College of Engineering
King Khalid University
Abha, Kingdom of Saudi Arabia

Program Learning Outcomes Assessment Plan

Year-1447

Master in Chemical Engineering

Quality and Development Committee

Department of Chemical Engineering

Contents

Introduction

Program Mission

The Chemical Engineering Department of King Khalid University is engaged in pursuing its mission and plans which focus on high-quality education research, innovation, health, safety environment, and community services. The department engages its staff and resources for the continuous achievement of the following mission for its post-graduate program:

Produce engineers of a high level of competence and skills to conduct engineering research, solve engineering problems, and provide scientific contributions in the service of the community and industrial institutions in the Kingdom and the Gulf region.

Stakeholders

The Department of Chemical Engineering consistently involves its constituencies in the continuous development of the program structure. The following are the stakeholders:

- Students
- Alumni
- Faculty
- Employers
- External Advisory Board (EAB)

Students

Students are the most significant constituency, with clear aspirations of becoming professional engineers. They are the primary input to the program, an integral part of the process, and the output of the process. Students are expected to be technically qualified, marketable, and productive to society. Hence, student feedback is considered when defining the program goals (PGs). The program solicits their involvement and input through student feedback surveys. Students' representatives are also invited to meetings.

Alumni

This group consists of students who have graduated from the program with a degree certificate and are currently employed in various Government Offices, Private sectors, Public Sectors, and Educational Sectors, or are pursuing higher education within or outside the country. Alumni gain additional perspectives on the engineering and technical field and the program they graduated from. Alumni have a unique view of how the program has supported their career goals and professional accomplishments. Hence, their input is critical. They are involved through the Alumni survey.

Faculty

Faculty members have the skills and knowledge required to manage the educational process. They understand the future vision and challenges. Faculty members are responsible for achieving PLOs through the teaching-learning process and providing guidance and counseling services to the students. The faculty members conduct assessments and evaluations that provide the basis for continuous improvement. Hence, their input is important. They provide consultations, and they are involved in the satisfaction and feedback survey.

Employers

Employers range from the public to the private sector, and from small to large businesses. Employers provide critical feedback on the competencies and capabilities expected of graduates and the graduates' employability. Their expectations of young chemical engineering professionals form the basis for setting objectives and strategies to achieve them.

Employer satisfaction reflects a program's quality and gives graduates a competitive edge. Therefore, their input is important and a priority. Employers' meticulous involvement is through our Employer Surveys.

External Advisory Board (EAB)

It consists of managers, engineers, industry leaders, and professors from the academy. Selected faculty members of the College of Engineering are also board members. It shares industrial and academic practices for establishing and reviewing PEOs and for deciding action plans and strategies for improvements. EAB feedback is significant to the program.

Program Goals (PGs)

The post-graduate program goals were established with stakeholder involvement. Upon completion of the program, the graduates will possess the following abilities for a successful career in their professional life:

PG 1: To grow into an excellent teaching and learning facility capable of fostering skills and critical thinking in its program graduates.

PG 2: To emerge as a world-class infrastructure and service facility for technical education to fulfill the national aspiration and to serve the international community.

PG 3: To utilize and expand the existing facilities for research and development.

PG 4: Graduates shall apply broad knowledge of chemical engineering, international conventions, and standards in their professional industrial activities to work successfully in a diversified field of chemical engineering.

PG5: Graduates shall conduct independent scientific research and pursue advanced doctoral and post-doctoral careers in research and academia.

PG6: Graduates shall develop innovative engineering solutions to regional and global chemical engineering problems for the welfare of the community.

PG7: Graduates shall work with safety, ethical, and environmental responsibilities, performing well in teams.

Alignment of Program Goals with NQF Domains

Table 1 shows the alignment of program Goals (PGs) with the learning domains and NQF areas.

Table 1 - Alignment of Program Goals with NQF Domains

NQF Domain		NQF Areas of Learning	Mapping PGs
Knowledge and understanding		Theoretical, factual, and procedural knowledge	PG-1, PG-4
		Knowledge of processes, materials, techniques, practices, conventions, and terminology	PG-1, PG-4
		Specialized knowledge	PG-1, PG- 2, PG-3-5
		Knowledge of research and inquiry	PG-1-3, PG-5
Skills	**Cognitive Skills**	Application of knowledge	PG-1, PG-4
		Solve problems in complex and advanced contexts	PG-1, PG-4, PG-6
		Provide creative solutions in complex and advanced contexts and current issues	PG-1, PG- 2, PG-3, PG-4, PG-5, PG-6
		Apply specialized techniques of research and inquiry to carry out advanced research or a professional project	PG-1, PG- 2, PG-3, PG-4, PG-5
	Practical and Physical Skills	Using processes, techniques, tools, instruments, and materials	PG-1, PG-2
		Carrying out complex and advanced practical tasks and procedures in a specialized area	PG-1, PG- 2, PG-3, PG-4, PG-5
	Communication and ICT Skills	Communication	PG-1
		Use quantitative and qualitative methods to process data and information in complex and advanced contexts	PG-1, PG- 2, PG-3, PG-4, PG-5
		Select, use, and adapt advanced digital technology to support and enhance leading research and projects	PG-1, PG-2, PG-3, PG-4, PG-5
Values, Autonomy, and Responsibility	**Values & Ethics**	Values, ethics, and citizenship.	PG-1, PG-7
	Autonomy and Responsibility	Self-development (lifelong learning), decision-making, and autonomy	PG-1, PG-7
		Managing tasks and activities	PG-1, PG-7
		Participation, collaboration, leadership, and responsibility	PG-1, PG- 2, PG-7
		Contribute to the fostering of a quality life for the community	PG-1, PG- 2, PG-7

Program Learning Outcomes (PLOs)

The Program Learning Outcomes (PLOs) contribute to the attainment of the institutional mission, and the Course Learning Outcomes (CLOs) of the planned curriculum contribute to the PLOs. Thus, they bridge the mission and learning through the courses. Table 2 below shows the Program Learning Outcomes (PLOs).

Table 2 - Program Learning Outcomes (PLOs)

Upon completion of the program, the graduate will have the ability to:

PLO Domains	Code	Outcomes
Knowledge, and understanding	K1	In-depth, critical, and specialized knowledge of principles, concepts, terminologies, processes, and materials in chemical engineering
	K2	Advanced knowledge and understanding of established, specialized, and recent developments in research and inquiry techniques
Skills	**Skills (Cognitive skills)**	
	S1	Apply specialized knowledge of theories, principles, and concepts of chemical engineering to solve complex and advanced problems.
	S2	Ability to conduct advanced research, critically review to analyze current complex issues, and provide creative solutions
	Skills (Practical and Physical skills)	
	S3	Use advanced and specialized processes, techniques, tools, instruments, and materials to carry out complex practical tasks in specialized areas related to chemical engineering.
	Skills (Communication and ICT skills)	
	S4	Communicate in various forms to demonstrate and disseminate knowledge, skills, research results, and innovations related to chemical engineering to a variety of audience
	S5	Use and adapt digital technology, ICT tools, and applications to process and analyze various data and information in complex contexts or research.
Values, Autonomy, and Responsibility	**Values and Ethics**	
	V1	Demonstrate an understanding of integrity, professionalism, and academic values related to various complex and advanced contexts of chemical engineering.
	Autonomy and Responsibility	
	V2	Plan, perform, monitor, and manage self-learning and professional tasks with high autonomy and decision-making.
	V3	Demonstrate responsibility, collaboration, and leadership in research and professional project groups and contribute to community development.

Mapping Between PLOs and PGs

The following Table 3 shows how PLOs relate and contribute to the achievement of the Program Goals (PGs):

Table 3- Mapping Between PLOs and PGs

PG Code		PG-1	PG-2	PG-3	PG-4	PG-5	PG-6	PG-7
PLO Codes	PG description / PLOs description	*Excellent teaching and learning facility*	Infrastructure and service facility	Facilities for research and development	Graduates apply broad knowledge of chemical engineering	Graduates conduct independent scientific research and pursue studies	Graduates develop innovative engineering	Graduates work with safety, ethical, and environmental responsibilities
Knowledge								
K1	In-depth and critical knowledge of various concepts	√			√	√	√	
K2	Advanced knowledge of specialized, and recent developments	√			√	√	√	
Cognitive skills								
S1	Apply specialized knowledge theories, principles, and concepts	√			√	√	√	
S2	Conduct advanced research and provide creative solutions	√	√	√	√	√	√	
Practical and Physical skills								
S3	Carry out complex practical tasks using advanced tools and techniques	√	√	√	√	√	√	
Communication and ICT skills								
S4	Communicate in various forms	√				√		√
S5	Use and adapt digital technology, ICT tools, and applications	√	√	√	√	√	√	
Values and Ethics								
V1	Integrity, professionalism, and academic values	√				√		√
Autonomy and Responsibility								

V2	**Self-learning and professional tasks and decision-making.**	√			√		√	√
V3	**Responsibility, collaboration, and leadership**	√		√			√	√

PLO Distribution over NQF Learning Domains

The consistency of PLOs with the NQF Level 7 (Master Level Degree) Domains and Areas of Learning is shown in Table 4 below:

Table 4 - Mapping of PLOs with NQF

NQF Domain		NQF Areas of Learning	Mapping PLOs
Knowledge and understanding		Theoretical, factual, and procedural knowledge	**K1**
		Knowledge of processes, materials, techniques, practices, conventions and terminology	**K1**
		Specialized knowledge	**K2**
		Knowledge of research and inquiry	**S2**
Skills	**Cognitive Skills**	Application of knowledge	**S1**
		Solve problems in complex and advanced contexts	**S1**
		Provide creative solutions, in complex and advanced contexts and current issues	**S1, S2**
		Apply specialized techniques of research and inquiry to carry out advanced-research or professional project	**S2, S3**
	Practical and Physical Skills	Using processes, techniques, tools, instruments, and materials	**S3**
		Carrying out complex and advanced practical tasks and procedures in a specialized area	**S3**
	Communication and ICT Skills	Communication	**S4**
		Use quantitative and qualitative methods to process data and information in complex and advanced contexts	**S4**
		Select, use, and adapt advanced digital technology to support and enhance leading research and projects	**S5**
Values, Autonomy, and Responsibility	**Values and Ethics**	Values, ethics, and citizenship.	**V1**
	Autonomy and Responsibility	Self-development (lifelong learning), decision-making, and autonomy	**V2,**
		Managing tasks and activities	**V2**
		Participation, collaboration, leadership, and responsibility	**V3**
		Contribute to the fostering of a quality life for the community	**V3**

Program Learning Outcome Mapping with ABET and NCAAA Learning Outcomes

The mapping of PLOs with the NCAAA learning outcomes is shown in the following table:

Table 5 - Mapping of PLOs with the NCAAA learning outcomes

NCAA Learning Outcomes		Mapping PLOs
NCAAA Domains	**Areas**	
Knowledge	Knowledge of specific facts	K1, K2
	Knowledge of concepts, principles, and theories	K1
	Knowledge of procedures	K2, S3
Cognitive Skills	Apply conceptual understanding of concepts, principles, theories	S1
	Apply procedures involved in critical thinking and creative problem solving, both when asked to do so, and when faced with unanticipated new situations	S1, S2
Interpersonal Skills and Responsibility	Take responsibility for their learning and continuing personal and professional development	V1 V2
	Work effectively in groups and exercise leadership when appropriate	V3
	Act responsibly in personal and professional relationships	V3
	Act ethically and consistently with high moral standards in personal and public forums	V1, V3
Communication, IT, and Numerical Skills	Communicate effectively in oral and written form	S4
	Use information and communications technology	S5
	Use basic mathematical and statistical techniques	S5

The mapping of PLOs with the ABET student outcomes at the Masters level is shown in the following table:

Table 6 - Mapping of PLOs with the ABET student outcomes.

ABET Outcomes	Mapping PLOs
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	S1
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	S2
3. An ability to communicate effectively with a range of audiences	S4
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	V1-3
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	V3
6. An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to conclude.	S3
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	V2

PLOs Mapping with Program Courses

Table 7 shows how the PLOs are introduced through the curriculum courses and how students practice and master them through the courses. These mapped courses are chosen for the assessment of the PLOs:

Table 7 – Distribution of PLOs over Curriculum Courses

Course Code	Course name	Knowledge		Skills					Values		
		K1	K2	S1	S2	S3	S4	S5	V1	V2	V 3
7102CHME -4	Thermodynamics	P	M	M	I				P		
7104CHME -4	Applied Mathematics in Chemical Engineering	M	M	I	P			P	I		
7105CHME -4	Process Modeling and Control	I	I		P	P		M			
7101CHME-3	Transport Phenomena - 1	I	I	P		P				M	
7106CHME-3	Transport Phenomena - 2	I	I	P		P				M	
7201CHME-4	Reaction Engineering	P	P	P	P				I		
7402CHME-4	Industrial Safety & Risk Assessment	I	I		P		I			I	P
7302CHME-4	Polymer Science and Engineering	I	I				I		I	I	
7205CHME-4	Particle Engineering	P	P	P	P				I	I	
7202CHME-4	Heterogeneous Catalysis	I	I	I		I	P		P		M
7306CHME-4	Project Management	P	P				P	P	I		
7502CHME-4	Technology Management	I	I		P		P				M
7404CHME-4	Energy Systems and Sustainability	P	P	I		P			P		
7403CHME-4	Wastewater Treatment Technologies	I	I	I	P					P	P
7303CHME-4	Corrosion Control	I	I	I	M	p			I		
7204CHME-4	Oil Refining Engineering	M		I	M	P					
7203CHME-4	Biochemical Engineering	M	M				I	I	M		
7206CHME-4	Petrochemical Processing Engineering	M	M		P	M					

Course Code	Course name	Knowledge		Skills					Values		
		K1	K2	S1	S2	S3	S4	S5	V1	V2	V 3
7501CHME-4	Selection Process and Equipment Design	M	M	M	I			P			
7207CHME-4	Gas Processing Engineering	M	M		P	M					
7304 CHME-4	Nanotechnology	M	M		P	M				M	
7305CHME-4	Mineral Processing	I	M		P	P				M	
7601CHME-3	Master Thesis	M	I	M	M	P	M	I	M	P	P

PLOs Mapping Missions and Graduate Attributes

The program tree below in Figure 1 represents how the PLOs contribute to attaining the GAs and the mission.

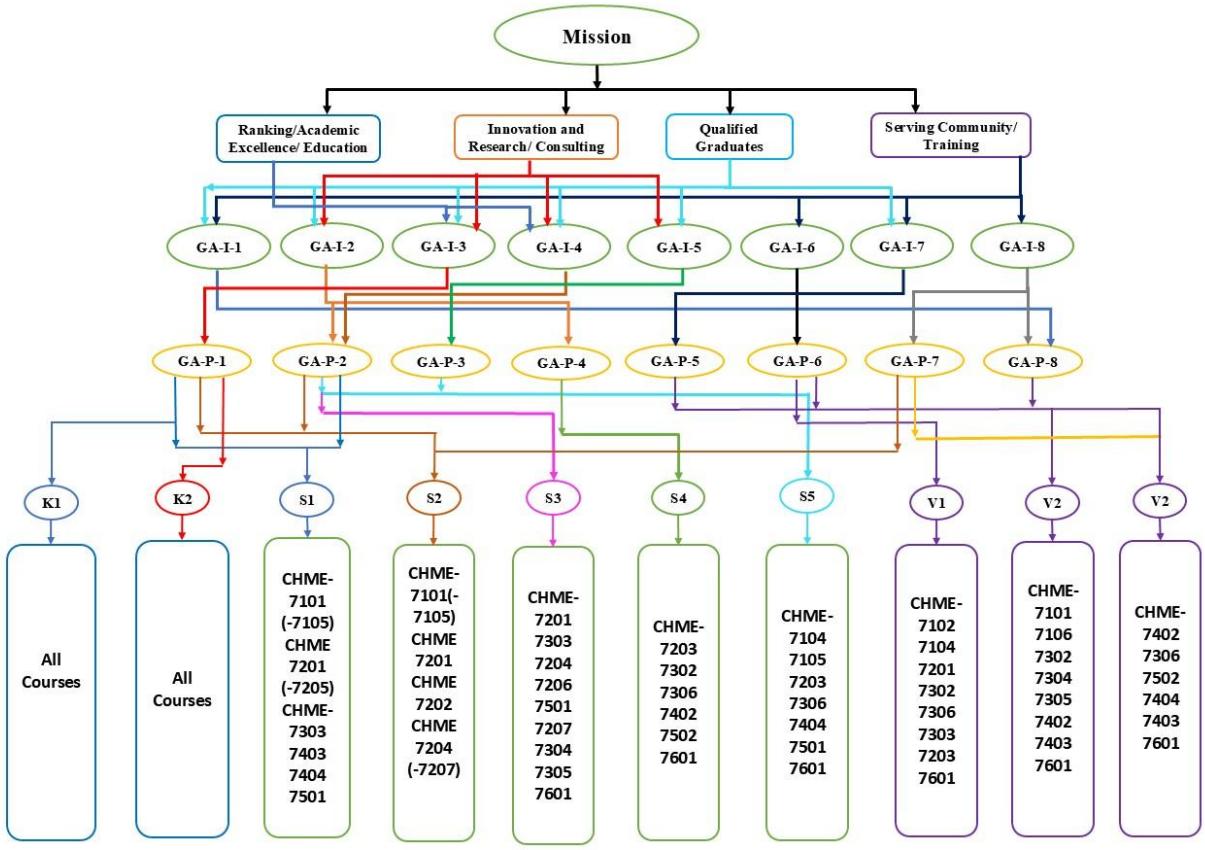

Figure 1 – Program Tree

Continuous Improvement Process

The department has a well-established continuous improvement process which is not only limited to the assessment of PLOs, but also involves measurement, assessment, and evaluation of the following:

- Program Goals
- Program Learning Outcomes
- Key Performance Indicators
- Course Evaluations
- Faculty development and performance evaluations
- Academic Advisory and Scientific Supervision
- Alumni and Employer

The PLO assessment process is a part of the entire assessment process shown in the following Figure 2:

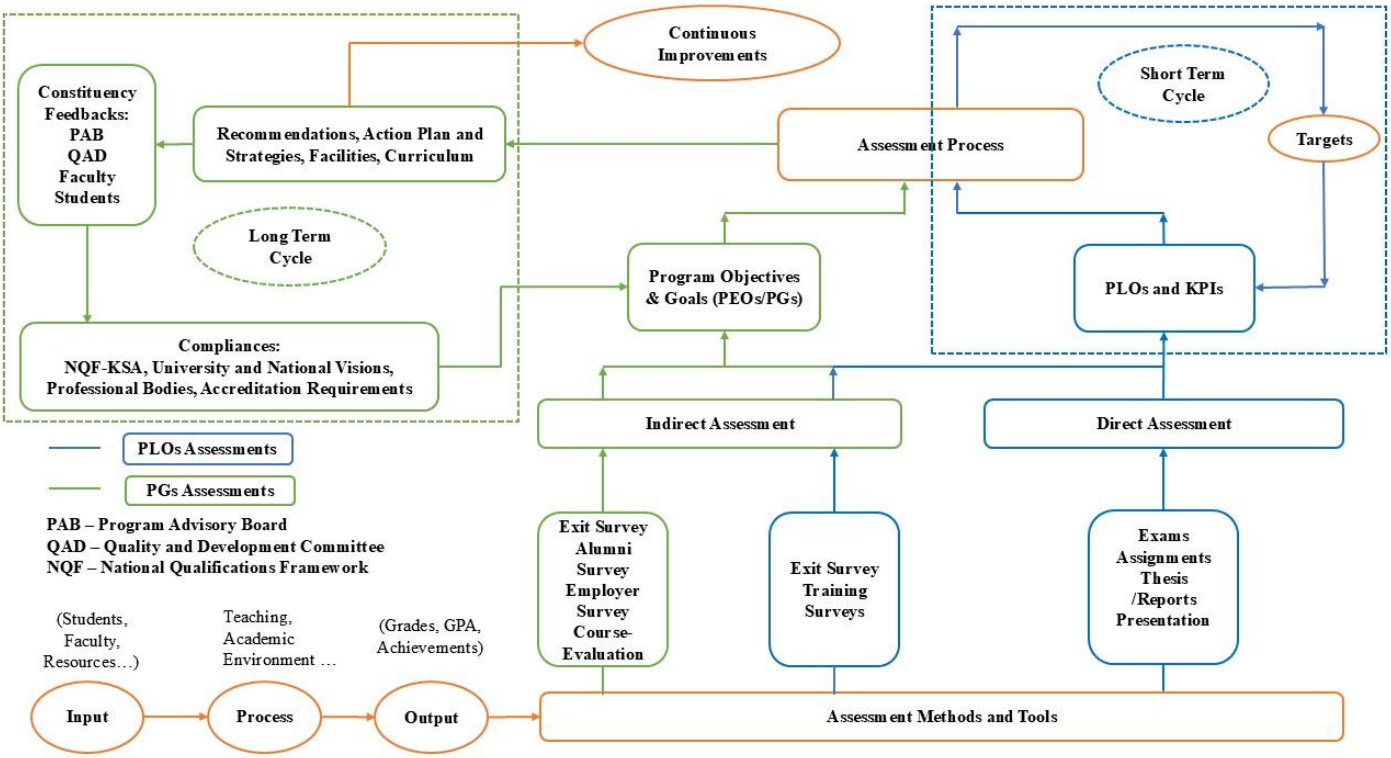

Figure 2 – Assessment Process for Continuous Improvement

PLO Assessment Process

The PLO assessment process aims to

- Assess the learning outcomes expected from students

- Evaluate the quality of teaching and learning strategies
- Provide strong evidence for decisions at the program level and support continuous improvements.
- Ensure the quality of the program

The PLO assessment is carried out with various direct and indirect assessment methods and tools to gather evidence, as shown in Figure 3.

PLOs Assessment Methods

Direct Assessment Methods

- Designated Problems in Exams/ Quizzes/Assignments.
- Faculty/supervisor observations from Assignments/Projects/Thesis work/Presentations

Indirect Assessment Methods

- Exit Surveys for CLOs and PLOs.

- Exit Interviews
- Alumni survey
- Employer survey

Achievements Target for PLOs

At least 70% of students are expected to attain a minimum achievement level of 70%, equivalent to 3.5 out of 5.0, in the assessed course learning outcome.

General Assessment Methodology

Direct assessment shall follow the steps below:

1. Plan assessment activities such as designated examination or quiz questions, assignments, laboratory work, projects, presentations, and thesis-related tasks that are explicitly mapped to the relevant CLO and PLO.
2. Grade the mapped assessment activity using the approved marking scheme or rubric. For course-level direct attainment, determine the percentage of assessed students who achieve at least 70% in the designated PLO-related evidence.
3. For teamwork, projects, laboratory work, presentations, and thesis activities, use an approved rubric with criteria explicitly aligned to the intended PLO. Supervisors and evaluators should retain the rubric scores and representative samples of student work as evidence.
4. Apply the rubric criteria consistently and, where more than one evaluator is involved, conduct moderation to improve consistency of scoring.
5. Submit the course assessment summary, sample-size information, mapped evidence, and representative student work to the Quality and Development Committee through the approved departmental repository.

Indirect assessment uses structured PLO surveys to capture students' perceptions of their attainment and, where appropriate, feedback from alumni and employers. The Quality and Development Committee coordinates the collection, validation, and reporting of these data. Indirect evidence supports direct results and should not replace direct evidence.

PLO Assessment Process

The PLO assessment process is a part of the short-term assessment cycle that provides feedback for continuous improvement. To begin measuring PLOs, various instructors conduct direct assessment activities. Faculty members systematically plan activities and tests, such as exams, quizzes, projects, and presentation tasks, from which they collect data to measure PLOs and record evidence. The Quality and Development Committee (QAD) initiates indirect assessment activities. The committee contacts and follows up with the recipients who provide the assessment survey data. The assessment process consists of the following steps, as shown in Figure 3:

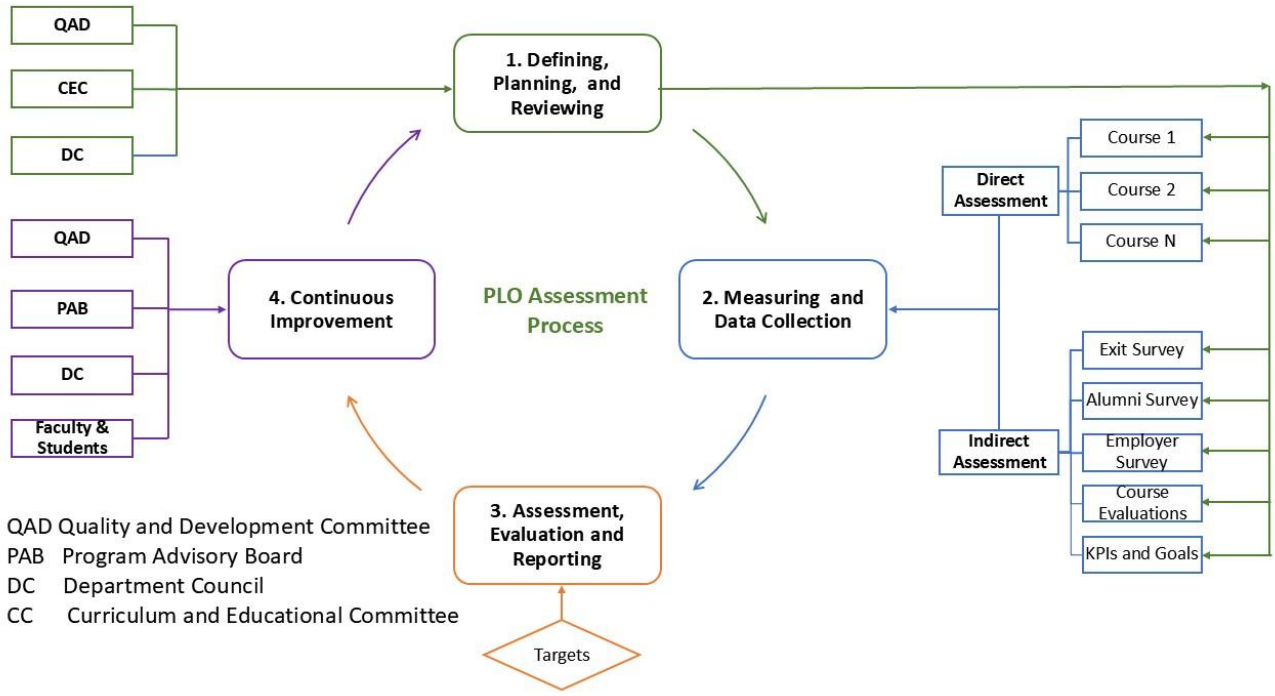

Figure 3 – PLO Assessment Process

Steps Involved in the PLO Assessment Process

Defining, planning, and Reviewing

At the beginning of the academic year, the Quality and Development Committee reviews the previous assessment report, identified gaps, course offerings, PLO-course mapping, assessment tools, and the approved target. The committee confirms the PLOs to be assessed, the evidence sources, responsibilities, and submission deadlines. Any changes to the assessment plan are documented and approved through the appropriate departmental process.

Measuring and Data collection

Course instructors conduct the approved direct assessment activities and record PLO-specific attainment together with the number of students assessed. Each assessment item must be traceable to the relevant CLO and PLO. Evidence should include the assessment tools, marking scheme or rubric, attainment summary, and representative samples of student work. Missing or non-applicable evidence must be recorded.

PLO-related indirect assessment activities are coordinated by the Quality and Development Committee (QAD). Student PLO surveys should be collected systematically, while alumni and employer feedback may be obtained in coordination with the relevant departmental committees. The number of respondents must be recorded for every indirect result.

The QAD should organize periodic orientation or moderation sessions to support faculty members in mapping assessment evidence, applying rubrics consistently, and reporting PLO data accurately.

Assessment, Evaluation, and Reporting

The data collected from measuring PLOs through direct and indirect methods across courses is aggregated and evaluated at the program level. Direct and indirect PLO evidence should be verified through PLO mapping, sample sizes, and completeness of evidence. The QDC compares each PLO result with the approved target, examines direct-indirect differences, sample-size adequacy, and recurring trends, and identifies strengths, concerns, and areas for improvement. The PLO assessment report should include the evidence base, sample calculation file, interpretations, action plan, responsible persons or committees, completion dates, and a follow-up mechanism to verify the effectiveness of implemented actions in the next assessment cycle.

Continuous Improvement and Closing the Loop

Following approval of the annual PLO assessment report, the Department Council reviews the findings and approves appropriate improvement actions. Actions may address teaching and learning strategies, assessment design, student support, curriculum mapping, laboratory or software resources, thesis assessment, or faculty development. The QAD monitors implementation and records completion evidence. In the next assessment cycle, the relevant PLO results are reviewed to determine whether the action produced the intended improvement. This closes the assessment loop and links evidence directly to program development and efficiency.

Data Aggregation and Program-Level Assessment

PLO results are aggregated using student-count weighting so that evidence from courses or semesters with different numbers of assessed students is represented proportionally, as shown in the following table - 8.

Table – 8 Program Level Calculation Guidelines

Measure	Calculation / Rule	Interpretation
Course-level direct attainment	d_i = percentage of assessed students who attain at least 70% in the designated PLO with evidence.	Reporting provides d_i together with the number of assessed students n_i.
Program direct weighted average	$D = \Sigma(n_i \times d_i) / \Sigma n_i$, using only valid direct assessments.	Aggregates all valid course and semester direct evidence for the PLO using the corresponding sample sizes.

Measure	Calculation / Rule	Interpretation
Course-level indirect attainment	I_j = percentage of assessed students who attain at least 70% in the designated survey.	Reporting provides I_j together with the number of assessed students m_i.
Program indirect weighted average	$I = \Sigma(m_j \times i_j) / \Sigma m_j$, using only valid survey observations.	m_j is the number of valid respondents for indirect evidence.
Program weighted average	$P = 0.80D + 0.20I$ when both D and I are available.	The approved reporting model gives 80% weight to direct and 20% to indirect evidence.

Any PLO without direct evidence should not be considered fully assessed. If no valid direct evidence exists, the PLO should be reported as not available, and a suitable corrective action should be initiated. If indirect evidence is missing, it should be reported as Direct-only / incomplete course assessment.

Assessment Schedule and Frequency

All PLOs are reviewed annually. Direct and indirect evidence are collected each semester from all the mapped courses. The annual cycle is designed to ensure that each PLO has sufficient evidence and sample size. The gaps identified in one cycle are to be addressed in the next.

Table - 9: Assessment Schedule and Frequency Guidelines

Stage / Timing	Main Activity	Responsibility	Output
Beginning of academic year	Review previous report; confirm selected PLOs, courses, tools, rubrics, and responsibilities.	QAD / Program Coordinator	Approved annual assessment matrix and schedule
Beginning of each semester	Instructor identifies the mapped CLO/PLO assessment items and verifies the assessment tool or rubric.	Course Instructor / Coordinator	Course-level assessment plan
During each semester	Conduct direct assessments and retain evidence and sample student work.	Course Instructor / Thesis Supervisor	Direct attainment data and evidence
End of each semester	Submit PLO results, sample sizes, rubrics, and evidence; conduct/collect student PLO survey as planned.	Course Instructor / QAD	Validated semester dataset
End of academic year	Aggregate semester data; conduct annual PLO analysis; identify data gaps and improvement priorities.	QAD	Annual PLO assessment report
After report approval	Approve actions, assign responsibilities and due dates, and monitor implementation.	Department Council / QAD	Approved improvement action plan
Next assessment cycle	Review effectiveness of completed actions and compare with new PLO results.	QAD / Department Council	Closing-the-loop evidence

Assessment Strategies

The annual assessment strategy uses multiple evidence sources and prioritizes courses in which a PLO is practiced (P) or mastered (M). Mastery-level evidence should be used whenever it is offered during the assessment year. To strengthen validity and coverage, the program-level assessment should use multiple courses with direct evidence for a PLO. Flag assessments are supported by only one course or a small sample in the annual report, and in the following cycle add an additional mapped source course. The Master Thesis is an important source of advanced, integrative evidence and should be included for the PLOs to which it is mapped, particularly research, communication, autonomy, responsibility, collaboration, and leadership outcomes.

Assessment Methods and Tools

The following Table 10 summarizes general assessment methods and tools. Course-specific methods and tools should be available in the course specifications.

Table – 10 Assessment Methods and Evidence Tools

Assessment methods	Assessment Tools	Use in PLO Assessment
Direct - examination/quiz items	Designated problems, derivations, analysis questions, case-based items	Knowledge and cognitive PLOs can be mapped directly and measured with grades or scores.
Direct - assignments/projects	Design problems, modeling tasks, literature reviews, research tasks, group projects	Advanced problem solving, research, digital tools, autonomy and teamwork
Direct - laboratory/practical work	Laboratory tasks, process/equipment operation, data collection and analysis rubrics	Practical and specialized process/tool PLOs
Direct - presentation/thesis	Oral presentation, thesis report, defense, supervisor/examiner rubric	Communication, research, digital, ethics, autonomy, leadership and integrative PLOs
Indirect - student PLO survey/exit survey	Surveys aligned with individual PLOs	Student's perception with direct evidence
Indirect - alumni/employer feedback	Approved surveys and feedback	Longer-term validation of program relevance and graduate capability: vision , mission and program goals

Selected Courses for PLO Assessment

The preferred direct evidence sources below are derived from the approved curriculum mapping in Table 7. The QAD should confirm the courses actually offered in the assessment year and select the strongest available P/M-level evidence. If a preferred course is not offered, another mapped P or M course may be used with documented justification. Introductory (I) evidence should be used only when suitable higher-level evidence is unavailable.

Table – 11 PLO Assessment Suggested Courses

PLO	Suggested Direct Assessment Tools	Preferred P/M-level Evidence Sources
K1	Advanced problems, design/research work, thesis evidence	7104 Applied Mathematics; 7204 Oil Refining; 7501 Selection Process and Equipment Design; 7601 Master Thesis
K2	Advanced/specialized problem solving, modelling and recent developments	7102 Thermodynamics; 7105 Process Modelling and Control; 7501 Selection Process and Equipment Design; 7207 Gas Processing
S1	Complex problem solving, design tasks, thesis analysis	7102 Thermodynamics; 7501 Selection Process and Equipment Design; 7601 Master Thesis
S2	Research/review tasks, complex issue analysis, creative solutions	7303 Corrosion Control; 7204 Oil Refining; 7601 Master Thesis
S3	Specialized processes/tools, practical or research procedures	7206 Petrochemical Processing; 7207 Gas Processing; 7304 Nanotechnology; 7601 Master Thesis
S4	Reports, presentations, project activities, thesis defense	7601 Master Thesis; 7306 Project Management; 7502 Technology Management
S5	Modelling, data analysis, digital/ICT applications	7104 Applied Mathematics; 7105 Process Modelling and Control; 7404 Energy Systems and Sustainability; 7501 Selection Process and Equipment Design
V1	Ethics/professionalism rubric, academic integrity and responsibility	7203 Biochemical Engineering; 7601 Master Thesis; 7306 Project Management
V2	Independent work, planning, self-learning and decision-making	7101/7106 Transport Phenomena; 7304 Nanotechnology; 7305 Mineral Processing; 7601 Master Thesis
V3	Teamwork/leadership rubric, project/thesis group responsibility and community contribution	7502 Technology Management; 7306 Project Management; 7402 Industrial Safety & Risk Assessment; 7404 Energy Systems and Sustainability; 7403 Wastewater Treatment Technologies; 7601 Master Thesis

Special attention should be given to the PLOs which are measured with lower sample sizes during the annual cycle. Thesis and project-based evidence should be incorporated when available, with explicit rubric criteria.

Data Quality, Documentation and Record Retention

For every reported PLO value, retain a traceable evidence package containing the source course or thesis, CLO-PLO mapping, assessment instrument or rubric, sample size, attainment calculation, and representative student work. The QAD validates the dataset before aggregation and archives the approved calculation workbook and annual report. Any post-validation change must be documented with its reason, date, and person responsible.

The coordinator
Quality and Development Committee

Approval

Prepared by	**Quality and Development Committee, Department of Chemical Engineering**	
Approved by	**Department Council**	
Approved by	**College Council**	