VARDHAMAN COLLEGE OF ENGINEERING

(AUTONOMOUS)
Affiliated to JNTUH, Approved by AICTE,
Accredited by NAAC with A++ Grade,
ISO 9001:2015 Certified

OBE MANUAL

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JANUARY 2024

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Kacharam, Shamshabad, Hyderabad – 501218, Telangana, India

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Chapter 1

Outcome Based Education Framework

1.1 Introduction

Outcome-Based Education (OBE) represents a student-centric instructional paradigm that prioritizes the assessment of student performance through clearly defined learning outcomes. These outcomes encompass a broad spectrum of competencies including knowledge, skills, and attitudes. The hallmark of OBE lies in its evaluative focus, systematically measuring the attainment of specified knowledge, skills, and behaviours by graduates both upon program completion and in subsequent professional endeavours.

Within the OBE framework, the educational objectives for a given engineering program are meticulously established in advance, encompassing the requisite knowledge and skill sets. Students undergo comprehensive evaluation against these predetermined outcomes throughout their academic journey. This ensures a structured and objective assessment of their progress and competency development.

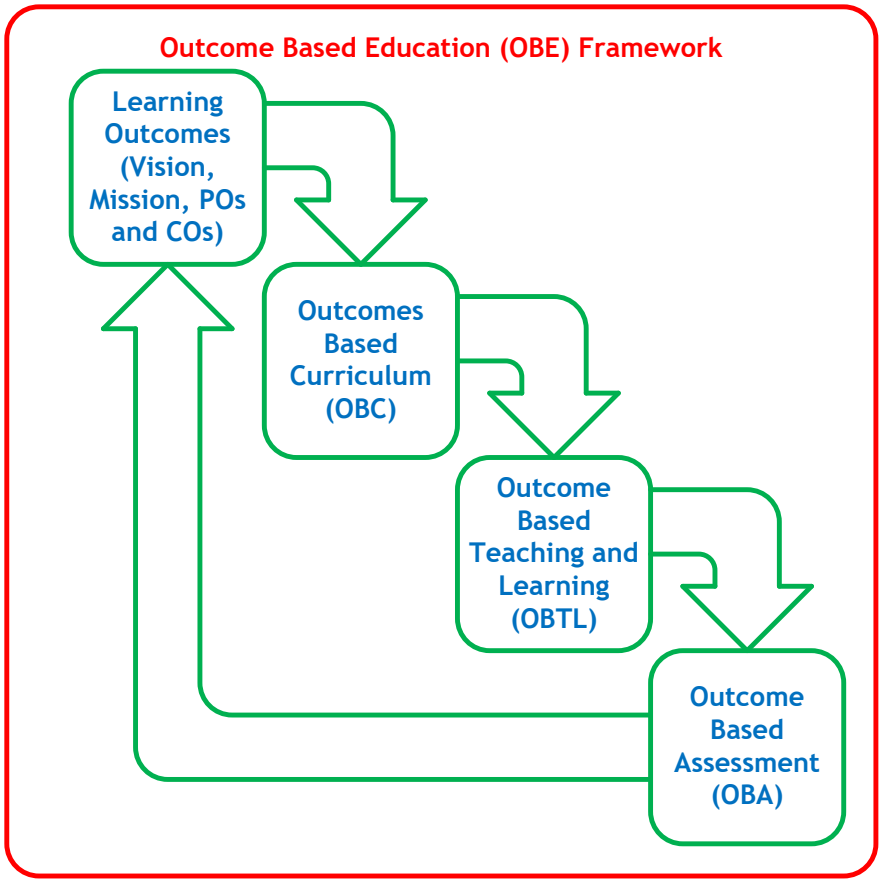


Fig. The Outcome Based Education (OBE) Framework

The OBE model is structured around the articulation of intended learning outcomes, which include the vision and mission of the program, Program Educational Objectives (PEOs), Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs). This framework guides the design and development of the curriculum, informs the deployment of teaching and learning activities, and shapes the assessment methodologies.

Through this rigorous approach, OBE aims to produce graduates who are not only proficient in their respective fields but also equipped with the ability to contribute meaningfully to their professions and societies.

1.2 Outcome Based Education

1.2.1 Principles of OBE

The foundational principles of Outcome-Based Education (OBE) are centred on four cardinal tenets that underpin its implementation and effectiveness. These principles are designed to ensure that the educational process is meticulously aligned with the intended learning outcomes, thereby fostering an environment conducive to student success and mastery. The principles are as follows:

1. **Clarity of Focus:** Central to the OBE model is the imperative that all pedagogical strategies and activities are unequivocally aligned with the predefined learning outcomes. This principle underscores the importance of a targeted approach to education, where the primary objective is to facilitate the development of students' knowledge, skills, and dispositions. Educators are tasked with the clear articulation of these outcomes, ensuring that students are equipped to meet the established benchmarks of success.
2. **Designing Down:** This principle advocates for a reverse-engineering approach to curriculum development. It necessitates initiating the design process with a comprehensive understanding of the desired learning outcomes at the culmination of the program. Subsequent instructional decisions, including content selection, teaching methodologies, and assessment techniques, are thereby informed and directed towards achieving these specified outcomes. This strategic approach ensures coherence and alignment throughout the educational experience.
3. **High Expectations:** Emphasizing the cultivation of a culture of excellence, this principle posits that setting ambitious standards of performance serves as a catalyst for deeper engagement and learning. By challenging students with rigorous expectations, educators foster an environment that not only supports but also propels students towards higher levels of achievement. This principle is predicated on the belief that success begets success, creating a virtuous cycle of learning and improvement.
4. **Expanded Opportunities:** Recognizing the diverse learning needs and pathways of students, this principle calls for the provision of varied and flexible learning opportunities. It acknowledges that while learning styles and paces may differ, most students can reach high standards provided they are afforded the appropriate support and resources. This principle champions inclusivity and adaptability, ensuring that education is accessible and equitable for all students.

Together, these principles form the bedrock of the OBE approach, guiding educators in the creation of a learning environment that is both focused and flexible, challenging yet supportive, ensuring that all students have the opportunity to achieve their fullest potential.

1.2.2 OBE Process

Constructive alignment represents a fundamental approach in the development of an Outcome-Based Education (OBE) syllabus, aiming to establish a learning environment meticulously designed to support activities conducive to achieving the specified learning outcomes. The essence of this process lies in the strategic alignment of all components within the educational framework, ensuring that the chosen teaching methodologies and assessment tasks are directly correlated with the learning activities envisioned in the intended outcomes.

At the heart of constructive alignment is the principle that the educational structure—from the delivery of content to the evaluation of student learning—should be cohesively organized around the learning objectives. This involves a deliberate design process where the outcomes define the types of learning activities students engage in, which in turn informs the selection of teaching strategies and assessment methods. The alignment ensures that the assessment tasks genuinely reflect the learning activities and, by extension, the learning outcomes, thereby providing a clear pathway for students to demonstrate their knowledge, skills, and attitudes as anticipated.

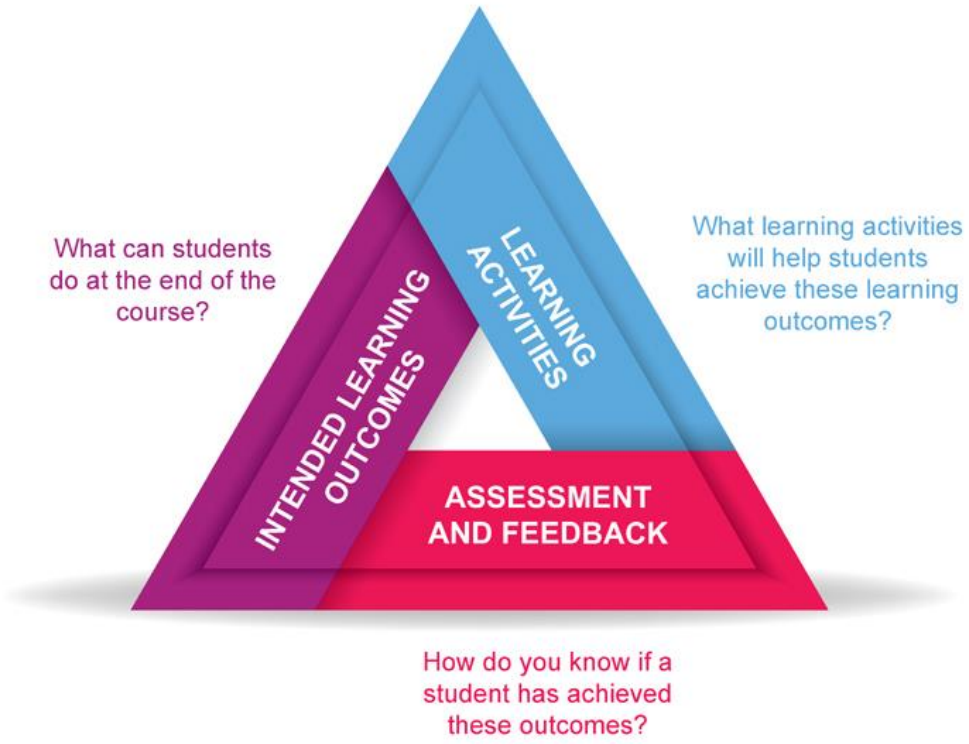


Fig 1. Constructive Alignment Process in OBE

1.2.3 Stakeholders

Internal Stakeholders:

Stakeholder	Purpose
Promoter/Management/ Governing Body Member	Defining growth plan and road map Providing physical, human, and financial resources Formulation of policies
Human Resources (Faculty and Supporting Staff)	Implementer (Contributor) of Policies Key contributor in developing/implementing growth plan Responsible for producing competent graduate/product from the institution
Students	Product of the institution and responsible for creating institute image

External Stakeholders:

Stakeholder	Purpose
Employer	Employing graduates and making an assessment on competence and industry readiness
Industry	Employer as well as participant in curriculum development and industry-institute activities
Alumni	Able to co-relate learning and practice
Funding Agencies	Provides financial assistance to the institution and interacts with the Principal Investigator/Faculty of the department/program
Regulatory/Accrediting Authorities	Prescribes norms and standards to ensure quality assurance and enhancement
Society	Provides intangible outcome from the Institute perspective

1.3 Anatomy of a Learner

The anatomy of a Learner: Attributes of Vardhaman College of Engineering student/graduate. The aim of the institution is to prepare a graduate who possesses the following all-round attributes which transforming a graduating learner to a successful engineer with all higher order thinking skills.

Critical Thinker and Problem Solver	**Brain/Mind** to think and solve
Innovative	An **eye** for innovation to see opportunities to growth
Team Player and Manager	**Ears** to listen and collaborate
Effective Communicator	**Mouth** to communicate effectively
Ethical & Values Driven	**Heart** filled with good ethics and values
Competent and Technology Oriented	**Hands** to utilize available technology and resources
Life-long Learner	**Knees** to endure life-long learning
Well-Rounded Citizen	**Feet** that can walk through various parts of life

1.4 Implementation of OBE

The OBE framework at Vardhaman College of Engineering fundamentally includes the following components:

1. Institute Vision, Mission, Quality Policy and Core Values
2. Department Vision and Mission
3. Program Educational Objectives (PEOs)
4. Program Outcomes (POs)
5. Curriculum Map showing alignment of courses with POs
6. Defining Course Outcomes (COs) for each course in the Curriculum
7. Outcomes-Based Teaching and Learning (OBTL) Delivery Process
8. Program Assessment and Evaluation Process
9. Continuous Quality Improvement Process

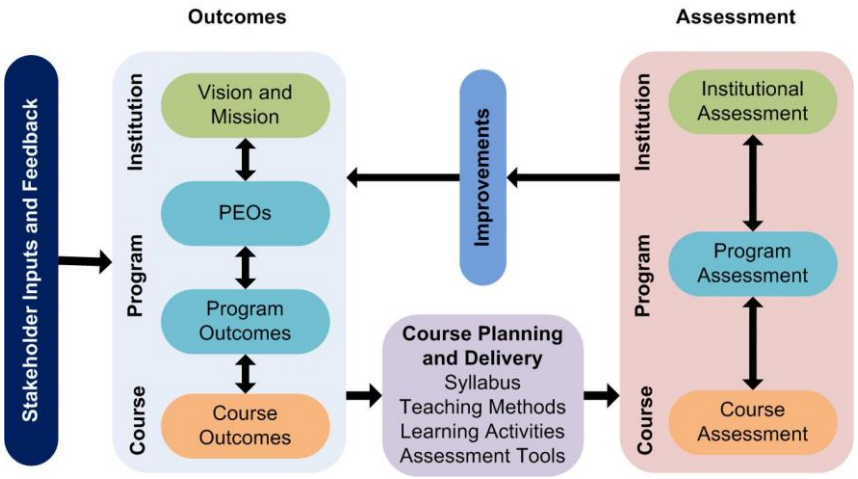


Fig 1.1. OBE Framework

The OBE framework at any institute can be successfully implemented through the involvement of all the internal and external stakeholders in its processes. The execution of Outcome Based Education (OBE) at institute / program / course level is possible through defined roles and responsibilities to the stakeholders.

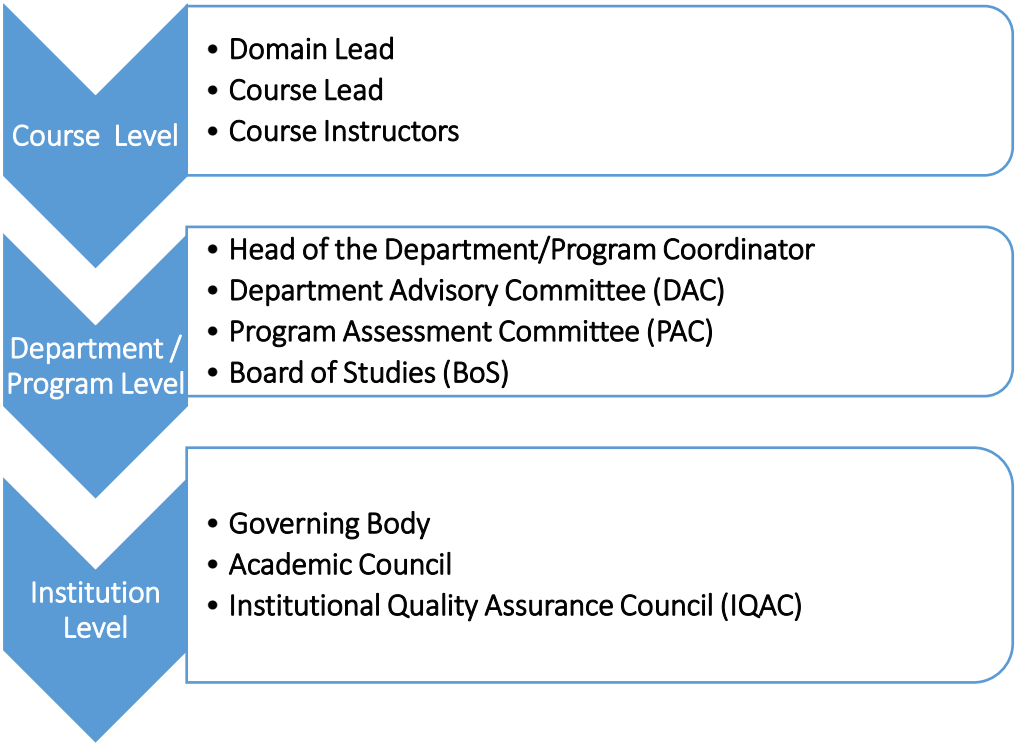


Fig 1.2. Internal Stakeholders Involved in the Implementation of OBE

Chapter 2

Vision, Mission, Core Values and Quality Policy

2.1 Introduction:

Establishing Vision, Mission, Quality Policy and Core Values is the first step for any institution to implement Outcome Based Education (OBE). There by in line with the vision and mission of the institution, the departments have to establish their own vision and mission statements. Vision statement typically indicates aspirations and mission statement states the broad approach to achieve aspirations. Institute vision and mission statements should ensure consistency with the department vision and mission statements.

Each and every program offered by the department should define three to four Program Educational Objectives (PEO) and should be mapped with the mission elements of the department. The vision and mission of the Institute/Department and the PEOs of the program are defined by taking the views of various stakeholders associated with the Institute/Department, latest developments, future scope and needs of the society.

Program Outcomes or Graduate Attributes are provided by National Board of Accreditation (NBA). Course Outcomes for all the courses of the curriculum need to be defined by the team of instructors and subject experts. The major components of Outcome Based Education(OBE) are Course Outcomes(COs) and Program Outcomes(POs). Based on how well these two parts are defined and evaluated, OBE attainment is measured.

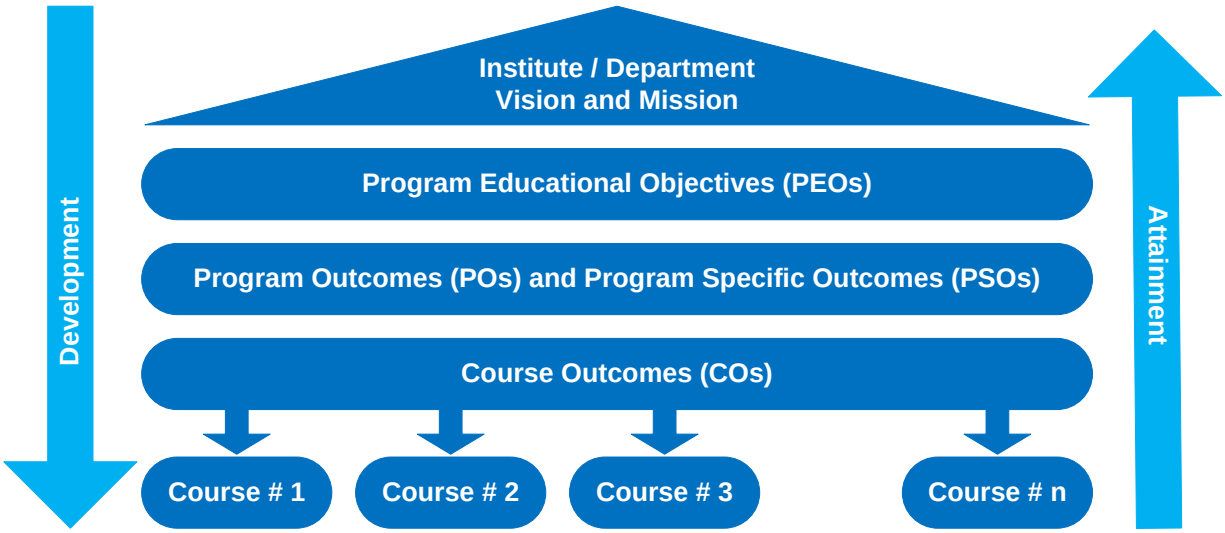


Fig. 2.1 Development and Attainment Flow of VMOs/PEOs/POs and PSOs/COs

2.2 Institute Vision, Mission, Quality Policy and Core Values

2.2.1 Vision

To be a pioneer institute and leader in engineering education to address societal needs through education and practice.

2.2.2 Mission

- To adopt innovative student-centric learning methods.
- To enhance professional and entrepreneurial skills through industry-institute interaction.
- To train the students to meet the dynamic needs of the society.
- To promote research and continuing education.

2.2.3 Quality Policy

We at Vardhaman College of Engineering, endeavor to uphold excellence in all spheres by adopting best practices in effort and effect.

2.2.4 Core Values

Academic Integrity

Achieving success by being sincere, loyal and ethical in all our practices.

Typical Actions

- We are sincere and committed in what we do.
- We conduct ourselves professionally and lead by example to all.
- We respond to a given situation rather than reacting.

Mutual Respect

Extending courtesy to all the stakeholders and to promote culture of inclusion and fairness.

Typical Actions

- We treat each other with dignity, courtesy and respect.
- We treat students impartially.
- We give due credit to others whenever it is due.

Social Responsibility

Being responsible citizens, share our collective achievements and contributions to the world around us.

Typical Actions

- We work together to maintain a safe and healthy campus where we live, learn and work.
- We collaborate, share knowledge and celebrate our collective achievements.
- We act with empathy and kindness to students while nurturing them.

Accountability

Accountable for our actions to the stakeholders in general and students in particular.

Typical Actions

- We take responsibility for our actions, decisions and the results.
- We practice ownership of our resources, managing them prudently and ethically.
- We strive to do our best in every situation to uphold the institution values.

Adaptability

Embrace change as a path to progress, success and innovation.

Typical Actions

- We embrace change that enables progress and innovation.
- We challenge the status quo and speak up when we find a better way to do something.
- We work with full potential and continuously expanding our knowledge, skills and capabilities.

Creativity

Become a change agent to performance, innovation and student success.

Typical Actions

- We embrace change that enables progress and innovation.
- We committed promote entrepreneurship among the interested students.
- We provide self-learning opportunities to the students to nurture their knowledge, skills and capabilities.

2.3 Department Vision and Mission

Each and every department of the institution has to establish the department vision and mission in line with the statements of institution vision and mission.

The department must establish the vision and mission through a consultative process involving the stakeholders (students, alumni, parents, professional bodies, faculty, industry, and management) considering the scope for growth of the department and future societal requirements.

The process to arrive at the Vision and Mission of the department is as follows:

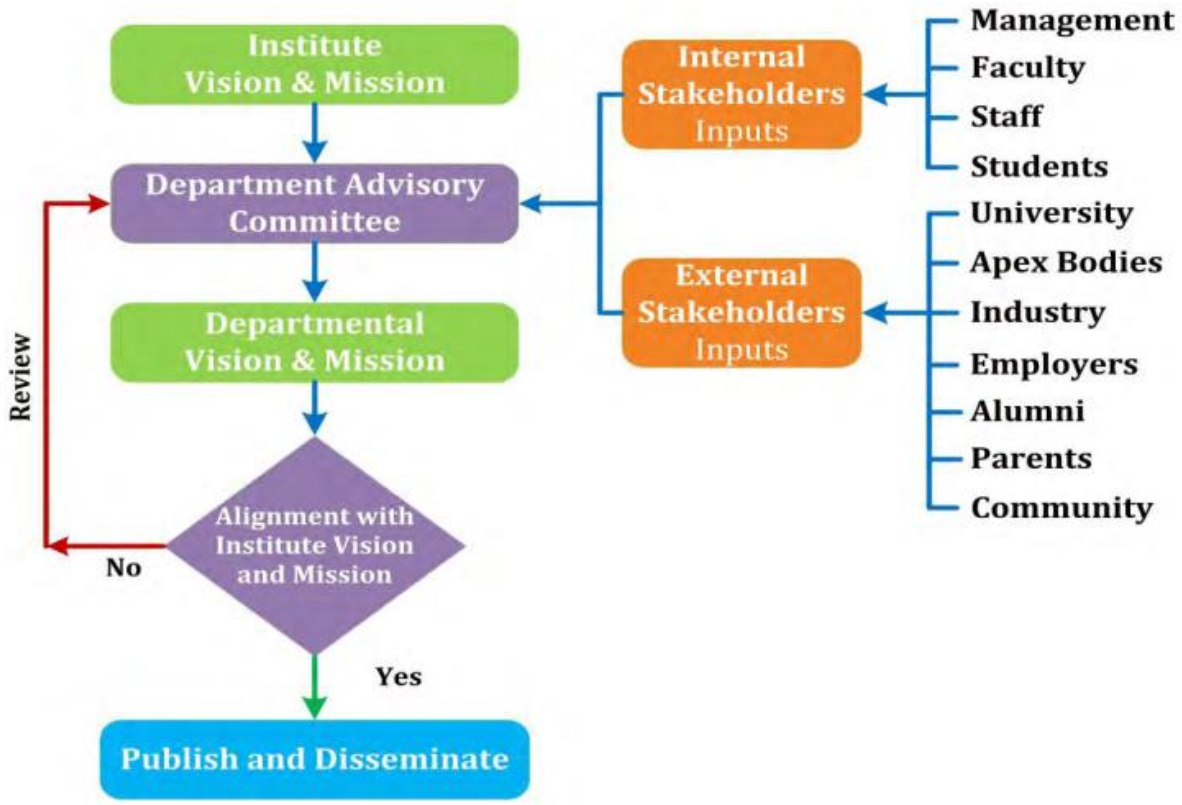


Fig 2.2. Process of defining Vision and Mission of the Department

The committee at the institute and department level is to ensure appropriate formulation, implementation and review of Vision and Mission statements and its development/review process.

The vision and mission of the departments at Vardhaman College of Engineering are available in the department's webpage at www.vardhaman.org.

2.4 Programme Educational Objectives (PEOs)

Program Educational Objectives are broad statements that describe the career and professional accomplishments that the programme is preparing graduates to achieve. Graduates are expected to demonstrate these attributes 3 to 5 years after graduation.

The PEOs must be defined based on the mission statements of the department. The elements of PEOs and mission statements should be consistent and indicated in the PEO-Mission element matrix. Program Curriculum and other attributes must contribute to the achievement of stated PEOs.

The Program Educational Objectives (PEOs) of the programs offered by the departments at Vardhaman College of Engineering are available in the department's webpage at www.vardhaman.org.

The PEOs creation and validation process is shown in fig. below.

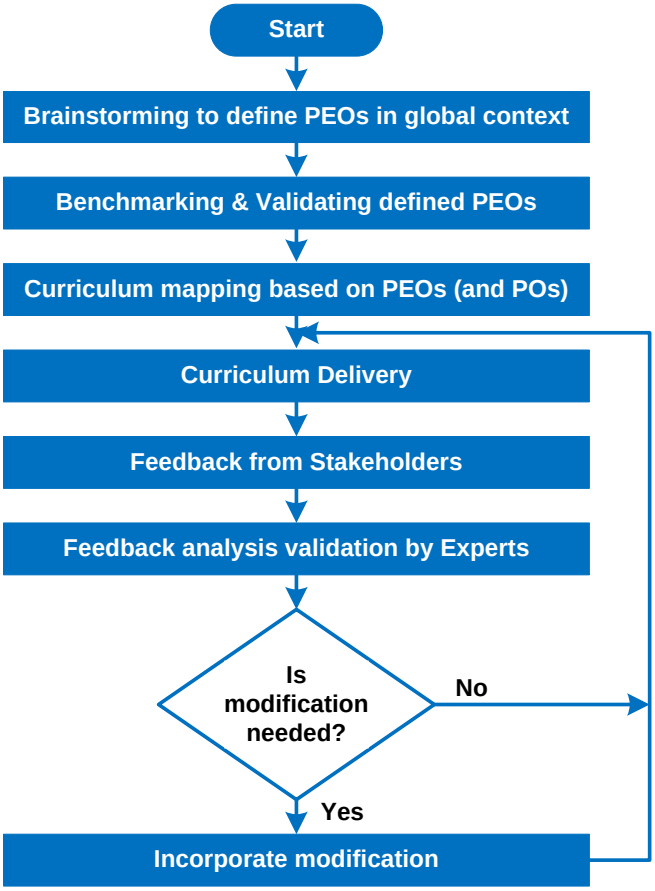


Fig 2.3. PEOs definition and validation process

Generate a "Mission of the Department-PEOs Matric" with justification and rationale of the mapping as follows:

Table 2.1. PEO-Mission Element Matrix

PEO#	PEO Statement	M1	M2	…	Mn
PEO1					
PEO2					
PEO3					
PEO4					

Note: M1, M2, … Mn are distinct elements of Mission statement. Enter correlation levels 1, 2 or 3 as defined below:

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)

If there is no correlation, put "-"

2.5 Program Outcomes (POs) or Graduate Attributes (GAs):

Program Outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviours that students acquire in their matriculation through the programme. The programme should demonstrate that the students attain the outcomes listed in Graduate's Attributes as defined by Washington Accord.

As per the Washington Accord, "The graduate attributes are exemplars of the attributes expected of a graduate from an accredited programme." The Graduate Attributes are defined by the National Board of Accreditation (NBA).

Program Outcomes (POs) represent the knowledge, skills and attitudes the students should have at the end of a four-year engineering undergraduate program. It describes the learning that will take place across the curriculum through brief statements, made in specific and on measurable terms.

The graduate attributes or program outcomes (POs) for B.Tech undergraduate engineering degree program are as follows:

PO1: Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identity, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: 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.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select and apply appropriate techniques, resources. and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: 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.

PO7: Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

PO10: 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.

PO11: 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.

PO12: 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.

2.6 Program Specific Outcomes (PSOs)

PSOs are statements that describe what the graduates of a specific engineering program should be able to do after the successful completion of engineering program. The parameters are based on initial capabilities, competence, skills, etc. keeping in mind the outcomes desired by the concerned profession.

The PSOs are program specific. PSOs are written by the department offering the program. There usually are two to four PSOs for a program offered by the department.

POs and PSOs are stated and proliferated for all programs clearly. There are certain parameters known as Graduates Attributes and they vary from discipline to discipline and level to level such as Undergraduate and Postgraduate Programmes.

The Program Specific Outcomes (PSOs) of the programs offered by the departments at Vardhaman College of Engineering are available in the department's webpage at www.vardhaman.org.

2.7 Dissemination of Vision, Mission, PEOs, POs/PSOs

Incorporate into Orientation Programs: Include information about the vision, mission, PEOs, POs, and PSOs in orientation programs for new students, faculty, and staff.

Include in Course Materials: Incorporate the vision, mission, PEOs, POs, and PSOs into course materials, syllabi, and other relevant documents to ensure that students are aware of the program's goals and objectives.

Post on Website: Display the vision, mission, PEOs, POs, and PSOs prominently on the program's website to make them easily accessible to all stakeholders.

Share in Meetings and Workshops: Discuss the vision, mission, PEOs, POs, and PSOs in faculty meetings, student workshops, and other relevant forums to ensure that everyone is aware of and understands them.

Include in Marketing Materials: Incorporate the vision, mission, PEOs, POs, and PSOs into marketing materials such as brochures, flyers, and advertisements to communicate the program's strengths and objectives to prospective students and employers.

Engage Alumni: Engage alumni in discussions about the vision, mission, PEOs, POs, and PSOs to demonstrate how the program has evolved and improved over time.

Use of social media: Use social media platforms to share information about the vision, mission, PEOs, POs, and PSOs and engage with stakeholders online.

Provide Training: Provide training for faculty and staff on how to effectively communicate the vision, mission, PEOs, POs, and PSOs to ensure consistency in messaging.

Seek Feedback: Encourage feedback from stakeholders on the vision, mission, PEOs, POs, and PSOs to ensure that they remain relevant and aligned with the needs of the program.

Celebrate Achievements: Highlight achievements related to the vision, mission, PEOs, POs, and PSOs to demonstrate progress and reinforce the importance of these goals and objectives.

Chapter 3

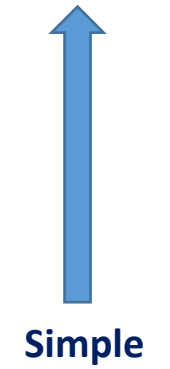
Bloom's Taxonomy

3.1 Learning Domains

Bloom's taxonomy of learning has evolved over time and is a tool commonly used to write learning outcomes. Dr. Benjamin Bloom (1913 - 1999) was an educational psychologist who in 1956, along with his team, developed a taxonomy of learning that classifies learning outcomes according to the following 3 domains:

Cognitive Learning Domain (Knowledge)	knowledge and intellectual development in your course.
Psychomotor Learning Domain (Skills)	physical movement and motor skills necessary to learn in your course.
Affective Learning Domain (Attitudes)	values, attitudes, appreciations, motivations, and priorities of the discipline or profession in your course.

The following table illustrates how learning outcomes are categorized according to the newly updated Bloom's Taxonomy.



Cognitive (KNOWLEDGE)	Psychomotor (SKILLS)	Affective (ATTITUDES)
Creating	Naturalizing	Characterizing
Evaluating	Articulating	Organizing
Analyzing	Fine Tuning	Valuing
Applying	Manipulating	Responding
Understanding	Imitating	Receiving
Remembering		

Cognitive Learning Domain - Definitions & Verb List

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
Creating	developing a hypothesis; devising a procedure; inventing a product	compose, design, plan, construct, produce, develop, create, devise, modify, organize, predict	Create a short story using similar plot devices in a new time or setting.	Create a new and unique piece of writing using similar plot devices.	Can the student generate new products, ideas or ways of viewing things.

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
Evaluating	distinguishing whether a process/product has internal consistency, inconsistencies or fallacies; detecting appropriateness of a procedure for a given task	assess, choose, critique, check, judge, evaluate, hypothesize, test, detect, measure, rate, monitor, rank, score, justify, validate, test	Write a response to one of the events in the play, either supporting or rejecting their actions on the basis of evidence from the play as well as personal opinion and projected/ actual consequences of action.	Evaluate the decisions of characters in the play, and support your ev aluation with textual evidence	Can the student justify a decision or course of action?
Analyzing	distinguishing relevant from irrelevant; determining fit or function within a structure; determining point of view, bias and/or values of presented material	analyze, appraise, conclude, contrast, correlate, determine, discriminate, distinguish, compare, attribute, deconstruct, integrate, outline, find coherence	Write an analytical paper comparing the antagonists and protagonists of the play.	Be able to analyze the relative roles of each character in the play and their relationships to each other.	Can the student differentiate between fundamental parts?
Applying	applying or demonstrating knowledge in a routine or non-routine task	apply, implement, carry out, use, utilize, demonstrate, execute, illustrate, generalize, predict, make, clarify why, utilize, show,	Write an advice column responding to one of the characters.	Apply the main ideas/themes in the play to another context.	Can the student use the new knowledge in another situation?
Understanding	changing from one form of representation to another; illustrating a concept; drawing conclusions, determining cause and effect	choose, interpret, cite, summarize, paraphrase, exemplify, compare, infer, translate, clarify, classify, extrapolate, conclude, match, give an example, discuss, explain, restate, respond, express, describe	Write a short (1 page) paper summarizing the plot and most important events in the play.	Understand and explain the main ideas of a play or piece of literature.	Can the student explain ideas or concepts?

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
Remembering	retrieving information from short and long term memory	accumulate, arrange, recognize, list, label, locate, define, describe, identify, retrieve, name, recall, repeat	A multiple-choice test designed to test the memory of learners.	Remember the names and relationships of a cast of characters in a play.	Can the student recall information?

Psychomotor Learning Domain - Definitions & Verb List

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
Naturalizing	Reproducing activity from instruction or memory	administer, apply, assist, assemble, build, carry out, collect, configure, contribute, draw, execute, fabricate, graph, implement, locate, measure, perform, recreate, select	A soccer or other strategic game (football, hockey)	Express oneself through purposeful movement and activity	Can the student carry out the task from instruction?
Articulating	Adapting and integrating expertise to satisfy a nonstandard objective	adapt, calculate, coordinate, combine, compile, construct, develop, edit, formulate, integrate, manipulate, modify, replace, repair, solve	A game of catch or soccer (or other game involving movement and passing).	Use more than one ability to integrate different sensory perceptions.	Can the student relate and combine activities for the purpose of developing methods to meet novel requirements?
Precision	Fine tuning. Making minor adjustments in the physical activity in order to perfect it	adjust, calibrate, conduct, control, complete, demonstrate, install, operate, show, perfect, practice, present, simulate	A soccer or other strategic game (football, hockey).	Adapt one's behaviour and movement to better achieve goals	Can the student perform or demonstrate with expertise?
Manipula	Reproducing activity from instruction or memory	administer, apply, assist, assemble, build, carry out,	Run for 25 minutes steadily.	Sustain an activity for a set period of time.	Can the student carry out the task from instruction?

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
		collect, configure, contribute, draw, execute, fabricate, graph, implement, locate, measure, perform, recreate, select			
Imitating	Attempted copying of a physical behavior	adhere, copy, duplicate, follow, replicate, repeat, trace	A game of dodgeball.	Instinctively respond to a physical stimulus.	Can the student repeat the action/process/ activity?

Affective Learning Domain - Definitions & Verb List

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
Characterizati	Acting consistently with the new value.	act, display, influence, internalize, integrate, relate, resolve, qualify, practice, verify	A group project, including group work on any assignment.	Work well in a team of peers	Does the student practice in accordance to their beliefs?
Organizing	Integrating a new value into one's general set of values, giving it some ranking among one's general priorities.	alter, arrange, build, codify, construct, compare, develop, discriminate, display, generalize, modify, order, organize, prioritize, reconcile	Organize and compare different cultural value systems, evaluating the differences between them and why these differences may have arisen.	Compare value systems and understand evidence behind values.	Does the student state beliefs and reasons?
Valuing	Showing some definite involvement or commitment.	argue, criticize, debate, decide worth, defend, devote, explain, join, justify, persuade, present, propose pursue, refute, share	Write an opinion piece on any issue, explaining one's own stance and reasons supporti ng that stance.	Demonstrate and explain own values regarding various topics.	Does the student express opinions?
Responding	Showing some new behaviors as a result of experience.	complete, contribute, comply,conform , cooperate, discuss,describe,	Present on a subject in front of the class, and answer questions from	Speak effectively in front of an audience and	Does the student participate actively?

	Definition	Output Verbs	Learning Assessment /Activity	Learning Outcomes	Evaluating Example
		examine, formulate, perform, provide other references/examples, react, respond, seek, use	peers about their presentation.	actively respond to others	
Receiving	Being aware of or attending to something in the environment.	ask, accept, attend, acknowledge, concentrate, follow, give, identify, select, recognize, retain	Be an audience member to another student's presentation, and then write a summary.	Listen to other students with respect	Does the student identify ideas or concepts from an experience?

3.2. Suggested Action Verbs for Course Outcomes

There are six levels of cognitive learning according to the revised version of Bloom's Taxonomy. Each level is conceptually different. The six levels are remembering, understanding, applying, analyzing, evaluating, and creating. Bloom's Taxonomy is frequently used in writing the course outcomes as it provides a readymade structure and list of action verbs. All levels of Bloom's taxonomy of thinking skills can be incorporated into expected learning outcome statements. Recently, Anderson and Krathwohl (2001) adapted Bloom's model to include language that is oriented towards the language used in expected learning outcome statements. A summary of Anderson and Krathwohl's revised version of Bloom's taxonomy of critical thinking is provided in Figure below:

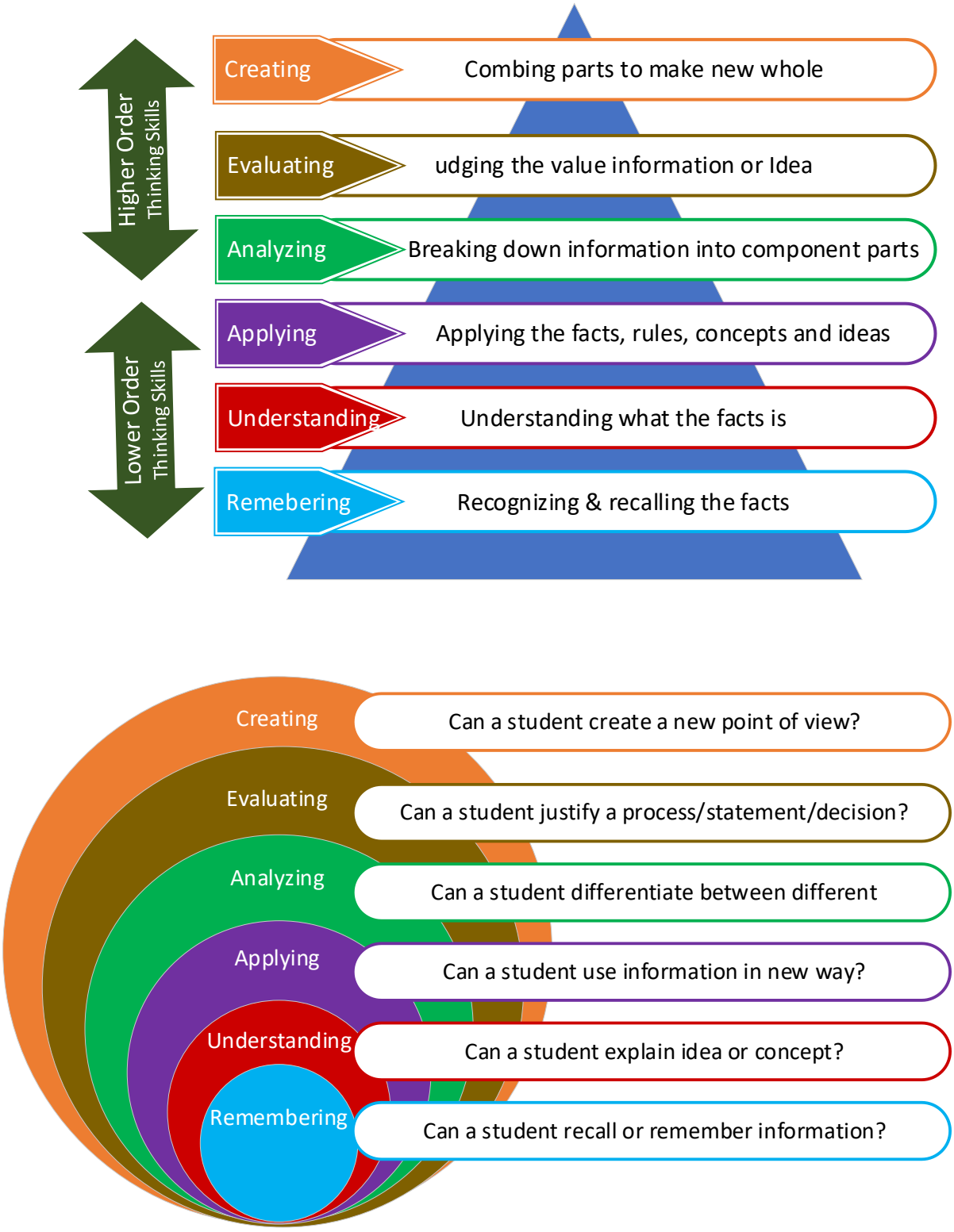


Fig 3.1: Blooms Taxonomy

Blooms Taxonomy Action Verbs:

Lower Order Thinking (LOT)			Higher Order Thinking (HOT)		
Remembering	**Understanding**	**Applying**	**Analyzing**	**Evaluating**	**Creating**
Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
• Define • Find • How • List • Select • When • Where • Which • Why	• Classify • Compare • Demonstrate • Explain • Illustrate • Interpret • Outline • Relate • Show • Summarize	• Apply • Build • Choose • Construct • Identify • Model • Organize • Plan • Solve • Utilize	• Analyze • Assume • Categorize • Contrast • Distinguish • Example • Function • Inference • Inspect • Relationships • Simplify • Survey	• Agree • Assess • Conclude • Criteria • Determine • Disprove • Estimate • Evaluate • Influence • Justify • Measure • Prioritize • Prove • Recommend	• Adapt • Change • Combine • Compile • Compose • Create • Design • Develop • Formulate • Improve • Invent • Maximize • Minimize • Modify • Originate • Predict • Propose • Solution

Illustration (use of action verb w.r.t knowledge dimension and order of thinking):

Use of action verbs	Factual	Conceptual	Procedural	Metacognitive
Remember	**List** properties of soil	**Recognize** characteristic of material	**Explain** working of pump	**Identify** strategies for report writing
Understand	**Summarize** features of a new product.	**Classify** adhesives by toxicity.	**Explain** assembly instructions.	**Predict** the behavior of member

Use of action verbs	Factual	Conceptual	Procedural	Metacognitive
Apply	**Respond** to frequently asked questions.	**Provide** advice to team members	**Carry out** pH tests of water samples.	**Use** modern techniques to get solution
Analyze	**Explain** the selection of tool/ activity.	**Differentiate** LOT and HOT	**Integrate** compliance with regulations.	**Assess** the project work
Evaluate	**Select** the appropriate tool	**Determine** relevance of results.	**Judge** efficiency of sampling techniques.	**Reflect** on one's progress.
Create	**Generate** a log of daily activities.	**Assemble** a team of experts.	**Design** efficient project workflow.	**Create** a learning portfolio.

Chapter 4

OBE Framework

4.1 Outcome Based Curriculum

4.1.1 Introduction

Designing a curriculum is not easy. It is a complicated process that needs to be carefully thought through and involves much strategic decision making. Curriculum developments and changes may serve a broad range of purposes, yet student learning is always at the core. Once faculty begin teaching in a new curriculum, they should also conduct a more localized and specific needs analysis to determine the learners' needs and the resources available. The following questions can provide a good starting point and help teachers plan accordingly:

- What are the outcomes for the course?
- How will the students attain these outcomes?
- What resources do the faculty and students need to attain them?
- What resources are currently available (e.g., textbooks, supplemental materials, classroom space, technology, syllabus, funding, mentors, co-workers, time)?

Many decisions in lesson planning and teaching are made on an ongoing basis, and the nature of ongoing decisions relates to the degree to which a curriculum is either **product-oriented or process-oriented.**

A **product-oriented curriculum** is organized around predetermined specifications that learners will reach as a result of instruction. In this type of curriculum, emphasis is placed on pre-course planning and positioning the faculty as the authority on the curriculum and the learners as receivers.

On the other end of the spectrum, a **process oriented curriculum** is the one in which the faculty and learners work together to negotiate a syllabus to address learner needs and preferences. The faculty is a facilitator and resource provider, and faculty and learners are considered collaborators.

Since the college become autonomous, the curriculum design has become an integral part of the institution. The college faculty are responsible for the curriculum offered by various programs offered in the college. Every department has a Board of Studies (BOS) which form the heart of the curriculum design process. The prime focus of the design of curriculum is based of outcomes-based education, a student centric learning model. Thus, the curriculum

design was made comprehensively blending the learning activities, teaching approach, assessment methods were completely based on the Outcome-based education.

Adequate number of brainstorm sessions were carried out involving various stakeholders, faculty being the fulcrum of entire process. Though the college is autonomous, it has a limited flexibility to improvise its curriculum. However, with the available norms of the university, the college blended the Curriculum with Good Design, Teaching Learning Processes, and Assessment. The institution follows Choice Based Credit System (CBCS) and adopted the AICTE model Curriculum of 160 credits for its B.Tech. program.

Each and every department has Board of Studies (BOS), Domain Leads, and Board of Examiners (BOE) who are responsible for developing the curriculum for the programs offered. The new curriculum and any suggested changes in the curriculum are carried out by the respective BOS/BOE as and when needed.

The college Academic Council is highest body that approves the proposed curriculum. All these Boards/Councils have nominations/representation of all the concerned stakeholders namely, government, university, faculty, industry experts, alumni and students. The curriculum has designed such that students are provided with more practice-based (laboratories) courses, so as to enhance their psychomotor abilities/skills.

From the academic year 2018-19, the concept of integrated courses has been introduced, in the revised teaching-learning-process. Innovative assessment tasks (practice, alternate assessment test and rubrics) were introduced so as to imbibe the expected graduated attributes which are also known as Programme Outcomes (as per NBA learning resources).

The design of curriculum arrived following a workflow commences with the Vision, Mission and PEOs of the program. Based on the PEOs, the syllabus was arrived at. Then various student learning outcomes were identified keeping the outcomes to be achieved at each and every level of the study.

The Student Learning Outcomes, namely Program Outcomes (POs), Programme Specific Outcomes (PSOs)and are assessed through curricular, co-curricular and extracurricular activities. In case the COs and POs are not achieved then necessary changes in the teaching methodology to reach the target levels of attainment are made (continuous improvement mode).

The rest of the chapter focusses on the steps involved in the process of curriculum designing or revising an existing curriculum.

There are four crucial steps of effective curriculum design. These steps can be used by any institute including those wanting to design their curriculum from scratch and others wishing to review their existing curriculum.

The following four steps may be followed to design or to refresh the curriculum.

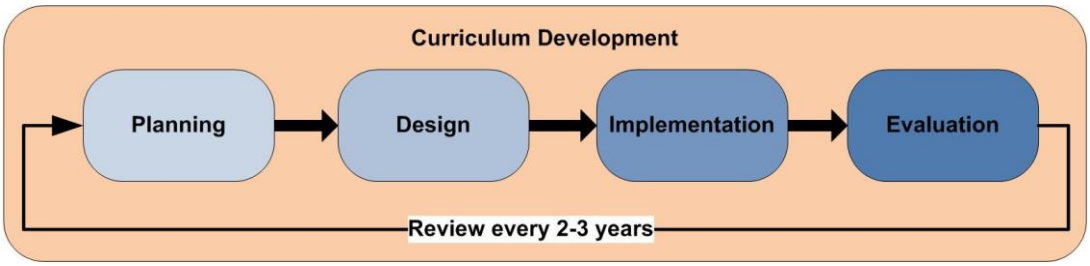


Fig 4.1. Steps involved to design or refresh a curriculum

4.1.2 Curriculum Design and Development

4.1.2.1 Curriculum Planning

It is a process in which participants at many levels (involvement of stakeholders) make decisions about what the purpose of learning ought to be, how these purposes might be carried out through teaching learning situations and whether the purposes and means are both appropriate and effective.

Curriculum Planning is the process of gathering, sorting, selecting, balancing and synthesizing relevant information from many sources in order to design those experiences that will assist learners in attaining goals of the curriculum.

Characteristics of Curriculum Planning:

- Ultimately concerned with experiences of learners
- Involves decisions about both context and methods
- Involves decisions about a variety of issues
- Involves many groups
- Takes place at many levels
- Is a continuous process

4.1.2.2 Curriculum Design

It is the pattern or structure of a curriculum. It is the arrangement or organization of the components of curriculum.

It is a specialized area of work which expects a faculty to have a deep understanding of the underlying concept of curriculum and also the skill to systematically design learning experiences to achieve socially desired goals. It is continuous and never ending process.

The Board of Studies (BOS) of the department is authorized for designing the program curriculum and revising it periodically. To meet program specific criteria for B. Tech program, the curriculum is designed to provide both breadth and depth ("T" curriculum) by taking the inputs from Lead Societies. The curriculum is designed keeping the AICTE model curriculum as a base. The BOS also studies various reports on future trends before designing the Curriculum. In the process of designing the curriculum, the guidelines given by affiliating university is also considered. Finally, it is ensured that the curriculum and its components contribute effectively in attainment of POs and PSOs.

The Curriculum is revised periodically for any changes based on attainment of POs and PSOs by BOS.

- BOS is the authority to propose changes in the curriculum.
- The composition of BOS ensures participation of all major stakeholders.
- BOS meets periodically to update curriculum
- BOS considers inputs from Affiliating university, AICTE model Curriculum, Future trend Reports, Program Specific Criteria suggested by Lead Societies and Program Educational Objectives
- Submission to the academic council for its approval
- Approved curriculum is adopted for implementation.

The curriculum structure follows a typical pattern as suggested by AICTE & hence the curriculum is divided into eight categories viz.

- Humanities & Social Sciences (HSS)
- Engineering Sciences (ES)
- Basic Sciences (BS)
- Professional Core (PC)
- Professional Electives (PE)
- Open Electives (OE)
- Environment Sciences and
- Project Work

Curriculum design began with strong focus on teaching-learning process to meet the desired Graduate Attributes. Accordingly, several curricular review meetings were conducted with the stakeholders followed by the meetings of concerned Board of Studies and the Academic Council.

In order to enhance the learning experience of students integrated (theory and practice together) courses were introduced. Course Outcomes were developed for each course by the domain experts from department thus making course effective in terms of delivery and assessment point of view. To run courses efficiently, Outcome-based Education (OBE) has been deployed. In order to ensure proper & effective teaching-learning methodology course packs were developed by the faculty in which the course delivery, assessment patterns specified to achieve stated objectives and outcomes of every course. The basic science (BS), engineering science (ES), professional core (PC) and professional elective (PE) courses ensure the attainment of PO1-5. PO6, PO7, PO8 and PO9 are difficult to achieve through the curriculum unless few HSS courses were introduced. All the programmes offer these courses as a part of its curriculum, which integrates the mainstreaming cross-cutting issues relevant to Gender, Environment Sustainability, Human Values and Professional Ethics. The HSS courses not only help students develop core skills such as critical thinking, problem solving, and communication, both oral and written but also achieve the Programme Outcomes, POs 6-12, which were not integral part of the curriculum previously.

Relevance of curriculum components to program outcomes

Course Component	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Basic Sciences	√	√	√									
Engineering Sciences	√	√										
Humanities and Social Sciences						√	√	√	√	√	√	
Professional Core	√	√	√	√	√							
Professional Electives	√	√	√	√	√	√	√	√	√	√	√	√
Open Electives						√	√	√	√	√	√	
Mini Project	√	√	√	√	√	√	√	√	√	√	√	√
Technical Seminar				√					√	√		
Project Work	√	√	√	√	√	√	√	√	√	√	√	√

The professional courses and open electives ensure that the students always up to date and learn cutting edge technologies. It is more likely that the students are more aware of the changing trends, disruptions and directions in profession. The curricular requirements

help the students to continue to make a meaningful contribution to their development and contribution to welfare of mankind.

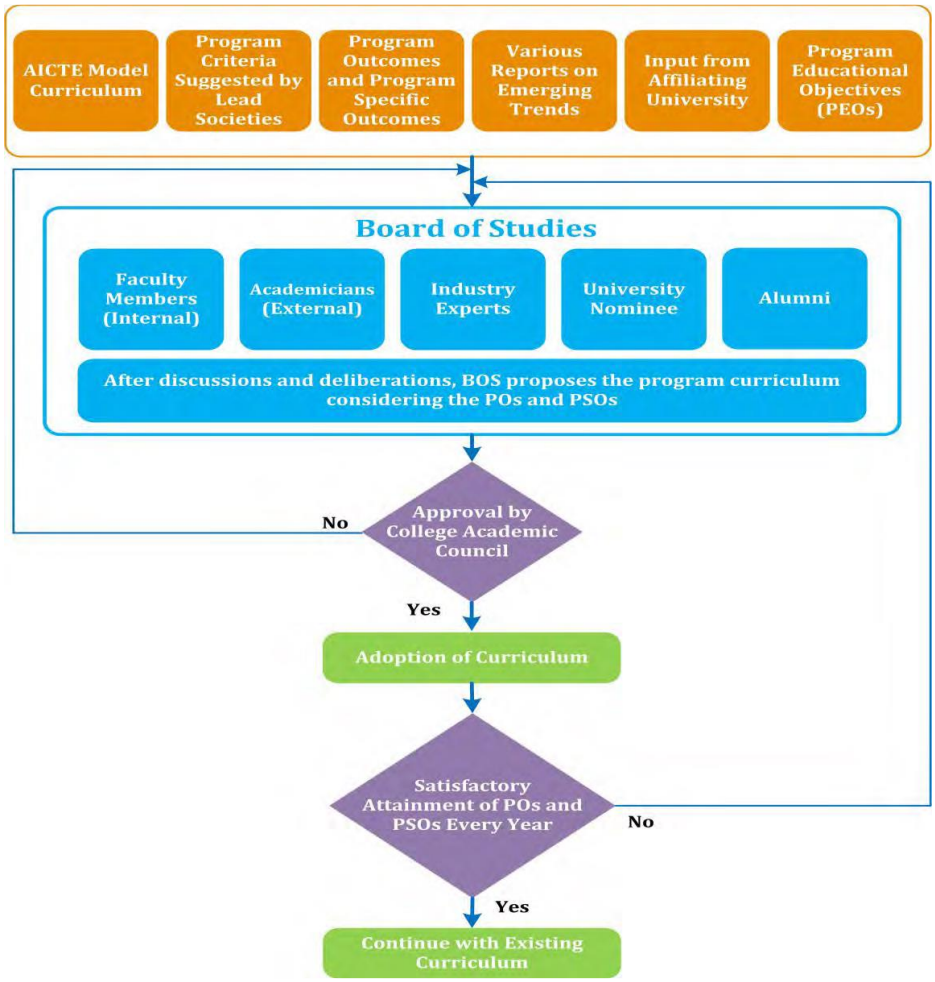


Fig 4.2. Process of designing the curriculum

4.1.2.3 Curriculum Implementation

A curriculum must be implemented if it is to make any desired impact on students and to attain its goals. And unless it is implemented, it cannot be evaluated for betterment. Inspite of careful planning and design, it is possible that a curriculum fails to meet the needs for which it is developed. It means putting into practice the written curriculum that has been designed in syllabi, course of study, curricular guides and subjects

It is a process wherein the learners acquire the planned or intended knowledge, skills, attitudes that are aimed at enabling the same learners to function effectively in the society.

4.1.2.4 Curriculum Evaluation

The College has been practicing Outcome-based Education (OBE) since 2014 onwards. OBE is a student centric teaching and learning methodology in which the course delivery, assessment is planned to achieve stated objectives and outcomes. The course outcomes (COs) form building blocks of OBE. The CO-PO mapping are being carried out to find the impact on

curriculum, based on which a gap analysis made and suitable actions have been taken to improve the curriculum requirements. The curriculum is best evaluated by the attainment computation of COs and POs.

4.1.3 Co-Curricular and Extra-Curricular Activities

The college believes in wholesome grooming of its students and ensures that students acquire all the graduate attributes before leaving its portals. Wholesome education is nothing but the Holistic education which not only make the graduating students competent but also develop passion towards engineering and compassion towards humanity in general and fellow peers in particular. Ample time and space is provided to balance the curricular (academic), co-curricular, extra-curricular and extension activities for the allround development of its students. Accordingly, efforts are made to ensure that the student is prepared to meet the requirement of the industry by offering special trainings through centres of excellence available in the respective departments. Every department has vertical domains to train the students in their chosen field of domain and offer add-on courses and certifications. Apart from this, the students are encouraged to visit industries, local areas and filed visits and pursue internships and training at the industry. This imparts all the skills required by the industry thereby the students become industry ready by the time they graduate from the portals of the institution. Special training, workshops and extension lectures are also organized through the department technical associations or the professional society chapters like IEEE, ISTE, IETE, ACM, CSI and etc.

4.1.4 Guidelines for Writing Course Outcomes

Course outcomes are the measurable parameters which evaluates each students' performance for each course that the student undertakes in every semester. COs are the statements of knowledge/ skills/ abilities that students are expected to know, understand and perform as a result from their learning experiences in each course.

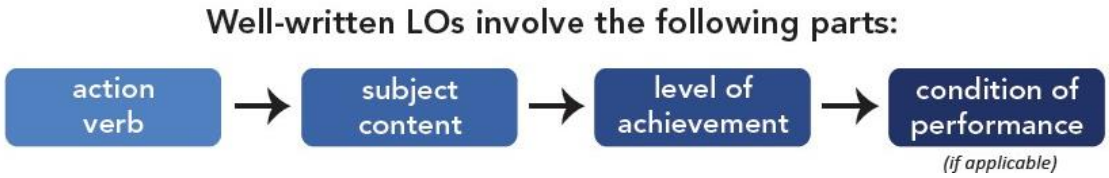
A well written CO facilitates lecturers in measuring the achievement of the CO at the end of the course. It also helps the lecturers in designing suitable delivery and assessment methods to achieve the designed CO.

Procedure to write Course Outcomes:

Well-written Course Outcomes involve the following parts:

- Action verb
- Subject content

- Level of achievement
- Condition of performance (if applicable)



The following involved in writing Course Learning Outcomes for a given course

Step 1

Select an action verb using Bloom's Taxonomy:

Make sure that you select a verb that you can observe and measure. There are many verbs that, can't be directly observed and therefore are difficult to assess in the classroom.

Step 2

Next, select the subject content students are performing that task for. For example, in CO1 , "areas of consensus and disagreement among publications on global warming" is the subject content: this is what the students are listing. Similarly, in the CO "Develop a business plan for a small business", the subject content is "a business plan".

Step 3

Next, decide if your CO requires either a level of achievement or a condition of performance.

Levels of Achievement

A level of achievement identifies how proficient students need to be in a task. For example, you might say "Write a literature critique with no grammatical errors". This tells students the level of achievement that's expected of them.

Importantly, you don't need a level of achievement for every CO. You don't need to say "effectively", "accurately", or "correctly" on a CO, for example: these are all implied. We expect students to achieve all outcomes in all courses correctly and accurately. Levels of achievement are for specific cases.

Conditions of Performance

A condition of performance identifies if students are only performing this outcome in a specific context. For example, in a Welding course with a field placement, you might say "Demonstrate speed control test on DC series motor with supervision". This tells students that they will be performing this task, but that they will be supervised while they do so.

Again, you don't need a condition of performance for every CO. Only include a condition of performance if that information clarifies the specific outcome students will achieve in the course.

Illustration:

Students are able to

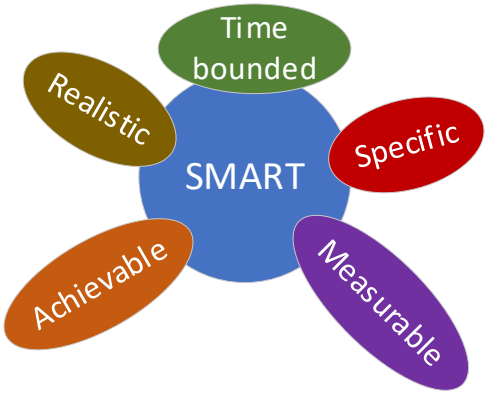
1) Design column splices and bases. → Action verb (underlined)

2) Determine the losses in a flow system. → Subject content

3) Use structural analysis software to a competent Level. → level of achievement

4) Demonstrate speed control test on DC series motor with supervision. Modes of performing task with action verb (underlined)

COs should be SMART. Use the following chart to see if your outcomes follow SMART principles:



Specific	Is there a description of a precise behaviour and the situation it will be performed in? Is it concrete, detailed, focused and defined?
Measurable	Can the performance of the outcome be observed and measured?
Achievable	With a reasonable amount of effort and application can the outcome be achieved? Are you attempting too much?
Relevant	Is the objective important or worthwhile to the learner or stakeholder? Is it possible to achieve this objective?
Time-bound	Is there a time limit, rate number, percentage or frequency clearly stated? When will this outcome be accomplished?

COs should have only one verb, and only one area of significant subject content. If your CO includes multiple verbs, select the one that articulates the highest level of learning students will demonstrate in the course. If your CO includes multiple topics, select the one that articulates the key outcome.

Note: If Laboratory is given as separate course (with course code) then there should be separate course outcomes for Laboratory.

4.1.4.1. Process to maintain Quality of the Course Outcomes

- After the course allotment from the department, identify the expected learning outcomes from the course i.e. what knowledge or skills from this course will students will acquire to perform well in the future. Make a list of learning outcomes first
- Look over the list and check the most important learning outcomes.
- Identify 4 to 6 most important learning outcomes from the course using the action verbs of learning levels
- It should be related to the skills, knowledge, and behaviour that students will acquire through the course.
- Check how clear and how important are the statements of outcomes for the students?
- Check each of the most important outcomes identified against the list of program outcomes stated the by NBA
- How many are on the list of key competencies of program outcomes?
- Existing COs are to be revised upon feedback from stakeholders or during the cycle of Curriculum Review

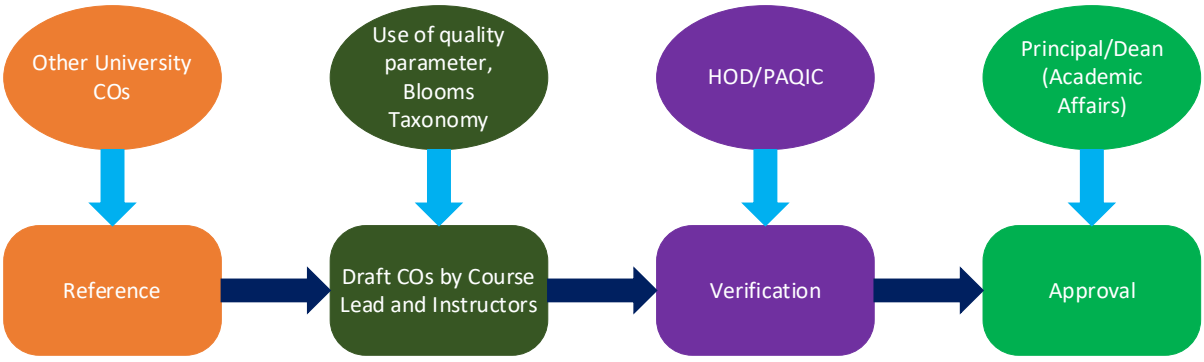


Fig 4.3. Process to maintain Quality of Course Outcomes

Observations:

- For the theory courses, while writing the COs, restrict between Blooms Level 1 to Level 4.
- For the laboratory courses, while composing COs, restrict between Blooms Level 1 to Level 5.
- For mini-project and major projects, extend up to Blooms Level 6 while composing COs

4.1.5 Performance Indicators

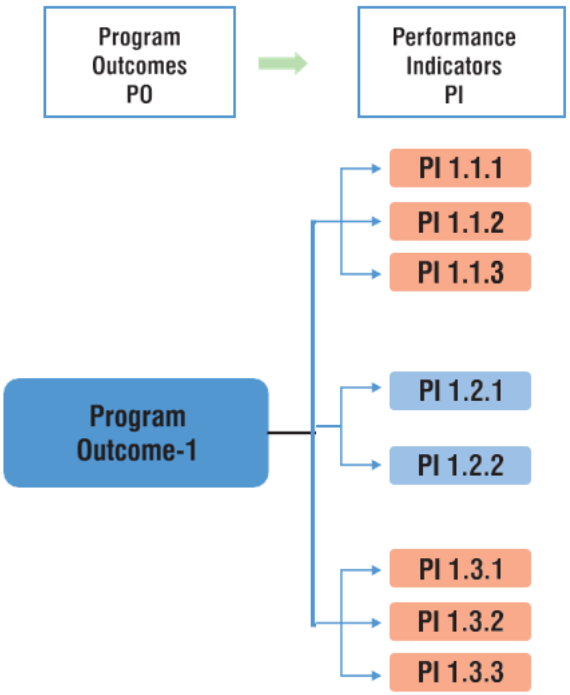


Fig. 4.4: Connecting POs to Performance Indicators

Program Outcomes – Performance Indicators

Following table gives the suggestive list of competencies and associated performance indicators foreach of the PO in Civil Engineering Program.

POs	PIs
PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.	PO1.1 Apply mathematical techniques to solve problems
	PO1.2 Apply laws of natural science to an engineering problem
	PO1.3 Apply fundamental engineering concepts to solve engineering problems
	PO1.4 Apply Civil engineering concepts to solve engineering problems
PO 2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated	PO2.1 Identify the mathematical, engineering systems, variables, parameters and other relevant knowledge that to solve the problems

POs	PIs
conclusions using first principles of mathematics, natural sciences, and engineering sciences.	PO2.2 Reframe complex problems into interconnected sub-problems and identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
	PO2.3 Combine scientific principles and engineering concepts to formulate models of a system or process that is appropriate in terms of applicability and required accuracy
	PO2.4 Apply engineering mathematics and computations to produce and validate results through skillful use of contemporary engineering tools and models
	PO2.5 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
PO 3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.	PO3.1 Define a complex/open-ended problem in engineering terms
	PO3.2 Determine design objectives, functional requirements and arrive at specifications
	PO3.3 Apply formal idea generation tools to develop multiple engineering design solutions
	PO3.4 Build models/prototypes to develop a diverse set of design solutions and Identify suitable criteria for the evaluation of alternate design solutions
	PO3.5 Consult with domain experts and stakeholders to select candidate engineering design solution for further development and refine a conceptual design into a detailed design within the existing constraints (of the resources)

POs	PIs
PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	PO4.1 Define a problem, its scope and importance for purposes of investigation and examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation
	PO4.2 Apply appropriate instrumentation and/or software tools to make measurements of physical quantities and establish a relationship between measured data and underlying physical principles
	PO4.3 Design and develop an experimental approach, specify appropriate equipment and procedures
	PO4.4 Use appropriate procedures, tools and techniques to conduct experiments and collect data and analyze data for trends and correlations, stating possible errors and limitations
	PO4.5 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
	PO4.6 Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including	PO5.1 Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources for engineering activities
	PO5.2 Create/adapt/modify/extend tools and techniques to solve engineering problems
	PO5.3 Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs and demonstrate proficiency in using discipline-specific tools

POs	PIs
prediction and modelling to complex engineering activities with an understanding of the limitations.	PO5.4 Discuss limitations and validate tools, techniques and resources and verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
PO 6: The 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 the professional engineering practice.	PO6.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
	PO6.2 Interpret legislation, regulations, codes, and standards relevant to Civil engineering and explain its contribution to the protection of the public
PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.	PO7.1 Identify risks/impacts in the life-cycle of an engineering product or activity
	PO7.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
	PO7.3 Describe management techniques for sustainable development and apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	PO8.1 Identify situations of unethical professional conduct and propose ethical alternatives
	PO8.2 Identify tenets of professional code of ethics as per ECI, ICE (India)
	PO8.3 Examine and apply moral & ethical principles to known case studies
PO 9: Individual and team work: Function effectively as an individual, and as a member or	PO9.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team

POs	PIs
leader in diverse teams, and in multidisciplinary settings.	PO9.2 Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal
	PO9.3 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
	PO9.4 Present results as a team, with smooth integration of contributions from all individual efforts
PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the 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	PO10.1 Read, understand and interpret technical and non-technical information
	PO10.2 Produce clear, well-constructed, and well-supported written engineering documents and create flow in a document or presentation with a logical progression of ideas so that the main point is clear
	PO10.3 Listen to and comprehend information, instructions, and viewpoints of others and deliver effective oral presentations to technical and non-technical audiences
	PO10.4 Create engineering-standard figures, reports and drawings to complement writing and presentations
	PO10.5 Use a variety of media effectively to convey a message in a document or a presentation
PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	PO11.1 Describe various economic and financial costs/benefits of an engineering activity and analyze different forms of financial statements to evaluate the financial status of an engineering project
	PO11.2 Analyze and select the most appropriate proposal based on economic and financial considerations

POs	PIs
	PO11.3 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks
	PO11.4 Use project management tools to schedule an engineering project, so it is completed on time and on budget
PO 12: Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO12.1 Describe the rationale for the requirement for continuing professional development
	PO12.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
	PO12.3 Identify historic points of technological advance in Civil engineering that required practitioners to seek education in order to stay current and recognize the need to keep current regarding new developments in Civil engineering
	PO12.4 Source and comprehend technical literature and other credible sources of information
	PO12.5 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

4.1.6 CO-PO/PSO Mapping

A Course Articulation Matrix (CAM) or CO-PO Mapping matrix correlates a course's individual COs with POs and PSOs. The strength of the correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation. CO-PO mapping is the development of a relationship between course outcome and program outcome for each class session/lab session/tutorial session and performing the assessment. Program outcomes are statements conveying the intent of a program of study. Specifically, program outcomes refer to what a student should know or be able to do at the end of a program, where as Course outcomes are specific and measurable statements that define the knowledge, skills, and attitudes that learners will demonstrate by the completion of a course.

This articulation matrix is initially designed by course instructor and later approved by DAC. The procedure to obtain this matrix is explained below.

Step1: Define Performance Indicators:

Program Outcomes(POs) give useful guidance at the program level for the curriculum design, delivery and assessment of student learning. However, they represent fairly high-level generic goals that are not directly measurable. Real observability and measurability of the POs at course level is very difficult. To connect POs with course content, course outcomes and assessment, there is a necessity to bring further clarity and specificity to the program outcomes. Hence for each PO, Performance Indicators (PI) need to be defined and Performance Indicators (PIs) that are explicit statements of expectations of the student learning. The list of PIs for each PO of the program given below.

PO#	PO Statement	Performance Indicators(PI)
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.	PO1.1 Apply mathematical techniques to solve problems PO1.2 Apply laws of natural science to an engineering problem PO1.3 Apply fundamental engineering concepts to solve engineering problems PO1.4 Apply Civil Engineering concepts to solve engineering problems

Step 2: Define Key elements of Course Outcomes:

For better understanding of Course Outcomes(COs) and to connect with PIs, Key element for COs can be defined as shown below:

CO1: Evaluate properties of concrete manufacturing materials to check their quality.

CO Key Elements
CO1.1: To examine physical and mechanical properties of cement
CO1.2: To evaluate the mechanical properties of Aggregates (Fine and Coarse Aggregate)

Step 3: Map Key elements of COs to PIs of POs:

In this step Key elements of COs are mapped with PIs of POs. A pictorial diagram can be drawn as shown below and mapping strength can be expressed using co-relation weight (Wxy). The

correlation weight varies between 0 and 1. An example of Co-relation weight on connection between CO Key Elements and PO1 Performance Indicators(PI) is given below and Fig 1.

CO Key Elements	PO1 PI	Co-relation Weight
CO1.1	PO1.1	W_{11}=0
	PO1.2	W_{12}=0
	PO1.3	W_{13}=0.4
	PO1.4	W_{14}=0
CO1.2	PO1.1	W_{21}=0.6
	PO1.2	W_{22}=0
	PO1.3	W_{23}=0
	PO1.4	W_{24}=0
CO1.3	PO1.1	W_{31}=0
	PO1.2	W_{32}=0.8
	PO1.3	W_{33}=0
	PO1.4	W_{34}=0.5

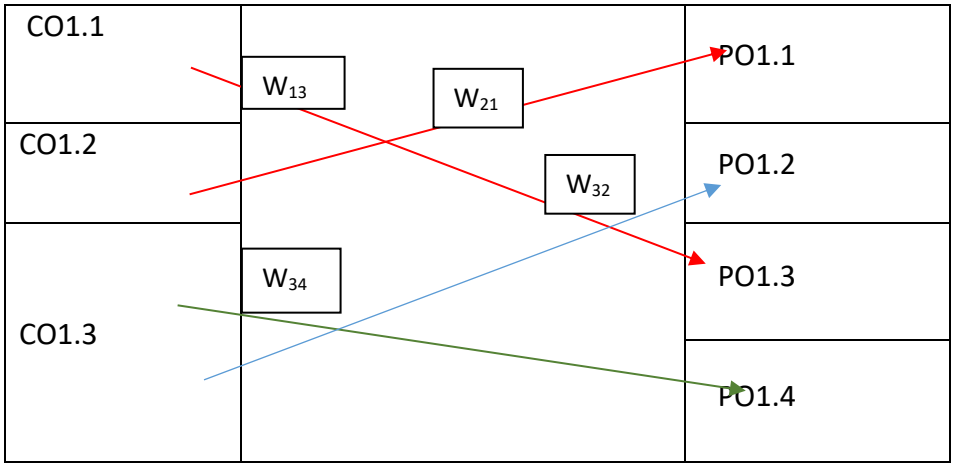


Fig. 4.5. CO-PO/PSO Mapping

Step 4: Calculate Co-Relation Level and mapping Level:

Once Co-relation weight are obtained, we can calculate Co-relation Level(CL) using following formula. The CL is the weighted average of all Key elements of CO.

$$Co-relation\ Level, CL = \frac{1}{m*n}\sum_{1,1}^{m,n} W_{xy}$$

$$m = No\ of\ CO\ key\ elements;\ n = No\ of\ PO\ Perfromance\ Indicators$$

Based on the above calculations for CO key elements and Performance Indicators (PIs), the CO relation level is obtained as 0.35.

Step 5: Calculate CO-PO mapping Level:

Finally, CO-PO mapping level can be obtained using co-relation level(CL). Using following formula. The CL is the weighted average of all Key elements of CO. The mapping level is defined based on the range of CL value as shown below. The procedure can be repeated for all COs and POs and Course Articulation Matrix can be obtained.

CL Range	**CO-PO Mapping Level**
0.1<CL	0
0.3<CL>0.1	1
0.6<CL>=0.3	2
CL>=0.6	3

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO12	PSO1	PSO2
CO1	2												
CO2													
CO3													
CO4													
CO5													

Based on above calculations CO1 is mapped to PO1 at Level 2.

4.2. Outcome Based Content Delivery

4.2.1 Introduction

In outcomes-based education (OBE), the design of the curriculum, syllabus, teaching and learning strategies, and assessment should be “constructively aligned” with the student performance, which are called “outcomes.” To effectively ensure that the course learning outcomes are achieved, the students must be engaged in the learning process. The

engineering instructor must not simply resort to blackboard teaching but must employ innovative teaching and learning activities that will stimulate the minds of the students and help them create and integrate knowledge about the course content and intended learning outcomes.

4.2.2 Academic Calendar and Teaching Plan

The institution prepares Academic Calendar with a lot of planning and involving all the heads of the departments are put forth to the Academic Committee. The academic committee comprising of Principal and Dean (Academics) finalizes the academic calendar by approving it. This is done in the beginning of the academic year so that course instructors can plan their content delivery and assessment accordingly. The calendar is also displayed on the college website www.vardhaman.org, notice boards of all the departments and is made available to the students and faculty before the commencement of the academic year/class work. The institution has an academic calendar for different programs like B.Tech, M.B.A and M.Tech which are available on our college website.

Vardhaman follows unique methods of teaching and learning practices which are learner centric and innovative in nature. Every faculty prepares Academic /Lesson (teaching) plan before the commencement of class work for every semester. The teaching plan is prepared in the form of “Course-Pack” and is made available to all the students well before the commencement of the classwork every semester. The contents of the Course-Pack is as follows:

1. Details of Course Type, L-T-P-C, Course Lead and Course Instructors
2. Course Overview and Course Prerequisites
3. Course Objective and Course Outcomes (COs)
4. Course Articulation Matrix and Mapping COs with Blooms Levels
5. Course Content, both theory and practice
6. Lecture Plan
7. Learning Resources (Text Books, Reference Books, Other Resources like MOOCs, Journals, Magazines and other important links or websites related to the course and etc.)
8. Delivery Methodologies
9. Assessment Methods
10. Self-Learning
11. Problem Based Learning

12. Project Based Learning

The copies are prepared by the course lead in consultation with the course instructors and is available in the form of course file in the respective department. The academic plan is following by each and every faculty and the action taken report of the compliance are recorded by the course lead. Later, Dean, IQAC and heads of the departments assess the performance of the faculty for the future course of action.

4.2.3 Student Centric Methods:

The institute adopts many student centric methods to enable the learner meet their learning goals, academic success with required competencies. Methods such as experiential learning, participative learning and problem solving are used at various stages and levels to enhance learning opportunities to the students. We at Vardhaman strongly believe that experiential learning bridges promote competencies of the students by enhancing their knowledge through application. Experiential Learning Methodologies followed in the Institution are learning by doing nano projects, micro projects, mini projects, internships/industry oriented mini projects and finally the major or capstone project. This enhances their ability to solve complex engineering problems during their program of study.

4.2.3.1 Active Learning

Active learning is a student centered approach in which the responsibility for learning is placed upon the student, often working in collaboration with classmates. In active learning teachers are facilitators rather than one way providers of information. Active learning approaches place a greater degree of responsibility on the learner than passive approaches such as lectures, but instructor guidance is still crucial in the active learning classroom. Active learning activities may range in length from a couple of minutes to whole class session or may take place over multiple class sessions.

Active learning activities help promote higher order thinking skills such as knowledge, analysis and synthesis.

Active learning engages students in deep rather than surface learning, and enable students to apply and transfer knowledge better.

Examples of Active Learning Techniques

- Think Pair Share: students ponder the answer to a question and then share their thoughts with a neighbour.

- Role Playing: "each student takes the role of a person affected by an Earth science issue, such as a volcano or a polluted lake and studies the impacts of Earth science issues on human life and/or the effects of human activities on the world around us from the perspective of that person."
- Jigsaw: In a jigsaw, the class is divided into several teams, with each team preparing separate but related assignments. When all team members are prepared, the class is re-divided into mixed groups, with one member from each team in each group. Each person in the group teaches the rest of the group what he/she knows, and the group then tackles an assignment together that pulls all of the pieces together to form the full picture, hence the name *jigsaw*.
- TAPPS: In Think Aloud Pair Problem Solving, students pair up with one in the role of problem solver and the other as listener. For each new problem, students switch roles.
- Peer Review: students review and comment on materials written by their classmates.
- Discussion: promoting a successful discussion depends on correctly framing questions. Discover tips for framing discussion questions to promote higher order thinking.
- Problem solving using real data: students use a variety of data to explore scientific questions.
- Just in Time Teaching: students read assigned material outside of class, respond to short questions online, then participate in collaborative exercises the following class period.
- Game Based Learning: uses competitive exercises, either pitting the students against each other or through computer simulations.

4.2.3.2 Practice Based Learning

As opposed to 'theory based learning,' practice-based learning requires the learner to learn and apply theory in an actual work environment, from the very beginning. The curriculum is made more practice based to impart practical skills to the students by introducing Integrated courses which combine theory and practical together and 'learning by doing' is the primary focus of these courses.

The ability of the students is assessed at the end of the semester once all the practice sessions are completed.

4.2.3.3 Problem Based Learning

Problem Based Learning is a student-centered pedagogy in which students learn about the subject through the experience of solving an open-ended problem. This problem is what drives the motivation and the learning. Through Project Based Learning, students not only strengthen their teamwork, communication, and research skills, but they also sharpen their critical thinking and problem-solving abilities essential for life-long learning.

Fig. Process of Problem Based Learning

A well-designed Problem Based Learning project provides students with the opportunity to develop skills related to:

- Working in teams.
- Managing projects and holding leadership roles.
- Oral and written communication.
- Self-awareness and evaluation of group processes.
- Working independently.
- Critical thinking and analysis.
- Explaining concepts.
- Self-directed learning.
- Applying course content to real-world examples.
- Researching and information literacy.
- Problem solving across disciplines.

Benefits of Problem Based Learning

- Become engaged with open-ended situations that assimilate the world of work
- Participate in groups to point out what is known/ not known and the methods of finding information to help solve the given problem
- Investigate a problem, through critical thinking and problem solving, brainstorm a list of unique solutions

- Analyze the situation to see if the real problem is framed or if there are other problems that need to be solved.

Implementation of Problem Based Learning

Rather than teaching relevant material and subsequently having students apply the knowledge to solve problems, the problem is presented first. PBL assignments can be short, or they can be more involved and take a whole semester.

Students generally must:

- Examine and define the problem
- Explore what they already know about underlying issues related to it
- Determine what they need to learn and where they can acquire the information and tools necessary to solve the problem
- Evaluate possible ways to solve the problem
- Solve the problem
- Report on their findings

4.2.3.4 Project Based Learning

Project-based learning is a student-centered pedagogy that involves a dynamic classroom approach in which students actively explore real-world problems and challenges and acquire a deeper knowledge. It is a style of active learning and inquiry-based learning.

In Project Based Learning, teachers make learning come alive for students. Students work on a project over an extended period of time – from a week up to a semester – that engages them in solving a real-world problem or answering a complex question. They demonstrate their knowledge and skills by creating a public product or presentation for a real audience.

As a result, students develop deep content knowledge as well as critical thinking, collaboration, creativity, and communication skills. Project Based Learning unleashes a contagious, creative energy among students and teachers.

The core idea of project-based learning is that real-world problems capture students' interest and provoke serious thinking as the students acquire and apply new knowledge in a problem-solving context.

The teacher plays the role of facilitator, working with students to frame worthwhile questions, structuring meaningful tasks, coaching both knowledge development and social skills, and carefully assessing what students have learned from the experience.

Typical projects present a problem to solve (What is the best way to reduce the pollution in the schoolyard pond?) or a phenomenon to investigate (What causes rain?).

Benefits of Project-Based Learning

- Increased attendance, growth in self-reliance, and improved attitudes towards learning
- Academic gains equal to better than those generated by other models, with students involved in projects taking greater responsibility for their own learning than during more traditional classroom activities
- Opportunities to develop complex skills, such as higher-order thinking, problem-solving, collaborating, and communicating
- Access to a broader range of learning opportunities in the classroom, providing a strategy for engaging cultural diverse learners

Assessing Students through Project-Based Learning:

Students are assessed in two ways:

1. **Individual assessments for each student** – may include research notes, teaching prep notes and teacher observation. Other assessments may include those assigned by the teacher, for example, each student in the class must write an individual research paper for a topic of their choice from within the theme of the overall PBL.

Group assessments – each Jigsaw group creates and presents their product, preferably to an audience other than the teacher or their class.

4.2.4 Strategies for Slow Learners and Fast Learners

Within the classrooms faculty have to deal with different types of students; some are very intelligent who learn very fast and some are quite weak who learn very slowly. Therefore, it is required to determine the abilities of the students in the class. Based on the ability determined, some students need only guidance and some students need a hard work and regular attention.

Generally, on the basis of their learning speed students can be classified in two groups; advanced learners and slow learners. Each type of students has different learning attitudes and learning habits. A faculty has to adapt a teaching methodology such that he/she may not lose the attention of the slow learners and bore the advanced learners.

The advanced learners

The student who learn fast are called advanced learners. Obviously their learning speed is more than the peers.

The slow learners

Slow learners are the students who have slow speed then other students. They need patience and a regular monitoring

Policy for Identification

a. Identification of learning abilities will be done through comprehensive evaluation to be taken by course teacher after completion of Module-I along with his/her participation in classes.
b. Slow learner and advanced learners would be identified for **each course** separately by teacher.
c. Every course teacher should conduct class test/ diagnostic test (Objective/Descriptive) after completion of Module-I to identify slow learners and advanced learners.
d. Categorize the list of slow learners and fast learners based on threshold (50% of maximum marks).
e. In class test/ diagnostic test, all the student who fall into category of slow learners shall be identified for remedial measures.
f. Remedial classes to be arranged for specific course for slow learners. The classes shall be continued till CAT-I.
g. All sports, ECA/CCA and library hours shall be converted into remedial classes.
h. If any slow learner continues to perform low in CAT-I after remedial classes, then case should be considered for personal coaching/ mentoring or counselling by mentor and HOD.
i. The remedial classes for slow learners identified after CAT-I shall continue till CAT-II.
j. The analysis of slow learner shall be maintained in course file and to be renewed by concerned HOD regular basis.
k. Progression Checks of improvements in Slow learners and Template for tracing the improvement in performance of students is attached in **Annexure-I.**
    i. Class Test/Diagnostic Test on Module-I
    ii. CAT-I
    iii. Class Test/Diagnostic Test on Module-III, IV.

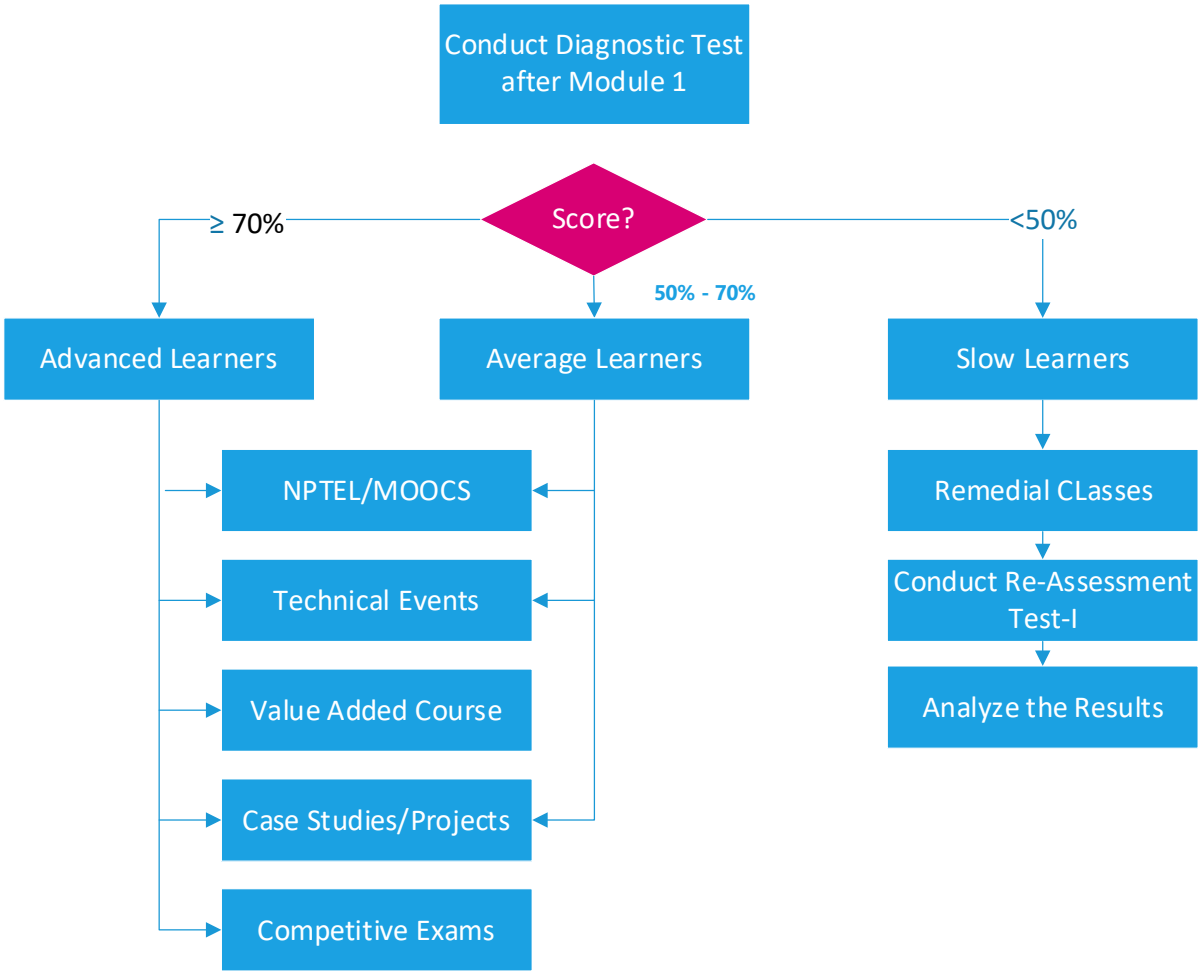
Note: Slow and advanced learners are also identified based on following parameters and their weightage.

S. No	Parameter	Weightage
1.	Past Performance of students [CGPA)	25%
2.	Course Instructor observation/ Class Participation	25%
3.	Marks obtained by student in class test/ diagnostic test (Objective/Descriptive) conducted for respective course	50%

Rubrics for Identification of Slow Learners and Advanced Learners

S. No	Threshold	Identification
1.	Score ≤ 50%	Slow Learners
2.	50 < Score < 70%	Average Learner
3.	Score ≥ 70%	Advanced Learners

Process of Identification:



4.3. Outcome Based Assessment

4.3.1 Introduction

Assessment is the process of gathering information about how well a student is achieving specific outcomes. It is a systematic and on-going process of collecting, interpreting, and acting on information relating to the goals and outcomes developed to support the department and institution's mission and vision. The assessment process is depicted in the figure below.

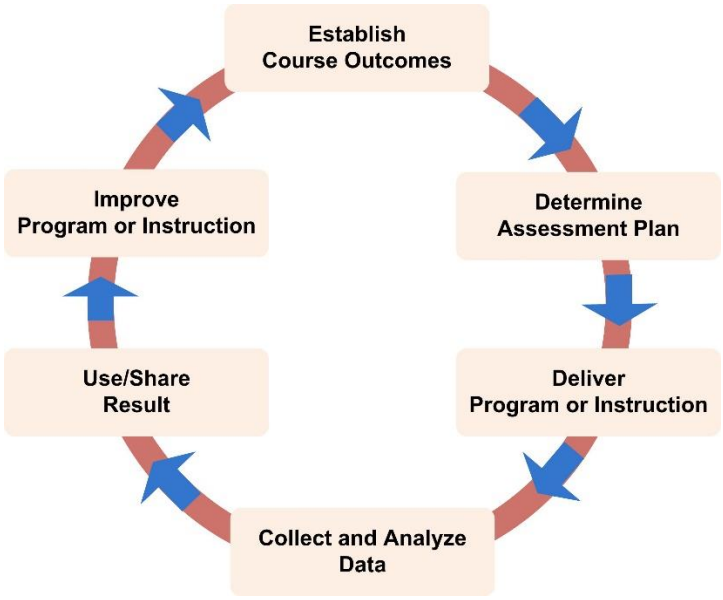


Fig.: Assessment Process

The learning levels as per Blooms Taxonomy are assessed through various assessment tools as mentioned below.

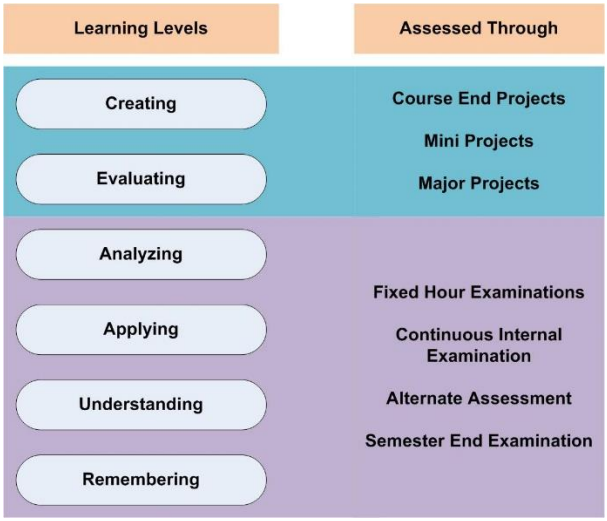


Fig. Assessment of Learning Levels

4.3.2. Assessment Tools, Methods and Weightages

4.3.2.1 Assessment Tools

Continuous Internal Examination

Continuous Internal Examination is a Formative assessment. It is a continuous process, which is a constant companion of the instruction process. This assessment is taken by the students at varying intervals throughout the course. Formative assessment is a process of evidence gathering about the students' learning progress and performance through Cumulative Internal Examination (CIE) by various assessment tools and bringing this knowledge back to the students, through feedback. Here feedback is an information provided by the teacher regarding aspects of students' performance and/or understanding of course contents. Teachers use the feedback, to assess the students' learning progress and can make specific adjustments of teaching activities and to make decisions with respect to readiness and remediation of students' learning. Formative assessment has the scope of guiding the instructions in such a way to meet the students learning needs and to make them regulators of their own learning. The following are various assessment tools to assess the students' learning progress and performance.

Type of Course	CAT1	CAT2	AAT	Practice
Integrated Course	✓	✓	✓	✓
Theory Course	✓	✓	✓	
Practical Course				✓

Type of Course	Review1	Review2	Viva-Voce
Internship	✓	✓	✓
Mini-Project	✓	✓	✓
Project Work	✓	✓	✓

CAT: Continuous Assessment Test. Two CAT tests shall be conducted one in the middle of the semester and the other at the end of the semester as a part of Continuous Internal Examination (CIE)

AAT: Alternate Assessment Tool. It is assessed by the respective course instructor by defining the assessment methods well before the commencement of the course. This is also the part of Continuous Internal Examination.

Continuous Internal Examination (CIE) is a formative assessment is conducted during the instructions. The components of CIE and weightages are listed below.

Continuous Internal Examination (CIE)				
S.No.	**Assessment Tool**	**Integrated course**	**Theory Course**	**Practical Course**
1.	Continuous Assessment (CAT)	40%	80%	
2.	Alternate Assessment (AAT)	20%	20%	20%
3.	Practice Test (PT)	40%		80%
	Total	**100%**	**100%**	**100%**

Semester End Examination

Semester End Examination is a Summative Assessment. Summative assessment is used to evaluate student learning, skill acquisition, and academic achievement at the conclusion of a defined instructional period. This assessment is taken by students at the end of the semester to demonstrate the "sum" of what they have or have not learned. Summative assessment is a process of evidence gathering about the students' learning progress and performance through Semester End Examination (SEE).

Semester End Examination (SEE) is a summative assessment conducted at the end of the semester and is assessed for 100% weightage for all types of courses (integrated, theory and practical), seminar, min-project and project work.

Table: Course Assessment Tools

Courses	Assessment Methods	Assessment Tools
Integrated Courses	Formative Assessment	Continuous Assessment, CAT-1
		Continuous Assessment, CAT-2
		Alternate Assessment, AAT
		Practice
	Summative Assessment	Semester End Exam, SEE
Theory Courses	Formative Assessment	Continuous Assessment, CAT-1
		Continuous Assessment, CAT-2
		Alternate Assessment, AAT
	Summative Assessment	Semester End Exam, SEE
Practical Courses	Formative Assessment	Day-to-Day Evaluation, DDE
		Lab Internal Exam, LIE
	Summative Assessment	Semester End Exam, SEE

CAT – Continuous Assessment, AAT – Alternate Assessment, SEE – Semester End Examination, DDE – Day to Day Evaluation, LIE – Laboratory Internal Evaluation

4.3.2.2 Assessment Methods

Course Outcomes of all courses of the program are measured by using two assessment methods:

1. Direct Assessment
2. Indirect Assessment

Direct Assessment

For Course Outcomes (COs), Direct Assessment includes Cumulative Internal Examination (CIE) and Semester End Examination (SEE). CIE is measured based on formative assessment whereas SEE is measured based on summative assessment. Weightage on each examination shown below.

Direct Assessment		
1.	Continuous Internal Examination (CIE)	50%
2.	Semester End Examination (SEE)	50%

For Program Outcomes (POs), total POs and PSOs are classified as, technical POs and non-technical POs. The first five POs and two formulated PSOs are called technical POs and remaining POs are called non-technical POs. The Integrated courses and theory courses cumulatively contribute for the PO attainment of a batch. These technical POs and PSOs attainment are calculated by adding the contribution level of Integrated and theory courses to each PO and PSO. The attainment level of non-technical POs is calculated using the various student activities along with Integrated and theory courses. The active student participation in co-curricular and extra- curricular activities within and outside the college contribute to the attainment of these POs.

Indirect Assessment

For Course Outcomes (COs), indirect assessment includes *Course End Survey (CES),* which is conducted on COs of each course at end of the course in on-line mode.

For Program Outcomes (POs), indirect assessment has three components, and they are:

1. Student Exit Survey (SES)
2. Co-Curricular Activities (CCA)
3. Extra-Curricular Activities (ECA)

Student Exit Survey (SES) is conducted on Program Outcomes (COs) and Program Specific Outcomes(PSOs) at the end of the program in on-line mode. Students exit survey is used in attainment calculation of both Technical and Non-Technical POs where as Co-Curricular

Activities and Extra-Curricular Activities are used only in attainment calculation of Non-Technical POs.

The weightages of direct and indirect assessments are listed below.

Course Assessment		
1.	Direct Assessment (DA)	90%
2.	Indirect Assessment (IDA)	10%

4.3.2.3 Assessment Weightages

<table>
<tr><td colspan="3">Direct Assessment (DA)</td><td colspan="2">In-Direct Assessment (IA)</td></tr>
<tr><td colspan="2">Assessment Tool</td><td>Weightage</td><td>Assessment Tool</td><td>Weightage</td></tr>
<tr><td rowspan="2">Continuous Internal Evaluation (CIE)</td><td>CAT-I</td><td rowspan="2">50%</td><td rowspan="3">Course End Survey - CES (Feedback on course outcomes collected from students)</td><td rowspan="3">100%</td></tr>
<tr><td>CAT-II</td></tr>
<tr><td colspan="2">Alternate Assessment</td></tr>
<tr><td colspan="2">Semester End Examination (SEE)</td><td>50%</td></tr>
<tr><td colspan="2">Total (CIE + SEE)</td><td>100%</td></tr>
<tr><td colspan="3">Weightage of Direct Assessment(DA) is 90%</td><td colspan="2">Weightage of In-Direct Assessment(IA) is 10%</td></tr>
<tr><td colspan="5">TOTAL = DA + IA = 100%</td></tr>
</table>

Chapter 5

Process of Attainment

5.1 Setting Performance Targets

Usually a target is defined as minimum desired or promised levels of performance you want to see from the students. It represents success at achieving the defined outcome.

Example of Setting Target:

65% of the students securing ≥60% of the marks

Setting a Target:

- It is not about guessing what you can achieve
- It involves knowing where you are now (CAY-1, CAY-2, CAY-3), what you are trying to achieve (CAY)
- Determining challenging but realistic amounts of improvement needed to get there

For courses offered from two or more years:

Method: Use Historical Data

- It can be helpful to use data that has already been gathered to establish a baseline, or starting point, for your target.
- Look at how the data for a particular period and see whether there has been an abrupt change in performance. If there has been, investigate the reasons for the change.
- If there were unusual circumstances during that period, the figure may not be a good reference point and you may want to consider using data from a different period to inform your target.
- Take average of three years if all are consistently increasing
- Take average of any two years excluding abrupt performance due to unusual circumstances

For new courses offered from current academic year:

Method: Use External Sources

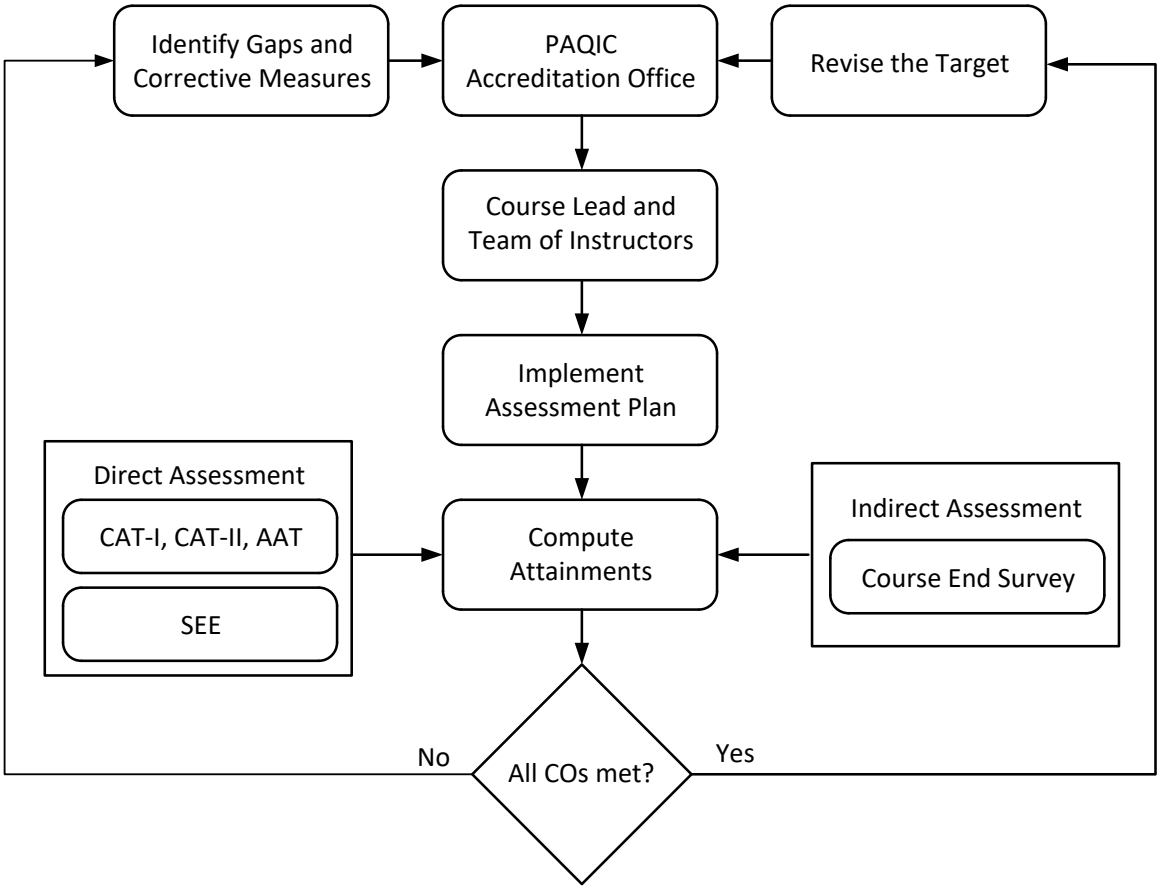
- When you do not have historical data, you might consider using information from outside data sources to benchmark or compare your performance data with those of other comparable universities / departments / programs. Then set targets that seem reasonable in light of the benchmarking information you've gathered.
- Program Assessment Committee
- BOS

Target of Course Outcomes: 65% of students should get 60% of marks

Attainment levels Vs Target Ranges	
Attainment Level	**Range of Target**
Level 1	65% - 70% of students scoring more than 60% of marks
Level 2	70% - 75% of students scoring more than 60% of marks
Level 3	75% - 100% of students scoring more than 60% of marks

5.2 CO Attainment

Process of CO Attainment:



1. Collect Question wise marks of CIE (CAT-I, CAT-II, AAT) and SEE
2. Segregate the marks of CAT-I CO wise and calculate the percentage of marks attained for a particular CO.

$$\%\,marks = \frac{obtained\,marks}{\max imum\,marks} \times 100$$

3. Likewise, calculate the CO wise percentage of marks of every individual student.
4. Calculate percentage of students those who are getting ≥ 60% of marks.

5. Repeat the process for CAT-II, AAT and SEE.
6. Calculate CO attainment through Direct Assessment by adding 50% of average of CO attainment in CAT-I, CAT-II, AAT and 50% of CO attainment in SEE.

Table 1 : Example of CO attainment through Direct Assessment

	CAT-I (100%)	CAT-II (100%)	AAT (100%)	Average of CIE (100%)	SEE (100%)	50 % on CIE	50 % on SEE	Total CO Attainment through DA (100%)
CO1	50.00		86.32	68.16	50.00	34.08	25.00	**59.08**
CO2	83.33		78.26	80.80	66.67	40.40	33.34	**73.73**
CO3		83.33	72.15	77.74	66.67	38.87	33.34	**72.21**
CO4		83.33	50.65	66.99	83.33	33.50	41.67	**75.16**
CO5		50.00	75.65	62.83	100.00	31.41	50.00	**81.41**

7. Collect Course End Survey
8. Calculate overall CO attainment by adding 10% of CO attainment in Course End Survey (Indirect Survey) and 90% of CO attainment through Direct Assessment

Table 2 : Example of overall attainment of COs

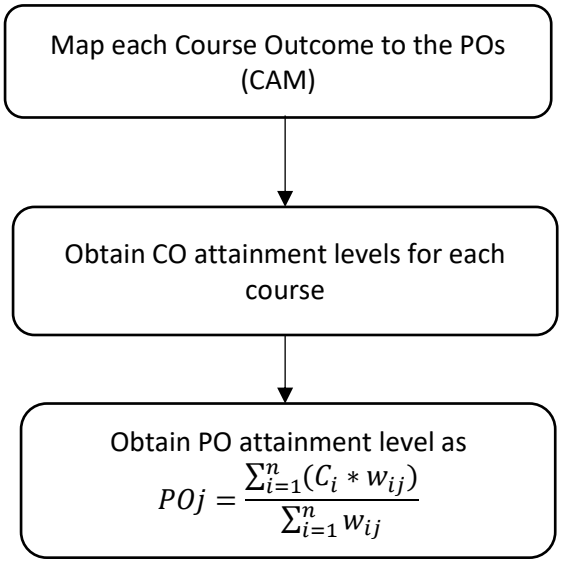
	CO Attainment through DA(100%)	90% of DA	CO Attainment through IDA (100%)	10% of IDA	Total CO Attainment %	Target %	Attainment (YES/NO)	Attainment Level
CO1	59.08	53.17	88.90	8.89	62.06	65	NO	0
CO2	73.73	66.36	77.80	7.78	74.14	65	YES	2
CO3	72.21	64.98	77.80	7.78	72.76	65	YES	2
CO4	75.16	67.64	72.20	7.22	74.86	65	YES	2
CO5	81.41	73.27	72.20	7.22	80.49	65	YES	3

9. Based on the total CO attainment %, assign Levels which are defined earlier.

10. If CO is attained, revise the target. If CO is not attained, write the action plan and implement next time.

5.3 PO/PSO Attainment

Process of PO Attainment:



$n = Number\ of\ Course\ Outcomes$

$C_i = Attainment\ of\ i^{th}\ Course\ Outcome$

$w_{ij} = Weight\ of\ i^{th} Course\ Outcome$
$(Mapping\ level\ 1,\ 2,\ 3)$

$POj = Attainment\ of\ j^{th}\ Program\ Outcome$

Where $j = 1\ to\ 5$

1. Take the Attainment Levels of COs and fill the cells as per the CO-PO mapping

Table 3 : Example of overall attainment of POs

PO	PO1			PO2			PO3			PO4			PO5		
CO	CO AT	Wt	PO AT	CO AT	Wt	PO AT	CO AT	Wt	PO AT	CO AT	Wt	PO AT	CO AT	Wt	PO AT
CO1	0.00	2	0.00				0.00	3	0.00						
CO2							3.00	3	0.64	3.00	2				
CO3	3.00	3	1.29				3.00	3	0.64	3.00	2	0.60			
CO4	3.00	2	0.86				3.00	3	0.64	3.00	3	0.90			
CO5							2.00	2	0.29	2.00	3	0.60			
Total PO AT %			**2.15**						**2.21**			**2.10**			

$$PO1 = \frac{CO_1 \times wt_{11} + CO_3 \times wt_{31} + CO_4 \times wt_{41}}{wt_{11} + wt_{31} + wt_{41}}$$

$$PO_1 = \frac{0 \times 2 + 3 \times 3 + 3 \times 2}{2 + 3 + 2} = 2.15$$

2. Similar way, calculate the attainment of all POs/PSOs

Chapter 6

Continuous Quality Improvement

Teaching and learning methodology and supporting facilities are then designed to achieve the intended outcomes. During the course of the programme, various measurement methods are used to gauge the level of the outcomes that have been attained by the students. Various countermeasures are then applied in order to further improve the attainment of the outcomes. This forms the basis of Continual Quality Improvement (CQI) in applying OBE.

The changes made in the curriculum are to reflect the needs of the stakeholders (students, alumni and employers) and industry demands for competent engineers. The implementation of the OBE approach at Vardhaman College of Engineering was started long back and is currently being practised by all the programs in the institution. The strategy in the implementation of OBE is adopted from P-D-C-A (Plan-Do-Check-Act) quality circle commonly used in the context of Quality Management System (QMS). As mentioned in previous chapters, the OBE approach starts with defining the outcomes that are required by the stakeholders. Three types of outcomes are defined, namely the Programme Educational Objective (PEO), Programme Outcomes (PO) and the Course Outcomes (CO). By definition, the PEO are the skills that the graduate should have after five years working in the industry, PO are desirable graduate attributes at the time of graduation while CO are the skills learnt by the students at the end of each course in the programme. The PEO, PO and CO are mapped to each other and thus the achievement of CO for all courses should contribute to the overall achievement of the PO and PEO. Formulation of PEO and PO are based on the attributes that are desirable and required by the stakeholders. The inputs come from various ways such as surveys from industry and other stakeholders. Having defined the outcomes, various methods are used as the delivery methods, for example by using non-traditional teaching methods such as the Cooperative Learning and the Problem-Based Learning (PBL). Next, the attainment of all outcomes (PEO, PO and CO) must be measured and utilised as a gauge for its effectiveness. The measurement methods vary from self-survey of the students, external survey, and formal assessments. Following the checking stage, the results are analyzed. Any shortcomings on the level of attainment for the outcomes can be addressed and further improvements can be devised in the re-planning stage. The P-D-C-A circle then continues until a sufficient level of attainment is met for all outcomes.

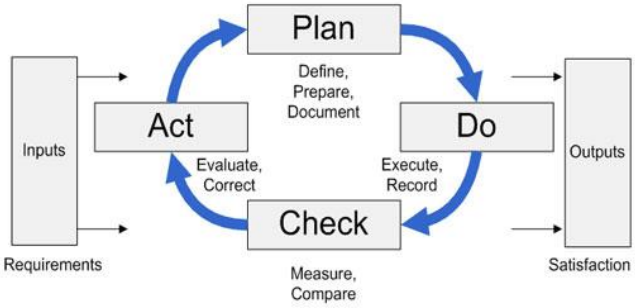


Fig. P-D-C-A Cycle

Plan:

- Designing Curriculum/Revising Curriculum
- Defining Learning Outcomes
- Preparing Teaching Plan
- Preparing Assessment Plan

Do:

- Implementing Curriculum
- Content Delivery
- Teaching and Learning Activities

Check:

- Curriculum Evaluation
- Assessment of Learning Outcomes (COs, POs and PSOs)

Act:

- Revising Curriculum
- Redefining learning outcomes
- Resetting target levels

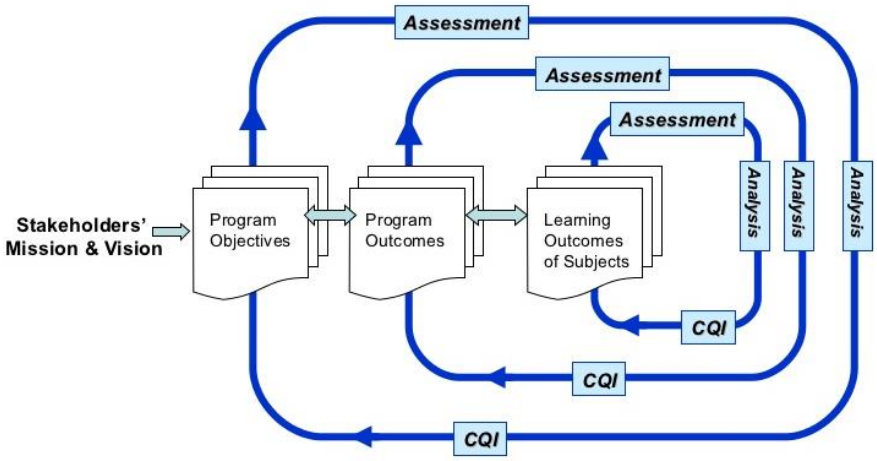


Fig. Continuous Quality Improvement

Vision:

- To be a pioneer institute and leader in engineering education to address societal needs through education and practice.

Mission:

- To adopt innovative student centric learning methods.
- To enhance professional and entrepreneurial skills through industry institute interaction.
- To train the students to meet dynamic needs of the society.
- To promote research and continuing education.

Quality Policy:

- We at Vardhaman College of Engineering, endeavor to uphold excellence in all spheres by adopting the best practices in effort and effect.

VARDHAMAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Affiliated to JNTUH, Approved by AICTE,
Accredited by NAAC with A++ Grade,
ISO 9001:2015 Certified