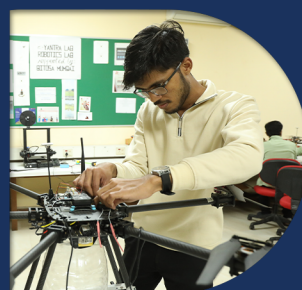
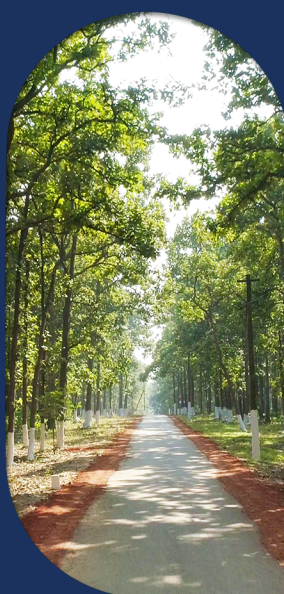




HANDBOOK ON OUTCOME BASED EDUCATION

INTERNAL QUALITY ASSURANCE CELL
BIRLA INSTITUTE OF TECHNOLOGY MESRA
RANCHI - 835215



A legacy of leadership

Established in 1955 by the visionary industrialist Mr. B.M. Birla, BIT Mesra was founded with a clear vision to offer its young minds a space, where their imagination could take wings and their ideas fruition. For over 6 decades now, the institute has nurtured minds with a rich heritage of academic excellence, developing learning frameworks that have been well ahead of times.





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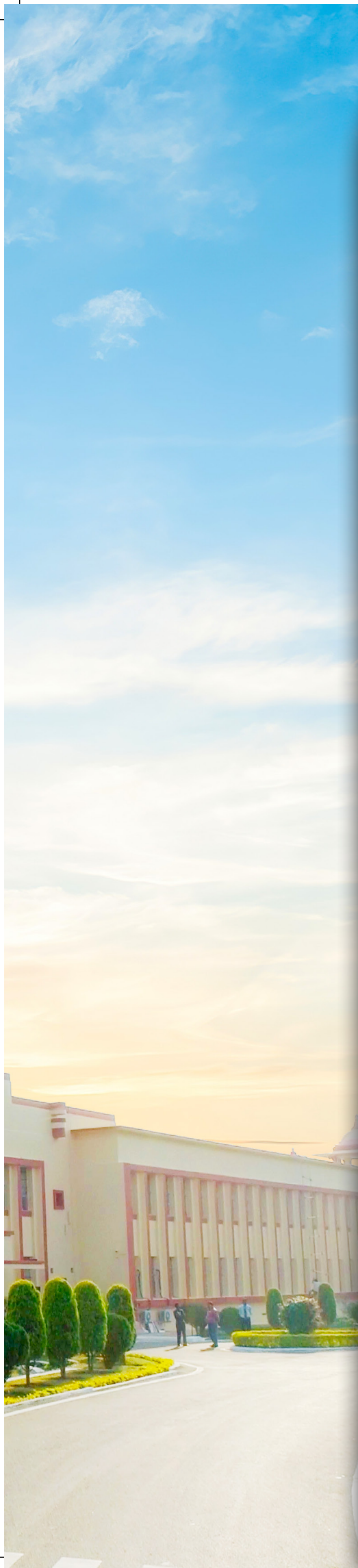
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1. Outcome Based Education

OBE is an educational framework that prioritizes the outcomes of the learning process, focusing on what students can actually do with the knowledge and skills they acquire. Unlike traditional education, which often emphasizes the transmission of content through direct instruction, OBE revolves around achieving specific, demonstrable results. OBE ensures structured program

accreditation, enables curriculum components to be clearly defined and measured, and produces industry-ready graduates equipped with relevant skills for the job market (Figure 1). From 13 June 2014, India has become a permanent signatory member of the Washington Accord.

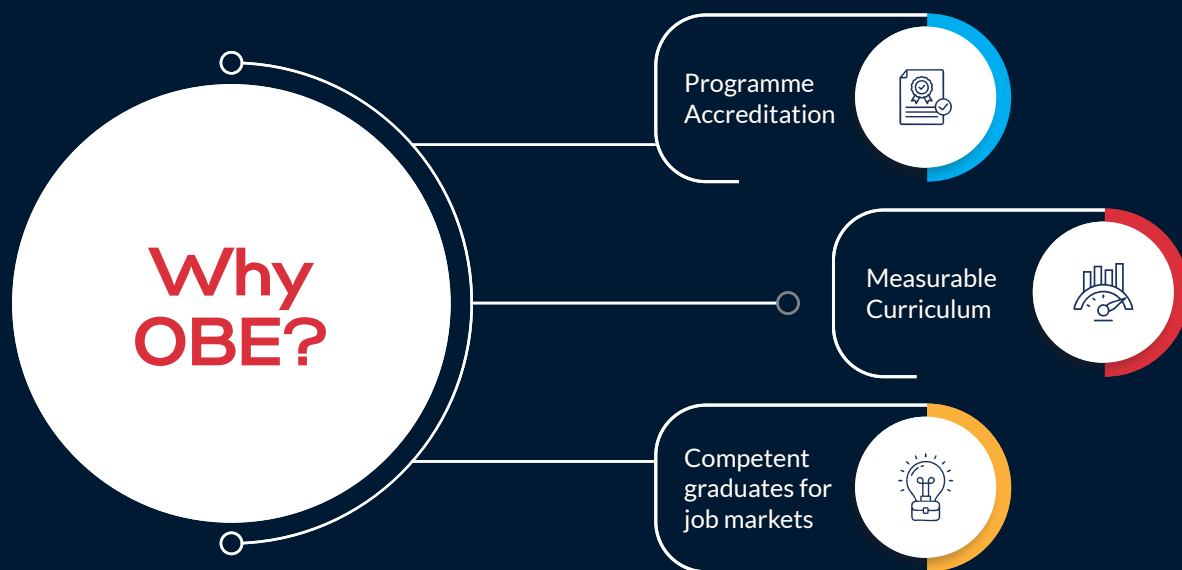


Figure 1: OBE framework



2. Detailed Discussion on How to Frame PEO, PO, PSO, and CO

As the OBE-based educational approach targets defining, achieving and assessing set learning objectives of the course, the OBE framework of any educational program is expected to contain clear and measurable objectives and outcomes at different levels. A diagram (Figure 2) has been presented to illustrate these relationships, showing the alignment of the institution's mission and vision

through PEOs, PSOs, POs and COs, demonstrating the hierarchical and interconnected structure of OBE. Also, it illustrates a cyclical process of planning, implementing, assessing, and improving educational practices through defined outcomes, teaching-learning support, and systematic evaluation to ensure continuous enhancement of academic quality and student performance.

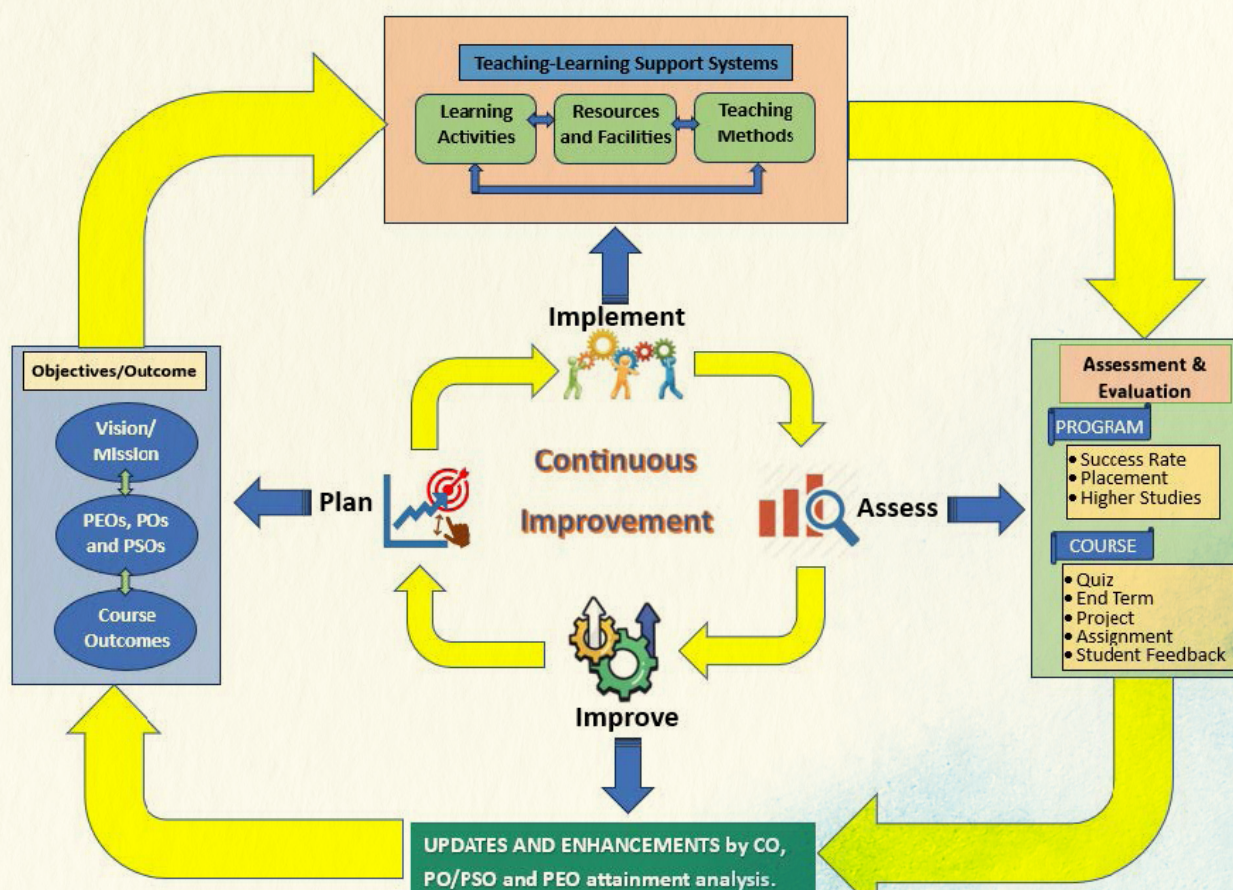


Figure 2: Continuous improvement model in the OBE framework

This structured approach ensures that educational programs are designed to meet specific and measurable outcomes that prepare students for professional success and lifelong learning. A detailed description,

including definitions and principles of the components of the framework, has been presented hereafter. A structured outlook of the activities and their respective responsibilities has been illustrated in detail in Table 1.

Table 1: Activities involved in designing and implementing the OBE framework

S. No.	ACTIVITIES	RESPONSIBILITIES
1.	Define the Vision and Mission of the Institute	Framing involves: Vice Chancellor, Deans, IQAC, external experts (industry and academia), distinguished alumni, and employers. To be approved by Academic Council, Board of Governors, and General Council. Revision: Likely in 10 years.
2.	Define the Vision and Mission of each Department aligning with the Vision and Mission of the Institute	Framing involves: departmental faculties, alumni, DAC, and BoS. To be approved by the Academic Council. Revision: Likely in 10 years.
3.	Define Program Educational Objectives (PEO), Program Outcomes (POs) and Program Specific Outcomes (PSOs) aligning with the Vision and Mission of the Department, for each Program	Framing involves: Departmental faculties, BoS, alumni for PEOs, PSOs and POs (for UG are the graduate attributes of the Washington accord) Revision: based on stakeholders' feedback Policy: No. of POs and PSOs
4.	Define Course Outcomes (COs) for each course in a Program (No. of COs preferably to be in the range 3-6)	Framing involves: Departmental faculties in consultation with domain experts, BoS within the department. Revision: Preferably every semester, based on previous CO, PO, and PSO attainment analysis
5.	Map Course Outcomes (COs) (through a typical rubric) to Program Outcomes (POs) and Program Specific Outcomes (PSOs)	High-3 Medium-2 Low-1 No-0
6.	Develop Course Assessment Rubrics	Course teacher
7.	Set Attainment Targets	Course introduced for the first time: Course teacher in consultation with domain experts and Head of the Department Regular course: based on previous attainment analysis The minimum attainment target should not be below the passing percentage.
8.	Carry out Assessments with COs mapped to each question	Course teacher
9.	Compute the Direct Assessment (DA) Data (Detailed description later in the manual)	UG
		Theory - 25% Internal 25% Mid Sem 50% End Sem
		Practical - 40% End Sem 60% Progressive Evaluation
		PG
		Theory - 30% Quiz 10% Seminar 10% Assignment 50% End Sem
		Practical - 40% End Sem 60% Progressive Evaluation

S. No.	ACTIVITIES	RESPONSIBILITIES
10.	Collect Indirect Assessment (IA) Data (Student Course exit feedback)	<ul style="list-style-type: none"> Associating each question in the feedback form to the respective COs. Evaluating the COs as a percentage based on the rating by each student for the respective course in the course feedback form. $CO_x = \frac{\sum_{i=1}^N CO_{x,i}}{N}$ <p>where N corresponds to the total number of students and x represents the No. of COs.</p>
11.	Compute CO Attainment for each Course in the Program	<p>Final $CO_x = (0.7 * DA) + (0.3 * IA)$ DA = direct assessment, IA = indirect assessment</p>
12.	Check if the CO attainment meets the predefined target or not.	<p>Course Coordinator Take corrective actions if the target is not met.</p>
13.	Compute PO/ PSO Attainment using the articulation matrix created in step 5 for Direct assessment and Stakeholder feedback for Indirect assessment for each Program in the Department.	<p>Program Coordinators and Head of Department. Final $PO/PSO_y = (0.8 * DA) + (0.2 * IA)$ Where y is the No. of POs/PSOs IA involves Program Exit Feedback from alumni and from other stakeholders like Employers and Parents.</p>
14.	If a target for PO/PSO attainment was set for the previous graduating batch, then check if the PO/PSO attainment obtained in Step 13, meets the set target or not.	<p>Program Coordinators and Head of Department. Perform a Gap Analysis and record its outcome.</p>
15.	Compute PEO Attainment by taking weighted summation of Alumni feedback (at least 3 years post-graduation), Employers and Parents.	<p>Institute level committee, Head of Department, Program Coordinators. $PEO_z = (0.5 * \text{Alumni Feedback}) + (0.5 * \text{Stakeholders})$ Stakeholders like Employers and Parents</p>
16.	Identify Strengths and Areas for Improvement, along with essential documentation	<p>SWOT analysis for each Program; All Attainment Analysis, Action Taken Report</p>



2.1 Program Educational Objectives

Program educational objectives (PEOs) are broad statements that outline the anticipated achievements of graduates within a few years after completing their program. These objectives focus on the knowledge, skills, and attitudes that graduates are expected to possess, which will enable them to succeed in their careers and contribute effectively to their profession and society.

2.1.1 Framework for PEOs:



Alignment with Mission and Vision:

- The PEOs should reflect and support the broader mission and vision of the institution. This alignment ensures that the program's goals contribute to the overall strategic direction and values of the institution.
- **Example:** If an institution's mission emphasizes innovation and leadership, the PEOs for a program might focus on preparing graduates to become innovative leaders in their respective fields of study.



Number of PEOs:

- Typically, a program should define 3 to 5 PEOs, which is considered optimal for providing clear and focused direction without being overly complex or difficult to assess.
- **Balanced Scope:** The objectives should cover a broad spectrum of career and professional accomplishments, ensuring that they address various aspects of a graduate's potential roles and contributions.



Descriptors of Career and Professional Accomplishments:

- **Time Frame:** PEOs describe what graduates are expected to achieve within approximately 3-5 years post-graduation. This time frame allows for meaningful career progression and professional development.
- **Specific Outcomes:** The objectives should detail specific achievements, such as acquiring advanced technical skills, attaining leadership positions, or making significant contributions to projects and organizations.



Mapping with Mission and Vision:

- **Coherence and Consistency:** Each PEO should be explicitly mapped to elements of the institution's mission and vision to ensure coherence and consistency across the educational offerings.
- **Purposeful Design:** This mapping process involves identifying how each PEO supports the institution's strategic goals and values, thereby ensuring that the program's objectives are purposefully designed to fulfil the institution's commitments to its stakeholders.



By clearly defining and aligning PEOs with the institution's mission and vision, educational programs can ensure that they are preparing graduates who are not only skilled and knowledgeable but also aligned with the broader goals and values of their alma mater. This alignment fosters a sense of purpose and direction, guiding graduates towards meaningful and impactful careers.

For example, the Department of Electrical and Electronics Engineering designed 4 PEOs for the BE program. PEOs of B.Tech. (EEE) are as follows:

1. To develop the capability to understand the fundamentals of Science and Electrical & Electronics Engineering for analyzing engineering problems with futuristic approach.
2. To foster a confident and competent graduate capable of solving real life practical engineering problems, fulfilling the obligation towards society.
3. To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning, enabling to excel in competitive participations at global level.
4. To nurture and nourish effective communication and interpersonal skills to work in a team with a sense of ethics and moral responsibility for achieving goals.





2.2 Program Outcomes

Program Outcomes (POs) are overarching statements that describe the knowledge, skills, and attributes that students are expected to acquire upon completion of an academic program. These outcomes encapsulate the core competencies that graduates should possess to excel in their chosen field and contribute meaningfully to society. POs serve as benchmarks for program effectiveness and guide curriculum development, teaching strategies, and assessment practices.

2.1.1 Framework for PEOs:

1. Broad and Comprehensive:

POs encompass a wide range of competencies relevant to the program's discipline or field of study. These may include subject-specific knowledge, technical skills, critical thinking abilities, communication skills, ethical values, etc.

Alignment with Stakeholder Needs: POs should be aligned with the expectations and needs of various stakeholders, including students, employers, industry professionals, accrediting bodies, and society at large.

2. Program-Specific and Contextual:

Tailored to Program Objectives: POs are tailored to the specific objectives and goals of the academic program. They reflect the unique mission, vision, and values of the institution and the program's academic department.

Informed by Industry Trends: POs should be informed by current and emerging trends in the relevant industry or profession. They should anticipate future challenges and prepare graduates to adapt to changing workplace environments.

3. Measurable and Assessable:

Measurable Outcomes: POs should be formulated in a way that allows for clear measurement and assessment of student attainment. This involves using precise language and identifying observable behaviours or outputs associated with each outcome.

Assessment Criteria: Criteria and indicators should be established to assess the extent to which students have achieved each PO. Assessment methods may include exams, projects, portfolios, presentations, internships, and capstone experiences.

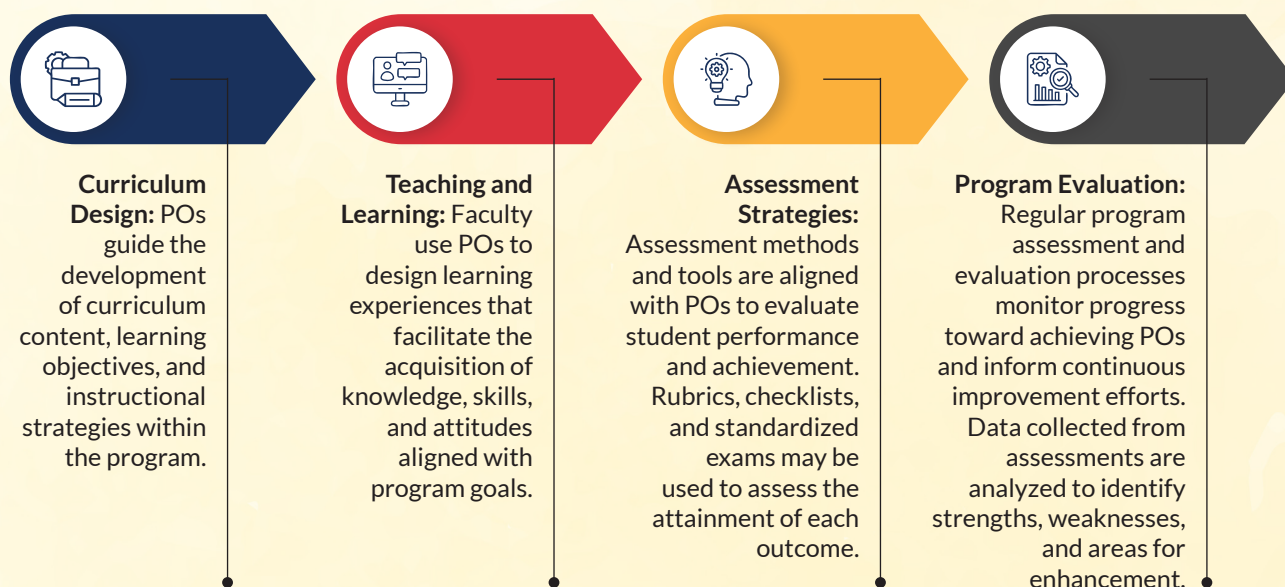
4. Continuous Improvement and Feedback Loop:

Feedback Mechanisms: Regular feedback from stakeholders, including students, alumni, employers, and faculty, should inform the review and refinement of POs. This ensures that POs remain relevant, responsive, and aligned with evolving needs and expectations.

Continuous Evaluation: POs should undergo periodic evaluation and review to ensure their effectiveness in preparing graduates for successful careers and lifelong learning. Adjustments may be made based on assessment data, industry feedback, accreditation requirements, and advances in scholarship.



5. Assessment and Implementation:



By defining clear and measurable POs, academic programs can ensure that their graduates are well-prepared to meet the demands of their profession, contribute to societal needs, and pursue lifelong learning and professional development.

For example, the POs of Birla Institute of Technology Mesra define the expectations from the students to achieve/accomplish while graduating where these POs are aligned with the graduate attributes that describe qualities, attitudes, behaviours, values, and ethics which will be developed by the learning process. These POs are forming a framework to prescribe the expectations of learning experiences in the graduating programme. It is expected that the students will be delivering similar qualities at their workplace after their graduation. The undergraduate B.Tech. programmes of Birla Institute of Technology Mesra are designed to achieve the following outcomes:

A graduate shall

1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet

specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

4. **Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **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.
7. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

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.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and

management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.



2.3 Program Specific Outcomes

Program specific outcomes (PSOs) are precise statements describing what graduates of a particular academic program should be able to do at the time of graduation. These outcomes are tailored to the specific skills, knowledge, and competencies that students are

expected to acquire through their specialized program of study. PSOs reflect the unique aspects and core strengths of the program and are designed to ensure that graduates are prepared to meet the demands of their specific field.

2.3.1 Framework for PSOs:

- **Tailored to the Program:**
 - » Program-Specific: PSOs are distinct to each academic program and focus on the specialized skills and knowledge that are critical for success in that field. For example, a Computer Science program will have different PSOs compared to a Mechanical Engineering program.
 - » Departmental Input: The faculty and the department offering the program are responsible for developing PSOs. This ensures that the outcomes are relevant and aligned with industry standards and advancements.
 - **Number of PSOs:**
 - » Typically, a program defines between 2 to 4 PSOs. This number is considered optimal to cover the essential aspects of the program without overwhelming the assessment process.
 - » Focused and Specific: Each PSO should be focused and specific, providing clear guidance on what students are expected to achieve by the end of the program.
 - **Detailed Description of Competencies:**
 - » Technical Skills: PSOs often emphasize the technical skills that students need to master. This includes the ability to use specific tools, techniques, and technologies relevant to their field.
 - » Problem-Solving Abilities: Graduates should be able to identify, analyze, and solve problems using the knowledge and skills gained in their program.
 - » Design and Development: PSOs may include the ability to design, develop, test, and implement solutions or systems that meet specified requirements.
 - » Practical Application: Emphasis is placed on the practical application of theoretical knowledge to real-world scenarios, ensuring that graduates can effectively transition from academic settings to professional environments.
- **Alignment with Program Outcomes:**
 - » Consistency and Coherence: PSOs should be consistent with the broader POs. They should contribute to achieving the overall educational goals of the program.
 - » Mapping to POs: Each PSO should be mapped to relevant POs to ensure that the program's specific objectives are integrated into the general educational framework.



2.3.2 Assessment and Improvement:

Regular Evaluation: The attainment of PSOs should be regularly evaluated through various assessment methods, including exams, projects, practical assignments, and industry feedback.

Continuous Improvement: Based on the assessment results, the program should continuously improve its curriculum, teaching methods, and resources to better achieve the PSOs.

By clearly defining and effectively implementing PSOs, educational programs can ensure that their graduates possess the specific competencies needed to succeed in their professional fields, thus enhancing their employability and readiness to contribute to society.

2.4 Course Outcomes

Course outcomes (COs) are specific, measurable statements describing what students are expected to learn and be able to do by the end of a particular course. COs are derived from the broader POs and PSOs and are

aligned with the cognitive, psychomotor, and affective domains of learning as defined by Bloom's Taxonomy. These outcomes guide both instruction and assessment within the course.

2.4.1 Framework for COs:

- Alignment with Program Objectives:

» Mapping to POs and PSOs: COs should be directly mapped to relevant POs and PSOs to ensure that the course contributes effectively to the overall program goals. This alignment ensures coherence in the educational process.

A CO can be mapped with PO/PSO by assigning score of High-3, Medium-2, Low-1, No-0. This

will be based on the relevance of COs with the POs, or PSOs.

» Supportive Role: Each CO supports the attainment of one or more POs or PSOs, forming a cohesive link between course-level learning and program-level expectations.

2.4.2 Rubrics for CO-PO mapping:

Questions should be framed relating COs and POs, with answer options as yes or no. Then based on the number/percentage of yes questions the level of COs should be assigned.

Example Framework:

For instance, if you are mapping a CO to PO1 (Engineering Knowledge), you might ask:

Does this CO involve applying knowledge of mathematics or natural sciences? (yes/no)

Does this CO require understanding of engineering fundamentals? (yes/no)

Does this CO relate to solving complex engineering problems? (yes/no)

Does this CO relate to specialized engineering knowledge? (yes/no)

By answering these questions, you can determine the level of correlation between the CO and PO1 according to the following Table 2.

Table 2. Example of rubrics for CO-PO attainment:

Table for Sample Rubrics	Strength of mapping
If more than 70% of the CO address a particular PO (or yes in three questions)	3
If more than 40% but less than 70% of the CO address the PO (or yes in two questions)	2
If less than 40% of the CO address the PO (or yes in one question)	1
If the CO does not address the PO	0

2.4.3 Characteristics of Effective COs:

Specificity:

COs should be specific and clearly state what students are expected to achieve. Vague or broad outcomes can be difficult to assess and may not provide clear guidance for students or instructors.

Measurable:

Outcomes should be phrased in a way that makes them measurable. This typically involves using action verbs from Bloom's Taxonomy that specify observable student behaviours or outputs.

Achievable:

COs should be realistic and attainable within the scope of the course. They should consider the level of the course, the duration, and the resources available.

Relevant:

The outcomes should be relevant to the course content and reflect the essential knowledge and skills that students need to acquire.

2.4.4 Structure of COs:

Action Verb:

Each CO begins with an action verb that indicates the level of cognitive, psychomotor, or affective engagement expected (e.g., analyze, design, implement, evaluate).

Content:

The content area or subject matter to which the action verb applies.

Context:

The context or conditions under which the performance is to be demonstrated.

Criterion:

The criteria or standards for acceptable performance (if applicable).



2.4.5 Designing of Effective COs

Designing effective COs is crucial for creating a structured and outcome-oriented curriculum. The COs should not be designed as per the modules/units of the program, rather the following detailed guidelines could help constructing COs that are specific, measurable, achievable, realistic, and time-bound (SMART):

i. Identify Essential Learning Areas:

- **Description:** The first step in designing COs is to pinpoint the critical knowledge, skills, and attitudes that students must acquire by the end of the course. This ensures that the outcomes are directly aligned with the core objectives of the course.
- **Application:** Review the course syllabus and outline the fundamental topics and skills. These should reflect what is essential for students to master in order to progress in their academic and professional careers.
- **Alignment:** Ensure that these learning areas are in harmony with the POs and PSOs. This alignment helps maintain consistency and relevance throughout the educational program.

ii. Use Action Verbs from Bloom's Taxonomy:

- **Description:** Bloom's Taxonomy provides a hierarchical classification of cognitive skills that can be used to formulate COs. Selecting precise action verbs helps in defining clear, observable, and measurable outcomes.
- **Application:** Utilize verbs such as "list", "describe", "apply", "analyze", "evaluate" and "create" to articulate the expected student performance. Advisable to avoid vague verbs like "understand" or "learn" which are difficult to measure.
- **Benefits:** This approach ensures that the COs are specific and measurable, facilitating accurate assessment of student learning.

iii. Define the Subject Content:

- **Description:** Each CO should explicitly state the specific content or skill area related to the chosen action verb. This provides clarity on what exactly students need to learn or accomplish.
- **Application:** Detail the content areas or skills that are crucial for students to master. For instance, a CO might involve "analyzing major and minor losses in fluid flow," where the specific content is clearly identified.
- **Clarity:** Specifying the subject content eliminates ambiguity and ensures that both instructors and students have a clear understanding of the learning expectations.

iv. Align COs with Learning Activities and Assessments:

- **Description:** COs must be supported by appropriate learning activities and assessment methods to ensure students can achieve the desired outcomes.
- **Application:** Design learning activities that provide opportunities for students to practice and master the skills or knowledge specified in the COs. Pair these activities with assessments that accurately measure their achievement.
- **Integration:** For example, a CO requiring students to "design a wastewater treatment plant" might be paired with a project-based assignment and evaluated through a detailed rubric assessing design quality and feasibility.

v. Ensure Measurability and Observability:

- **Description:** Effective COs must be measurable and observable, allowing instructors to assess whether students have achieved the desired outcomes.
- **Application:** Formulate COs in a way that student performance can be directly observed and measured through tests, projects, presentations, or other assessment methods.
- **Examples:** Instead of saying "students will understand fluid dynamics," a measurable CO would be "students will calculate flow rates and pressure drops in complex piping systems".

vi. Check for Specificity and Clarity:

- **Description:** COs should be precise, clear, and free from ambiguity to ensure they are easily understandable and actionable.
- **Application:** Each CO should focus on a single, specific learning outcome. Avoid combining multiple outcomes into one statement unless they are inherently linked.
- **Review:** Regularly review and refine COs for clarity. For instance, "students will explain the principles of thermodynamics" is clearer than "students will understand thermodynamics."

vii. Iterative Improvement:

- **Description:** The development of COs is an ongoing process that involves regular review and refinement to ensure they remain relevant and effective.
- **Application:** After the initial COs are drafted, gather feedback from colleagues, students, and other stakeholders. Use this feedback to improve and adjust the COs as necessary.

- **Continuous Enhancement:** Stay updated with advancements in the field and pedagogical practices to ensure the COs reflect current standards and best practices.
- **Example:** Regularly update COs to incorporate new industry standards or technological advancements, ensuring that they remain aligned with current professional expectations.

Developing well-defined Course Outcomes is a foundational step in creating a structured and effective educational experience. By following these detailed guidelines, educators can ensure that their COs are clear, specific, measurable, and aligned with broader program goals, ultimately facilitating a comprehensive and outcome-oriented learning environment.

2.4.6 Example Framework:

- **Each Course Addresses Multiple COs:**
 - » **3-5 COs per Course:** Typically, each course will have three (for sessional courses) to five (for theoretical courses) COs. This number is manageable for both teaching and assessment purposes and ensures that critical areas of learning are adequately covered.
- **Example COs for the course Building Materials and Construction:**
 - o After the completion of this course, students will be:
 - » **CO1:** Able to explain the manufacturing process, physical and chemical properties and uses of various building materials (K1).
 - » **CO2:** Able to analyze the suitability of different building materials and the significance of using those materials in relation to the building's function.
 - » **CO3:** Able to perform quality control tests on different construction materials.
 - » **CO4:** Able to plan and execute the construction of various components of substructure and superstructure



3. Steps For Calculating CO, PO/PSO And PEO Attainment

- Map the Questions to respective COs. Note that one question can map to multiple COs with different weights.

For eg. Q1 (a) → CO1 (60%), CO2 (40%) → Different weightage

Q1 (b) → CO1 (50%), CO2 (50%) → Equal weightage

Map for all forms of assessments.

- For each student, calculate the following:
 - For each assessment type, compute the weighted sum of marks obtained in questions mapped to the respective COs and the Total marks those questions carry.

For e.g., For Mid Semester Exam

$$Marks_{CO_x} = \sum_{i=1}^n M_i * W_i$$

$$Total_{CO_x} = \sum_{i=1}^n FM_i * W_i$$

x is the number of COs. x=1,2,3,4,5,...

M_i is the marks obtained and FM_i is the full mark for the i^{th} question mapped to CO_x and n is the total number of questions/assessments.

W_i is the weightage of the question i for CO_x . It can be any % value in the range [0, 100]

Assessments (FM)			Questions mapping to CO's												Mapped CO's				
Quiz 1 (10)		Q1, Q2														CO1, CO2			
Quiz 2 (10)		Q1, Q2														CO3, CO4			
Assignment (5)		Q1														CO4, CO5			
Mid Sem (25)	Q1,Q2,Q3,Q4,Q5	1(a)	1(b)	2(a)	2(b)	3(a)	3(b)	4(a)	4(b)	5(a)	5(b)								
		CO1	CO1	CO1	CO1	CO2	CO2	CO2	CO2	CO2	CO3	CO3							
End Sem (50)	Q1,Q2,Q3,Q4,Q5	1(a)	1(b)	2(a)	2(b)	3(a)	3(b)	4(a)	4(b)	5(a)	5(b)								
		CO1	CO1	CO2	CO2	CO3	CO3	CO4	CO4	CO4	CO5	CO5							

Quiz 1 mapped to CO1 (50%) & CO2 (50%)

	Internal (25%)			
	Quiz1(10)	Quiz2(10)	Assignment (5)	
Full Marks	5	5	5	5
Student 1	3	2	4	4
Student 2	2	5	3	5
Student 3	1	4	2	4
Student 4	4	4	4	5
Student 5	3	5	4	5
Student 6	2	2	3	5
Student 7	5	4	3	5
Student 8	3	5	4	5
Student 9	3	0	1	3
Student 10	1	4	4	3

	Mid Sem (25%)									
	Q1(a)	Q1(b)	Q2(a)	Q2(b)	Q3(a)	Q3(b)	Q4(a)	Q4(b)	Q5(a)	Q5(b)
Full Marks	2	3	2	3	2	3	2	3	2	3
Student 1	2	2	1	0	2	3	2	2	1	0
Student 2	1	0	2	3	2	3	1	1	1	0
Student 3	2	3	2	3	2	1	0	0	1	0
Student 4	2	3	2	3	2	3	2	3	2	1
Student 5	2	1	2	3	2	1	2	3	1	1
Student 6	2	1	2	3	2	1	2	2	1	2
Student 7	1	2	2	2	1	2	2	3	2	2
Student 8	1	2	1	2	1	2	2	2	2	1
Student 9	2	3	1	2	2	3	1	2	2	3
Student 10	1	2	1	1	1	3	1	1	2	3

	End Sem (50%)									
	Q1(a)	Q1(b)	Q2(a)	Q2(b)	Q3(a)	Q3(b)	Q4(a)	Q4(b)	Q5(a)	Q5(b)
Full Marks	5	5	5	5	5	5	5	5	5	5
Student 1	2	4	3	4	1	5	5	4	5	4
Student 2	3	4	4	5	4	5	4	4	4	4
Student 3	2	3	4	5	3	4	3	3	4	5
Student 4	3	5	3	3	4	5	4	3	4	3
Student 5	2	3	4	5	4	3	5	5	4	5
Student 6	4	5	4	5	4	4	5	4	4	2
Student 7	3	4	2	3	2	4	4	5	4	5
Student 8	2	3	4	2	4	5	4	4	3	4
Student 9	2	4	3	4	3	5	5	5	5	5
Student 10	4	5	4	5	2	5	5	4	5	4

$$\begin{aligned} \text{Marks}_{CO_1} &= \sum_{i=1}^3 M_i * W_i \\ &= 5 * \frac{50}{100} \\ &= 2.5 \end{aligned}$$

$$\begin{aligned} \text{Total}_{CO_1} &= \sum_{i=1}^3 FM_i * W_i \\ &= 10 * \frac{50}{100} \\ &= 5 \end{aligned}$$

CO1					CO2					CO3					CO4					CO5							
Internal	Mid Sem	End Sem	Out of Marks	Out of Marks	Internal	Mid Sem	End Sem	Out of Marks	Out of Marks	Internal	Mid Sem	End Sem	Out of Marks	Out of Marks	Internal	Mid Sem	End Sem	Out of Marks	Out of Marks	Internal	Mid Sem	End Sem	Out of Marks	Out of Marks			
2.5	5	5	10	6	10	2.5	5	9	10	7	10	3	5	1	5	6	10	5	7.5	0	9	10	2	2.5	0	9	10
3.5	5	6	10	7	10	3.5	5	7	10	9	10	4	5	1	5	9	10	6.5	7.5	0	8	10	2.5	2.5	0	8	10
2.5	5	10	10	5	10	2.5	5	3	10	9	10	3	5	1	5	7	10	5	7.5	0	6	10	2	2.5	0	9	10
4	5	10	10	8	10	4	5	10	10	6	10	4	5	3	5	9	10	6.5	7.5	0	7	10	2.5	2.5	0	7	10
4	5	8	10	5	10	4	5	8	10	9	10	4.5	5	2	5	7	10	7	7.5	0	10	10	2.5	2.5	0	9	10
2	5	8	10	9	10	2	5	7	10	9	10	2.5	5	3	5	8	10	5	7.5	0	9	10	2.5	2.5	0	6	10
4.5	5	7	10	7	10	4.5	5	8	10	5	10	4	5	4	5	6	10	6.5	7.5	0	9	10	2.5	2.5	0	9	10
4	5	6	10	5	10	4	5	7	10	6	10	3	5	3	5	9	10	5.5	7.5	0	8	10	2.5	2.5	0	7	10
1.5	5	8	10	6	10	1.5	5	8	10	7	10	2	5	5	5	8	10	4	7.5	0	10	10	2	2.5	0	10	10
2.5	5	5	10	9	10	2.5	5	6	10	9	10	3.5	5	5	5	7	10	6	7.5	0	9	10	2.5	2.5	0	9	10

b. For each assessment type, calculate Assessment_Percentage, Assessment_Score and Assessment_Level based on the predefined rubrics, for each CO.

Target- 60% of students achieve more than 60% score on the Direct Assessment

Sr No.	Level	Priority	Grading Scale Min Range	Grading Scale Max Range
1	High	3	65	100
2	Medium	2	45	64.99
3	Low	1	0	44.99

$$\text{Assessment_Percentage}_{CO_x} = \frac{\text{Marks}_{CO_x}}{\text{Total}_{CO_x}} * 100$$

$$\text{Assessment_Score}_{CO_x} = \begin{cases} 1, & \text{if } 44.9 > \text{Assessment_Percentage} > 0 \\ 2, & \text{if } 45 > \text{Assessment_Percentage} > 64.99 \\ 3, & \text{if } 65 > \text{Assessment_Percentage} > 100 \end{cases}$$

$$\text{Assessment_Level}_{CO_x} = \begin{cases} \text{LOW, if Assessment_Score} = 1 \\ \text{MEDIUM, if Assessment_Score} = 2 \\ \text{HIGH, if Assessment_Score} = 3 \end{cases}$$

$$\begin{aligned} \text{Assessment_Percentage}_{CO_1} &= \frac{\text{Marks}_{CO_1} * 100}{\text{Total}_{CO_1}} \\ &= \frac{0.63 * 100}{1.25} \\ &= 50\% \end{aligned}$$

Direct CO Assessment	CO1									
	Internal			Mid Sem			End Sem			AVERAGE SCORE
Direct Assessment	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	
Student 1	50	2	MEDIUM	50	2	MEDIUM	60	2	MEDIUM	53.33
Student 2	70	3	HIGH	60	2	MEDIUM	70	3	HIGH	66.67
Student 3	50	2	MEDIUM	100	3	HIGH	50	2	MEDIUM	66.67
Student 4	80	3	HIGH	100	3	HIGH	80	3	HIGH	86.67
Student 5	80	3	HIGH	80	3	HIGH	50	2	MEDIUM	70.00
Student 6	40	1	LOW	80	3	HIGH	90	3	HIGH	70.00
Student 7	90	3	HIGH	70	3	HIGH	70	3	HIGH	76.67
Student 8	80	3	HIGH	60	2	MEDIUM	50	2	MEDIUM	63.33
Student 9	30	1	LOW	80	3	HIGH	60	2	MEDIUM	56.67
Student 10	50	2	MEDIUM	50	2	MEDIUM	90	3	HIGH	63.33

Direct CO Assessment	CO2									
	Internal			Mid Sem			End Sem			AVERAGE SCORE
Direct Assessment	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	
Student 1	50	2	MEDIUM	90	3	HIGH	70.00	3	HIGH	70.00
Student 2	70	3	HIGH	70	3	HIGH	90.00	3	HIGH	76.67
Student 3	50	2	MEDIUM	30	1	LOW	90.00	3	HIGH	56.67
Student 4	80	3	HIGH	100	3	HIGH	60.00	2	MEDIUM	80.00
Student 5	80	3	HIGH	80	3	HIGH	90.00	3	HIGH	83.33
Student 6	40	1	LOW	70	3	HIGH	90.00	3	HIGH	66.67
Student 7	90	3	HIGH	80	3	HIGH	50.00	2	MEDIUM	73.33
Student 8	80	3	HIGH	70	3	HIGH	60.00	2	MEDIUM	70.00
Student 9	30	1	LOW	80	3	HIGH	70.00	3	HIGH	60.00
Student 10	50	2	MEDIUM	60	2	MEDIUM	90.00	3	HIGH	66.67

Direct CO Assessment	CO3									
	Internal			Mid Sem			End Sem			AVERAGE SCORE
	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	
Student 1	60	2	MEDIUM	20	1	LOW	60	2	MEDIUM	1.67
Student 2	80	3	HIGH	20	1	LOW	90	3	HIGH	2.33
Student 3	60	2	MEDIUM	20	1	LOW	70	3	HIGH	2.00
Student 4	80	3	HIGH	60	2	MEDIUM	90	3	HIGH	2.67
Student 5	90	3	HIGH	40	1	LOW	70	3	HIGH	2.33
Student 6	50	2	MEDIUM	60	2	MEDIUM	80	3	HIGH	2.33
Student 7	80	3	HIGH	80	3	HIGH	60	2	MEDIUM	2.67
Student 8	60	2	MEDIUM	60	2	MEDIUM	90	3	HIGH	2.33
Student 9	40	1	LOW	100	3	HIGH	80	3	HIGH	2.33
Student 10	70	3	HIGH	100	3	HIGH	70	3	HIGH	3.00

Direct CO Assessment	CO4									
	Internal			Mid Sem			End Sem			AVERAGE SCORE
	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	
Student 1	66.67	3	HIGH	0	0	LOW	90	3	HIGH	2.00
Student 2	86.67	3	HIGH	0	0	LOW	80	3	HIGH	2.00
Student 3	66.67	3	HIGH	0	0	LOW	60	2	MEDIUM	1.67
Student 4	86.67	3	HIGH	0	0	LOW	70	3	HIGH	2.00
Student 5	93.33	3	HIGH	0	0	LOW	100	3	HIGH	2.00
Student 6	66.67	3	HIGH	0	0	LOW	90	3	HIGH	2.00
Student 7	86.67	3	HIGH	0	0	LOW	90	3	HIGH	2.00
Student 8	73.33	3	HIGH	0	0	LOW	80	3	HIGH	2.00
Student 9	53.33	2	MEDIUM	0	0	LOW	100	3	HIGH	1.67
Student 10	80.00	3	HIGH	0	0	LOW	90	3	HIGH	2.00

Direct CO Assessment	CO5									
	Internal			Mid Sem			End Sem			AVERAGE SCORE
Direct Assessment	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	Assessment Percentage	Assessment Score	Assessment Level	
Student 1	80	3	HIGH	0	0	LOW	90	3	HIGH	56.67
Student 2	100	3	HIGH	0	0	LOW	80	3	HIGH	60.00
Student 3	80	3	HIGH	0	0	LOW	90	3	HIGH	56.67
Student 4	100	3	HIGH	0	0	LOW	70	3	HIGH	56.67
Student 5	100	3	HIGH	0	0	LOW	90	3	HIGH	63.33
Student 6	100	3	HIGH	0	0	LOW	60	2	MEDIUM	53.33
Student 7	100	3	HIGH	0	0	LOW	90	3	HIGH	63.33
Student 8	100	3	HIGH	0	0	LOW	70	3	HIGH	56.67
Student 9	80	3	HIGH	0	0	LOW	100	3	HIGH	60.00
Student 10	100	3	HIGH	0	0	LOW	90	3	HIGH	63.33

3. Calculate the Direct_Assessment_Percentage and Direct_Assessment_Score over the total number of students in the course, over all the assessment types. Check if the target is achieved or not.

$$\text{Direct_Assessment_Percentage}_{CO_x} = \frac{\sum_{j=1}^N \frac{\sum_{i=1}^M \text{Assessment_Percentage}_{CO_x}}{M}}{N}$$

$$\text{Direct_Assessment_Score}_{CO_x} = \frac{\sum_{j=1}^N \frac{\sum_{i=1}^M \text{Assessment_Score}_{CO_x}}{M}}{N}$$

Where N is the total number of students enrolled in the course, and M is the total types of assessments.

	CO1	CO2	CO3	CO4	CO5
Average Attainment % over all students Direct_Assessment_Percentage CO _x	67.33	70.33	66.33	53.67	59.00
Average Attainment level over all students Direct_Assessment_Score CO _x	2.47	2.57	2.37	1.93	1.97

4. The Direct Attainment of CO's is matched with the pre-defined Targets, to check if the CO's have been attained or not.

TARGET: The same target value is set for all the COs of a course.

TARGET SET: 60% STUDENTS MUST ACHIEVE 60% AND ABOVE

- If targets are achieved, we may set higher targets subsequently as part of continuous improvement.
 - If targets are not achieved then instead of lowering the target, an action plan should be put into place to attain the target in subsequent years.
5. Calculate the indirect assessment score. For this, take the Course Exit feedback from students on all the CO's and compute the average feedback score. The score for each question will be in 0,1,2 or 3 grade.

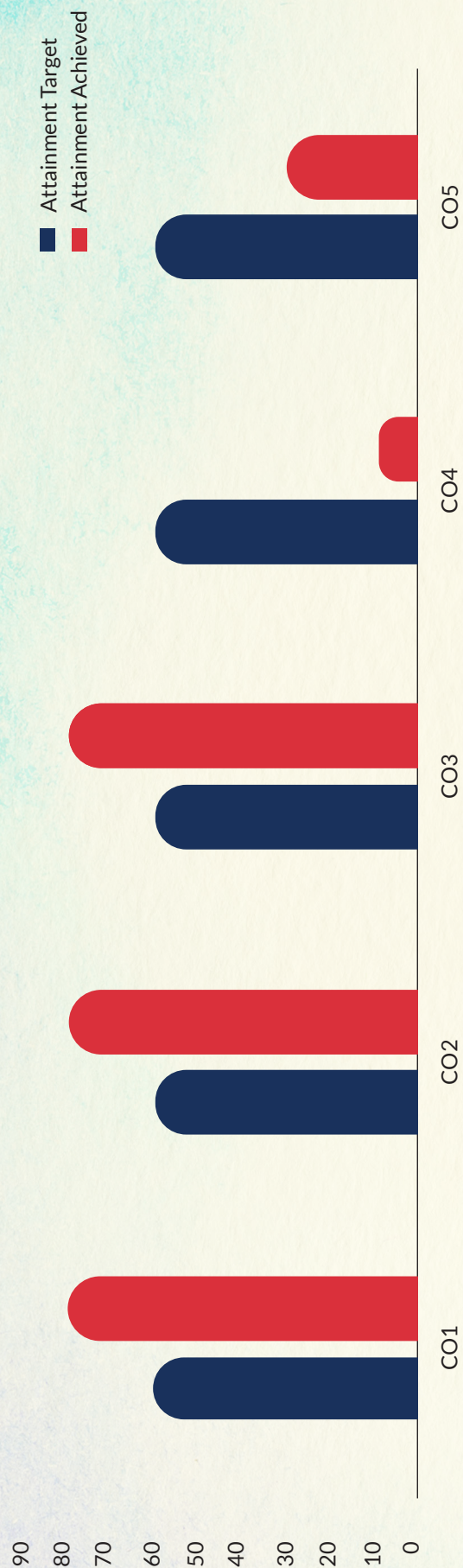
6. Calculate the final CO attainment for the course by taking 70% of Direct Assessment and 30% of the Indirect Assessment
 $\text{Attainment_Score}_{\text{COx}} = 70\% \text{ Direct_Assessment_Score}_{\text{COx}} + 0\% \text{ Indirect_Assessment_Score}_{\text{COx}}$

Indirect CO Assessment	Student Feedback on CO's				
	CO1	CO2	CO3	CO4	CO5
Student 1	3	3	3	2	1
Student 2	2	3	2	3	3
Student 3	3	2	3	3	2
Student 4	2	3	2	3	2
Student 5	3	3	3	1	2
Student 6	3	3	2	3	3
Student 7	3	3	3	3	3
Student 8	2	2	2	2	2
Student 9	3	3	3	2	1
Student 10	3	3	2	3	1
Indirect CO Attainment	2.7	2.8	2.5	2.5	2

AVERAGE
Over, all students

	CO1	CO2	CO3	CO4	CO5
Direct CO Attainment Level- A	2.47	2.57	2.37	1.93	1.97
Indirect CO Attainment Level- B	2.70	2.80	2.50	2.50	2.00
Attainment_Score _{COx} = 70%*A+ 30%*B	2.54	2.64	2.41	2.10	1.98
Final Attainment for each Course					

CO Attainment Calculations- using predefined Target					
	CO1	CO2	CO3	CO4	CO5
Number of students who have scored more than the target (60%)	8	8	8	1	3
Percentage of students who have achieved the target $T_x = (P/N)*100$	80	80	80	10	30
Attainment Level (3 if $T_x \geq 80\%$, 2 if $80 > T_x \geq 70\%$, 1 if $70 > T_x \geq 60\%$ and 0 if $T_x < 60\%$)	3	3	3	0	0
Only for checking if CO has been attained or not, and for modifying the Target of each CO for future [This calculation is purely based on Direct Assessment]					
	CO1	CO2	CO3	CO4	CO5
Attainment Target	60	60	60	60	60
Attainment Achieved	80	80	80	10	30



7. Calculate the Direct PO/PSO assessment for all courses in a program, by using the CO-PO/PSO articulation matrix, comprising the level of mapping of a certain CO to a particular PO/PSO. Note, the level of mapping, represented as $Level_{CO-PO_{x,y}}/Level_{CO-PSO_{x,y}}$ in the equation below can be 0, 1, 2 or 3, representing No, Low, Medium and High respectively.

Populate a table, comprising of $Direct_Assessment_Score_{CO_x}$ for each course in the program and their corresponding average $Level_{CO-PO}/Level_{CO-PSO}$

$$Direct_Assessment_Score_{PO_y} = \frac{\sum_{x=1}^5 Attainment_Score_{CO_x} * \sum_{x=1}^5 Level_{CO-PO_{x,y}}}{\sum_{x=1}^5 Level_{CO-PO_{x,y}}}$$

$$Direct_Assessment_Score_{PSO_y} = \frac{\sum_{x=1}^5 Attainment_Score_{CO_x} * \sum_{x=1}^5 Level_{CO-PSO_{x,y}}}{\sum_{x=1}^5 Level_{CO-PSO_{x,y}}}$$

where y is the number of POs and PSOs.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	
CO1	3	3	2	1	3	2	2	2	Calculations till this point are to be done by the individual course faculty
CO2	3	2		2	3	1			
CO3	2	2	2	2	1	3	2	3	
CO4	1	3	3	3	2	3	3	2	
CO5	3	3	2	2	2	2		3	
	2.54								
	2.64								
	2.41								
	2.10								
	1.98								

$Level_{CO-PO} / Level_{CO-PSO}$

Attainment_Score_{COx} of each CO, computed in step 6

Sample, random values, set for other courses in the program

$$(2.54 * 3 + 2.64 * 3 + 2.41 * 2 + 2.10 * 1 + 1.98 * 3) / (3 + 3 + 2 + 1 + 3) = 2.36$$

Assuming 5 courses in the program

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	
For all the Courses in the Program	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	
Course 1	2.36	1.72	1.68	2.04	1.68	1.83	1.59	1.89	To be calculated by the Program Coordinator by taking CO Attainments of all courses running in the program
Course 2	2.3	1.9	2.5	2.3	2.6	2.4	2.1	2.1	
Course 3	1.8	2.6	2.9	2.3	2.6	2	2.4	1.9	
Course 4	2.7	2.5	3	2.7	2.8	2.1	1.8	2.2	
Course 5	2.8	2.3	1.9	2.4	2.9	2.2	1.8	1.8	
Direct PO/PSO Assessment	2.39	2.20	2.40	2.35	2.52	2.11	1.94	1.98	

8. Calculate the Overall PO/PSO attainment for each program in the department using the following combination of Indirect (20%) PO/PSO Assessments:

$$Attachment_Score_{PO/PSOy} = 80\% Direct_Assessment_Score_{PO/PSOy} + 20\% Indirect_Assessment_Score_{PO/PSOy}$$

(10% Exit Survey, 5% Parents' Feedback, and 5% Employer Feedback)

Indirect PO/PSO Assessment		PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
Stakeholder Feedback	Exit Survey (10%)	2.4	2.6	1.8	2.2	2	1.4	2.9	1.9
	Parents Feedback (5%)	2.4	2.1	2.4	2.7	2.9	2.8	1.9	1.5
	Employer Feedback (5%)	2.8	2.5	2.6	2	2.4	2.1	2.2	3
		PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
Direct PO/PSO Assessment- A		2.39	2.20	2.40	2.35	2.52	2.11	1.94	1.98
Indirect PO/PSO Assessment	Exit Survey- B	2.4	2.6	1.8	2.2	2	1.4	2.9	1.9
	Parents Feedback- C	2.4	2.1	2.4	2.7	2.9	2.8	1.9	1.5
	Employer Feedback- D	2.8	2.5	2.6	2	2.4	2.1	2.2	3
Overall PO/PSO Attainment= 80% A+10% B+ 5% C+ 5% D		2.41	2.25	2.35	2.33	2.48	2.07	2.04	1.99
		Final Attainment for each Program							

All these feedback questions will be mapped to the PO/PSO's in 0,1,2 or 3 level and its average is put here

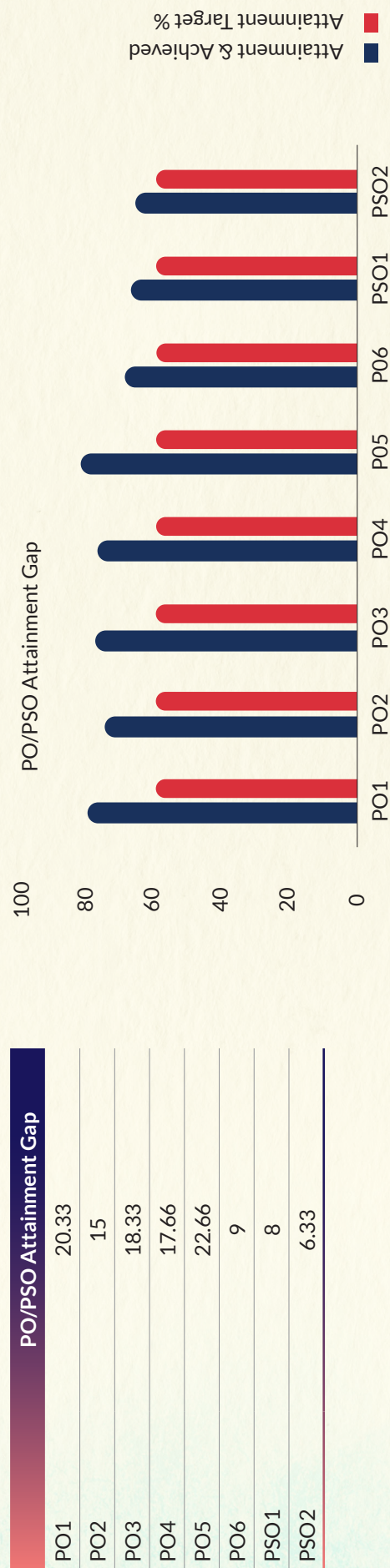
To be calculated by the Program Coordinator, by taking CO Attainments of all courses running in the program

9. The $Attainment_Score_{PO/PSO_y}$ are matched with the pre-defined Targets, to check if the PO's/PSO's have been attained or not.

TARGET: The same target value is set for all the PO's/PSO's for a Program.

TARGET SET: 60% (Can also be set in a scale of 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
Attainment Level Achieved	2.41	2.25	2.35	2.33	2.48	2.07	2.04	1.99
Attainment % Achieved	80.33	75	78.33	77.66	82.66	69	68	66.33
Attainment Target %	60	60	60	60	60	60	60	60



10. Calculate PEO attainment for a program that has at least 3 consecutive batches graduated, by using the indirect assessment tool. Assuming z is the total number of feedback received from alumni.

$$\text{Attainment_Score}_{\text{PEOz}} = 50\% \times \text{Alumni feedback (at least 3 years post graduation from BIT)} + 50\% \text{ Stakeholder's Feedback (Employers, Parents)}$$

PEO Assessment		PEO Assessment					Purely based on Alumni Feedback
Attainment_Score _{PEOz}	Alumni Feedback (at least 3 years post graduating from BIT)	PEO1	PEO2	PEO3	PEO4	PEO5	Final Attainment for each
		2.4	2.8	3	2.5	2.9	

Change in CO attainment targets for continuous improvement:

- There will always be a quantified target set for the designed COs. These targets for the attainment of the COs are set by the coordinator of the respective courses in that particular semester. It could be set by the available evaluation reports of the previous year's students. For example, the coordinator can set the CO attainment target of 60% for the course initially, however, the targets can be changed in the subsequent years by predicting the performance of the current students and/or previous experiences.

Gap analysis:

- As discussed earlier in the CO attainment targets, if the set targets are attained by the students of the year, higher targets can be set for the students in the upcoming years as parts of the continuous improvement.
- Alternatively, if the targets are not achieved, consequent gap analysis should be carried out, and the action plan should be prepared to ensure the attainment of the targets in the subsequent years.



Developed by -
Prof. Sudip Das
Dr. Tanushree Bhattacharya
Dr. Akriti Nigam
Dr. Bapi Gorain



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