assessment tools, including examinations and rubrics, contribute to the evaluation of