# Adhiyamaan College of Engineering (Autonomous), Hosur - 635 130.

(Approved by AICTE & Affiliated to Anna University, Chennai)

# Internal Quality Assurance Cell
# OBE Assessment Manual
# (Regulation 2022)

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# PREFACE

Outcome Based Education (OBE) Assessment Manual is to make the users aware of the OBE process which is being followed in Adhiyamaan College of Engineering (Autonomous), since 2015. All the stakeholders of the institute will be made aware of all the phases of OBE process, designed and implemented.

The present manuscript provides all corners of this OBE process i.e., design stage, training stage and implementation stage for the benefits of students and faculty of the institute. All the stakeholders of the institute i.e., students, parents, alumni etc. shall be made aware of the completed process and applications of OBE i.e., curriculum design and development, up gradation of teaching-learning process, design and implementation of assessment procedures.

The present first Version of this Assessment manual dealt with the Regulation 2022. OBE manual comprises of three sections in which the fundamentals of OBE framework, processes adopted and annexures.

# 1. Outcome Based Education (OBE) Framework

## 1.1 Terminology/ Definitions of OBE Components

Fundamental concepts and terminology of the Outcome Based Education are discussed as under:

**VISION**

- To foster ACE as a center for nurturing and developing world class Engineers and Managers who convert global challenges into opportunities through value-based quality education.

**MISSION**

1. To impart value-based quality education through effective teaching-learning processes.
2. To nurture creativity, excellence and critical thinking by applying global competency factors to contribute and excel in the rapidly growing technological world.
3. To continuously develop and improve holistic and innovative personality for global mobility.
4. To make ACE a centre for excellence.

**COURSE** is defined as a theory or a practical or a theory cum practical concepts studied in a semester.
Ex: Professional English-I

**PROGRAM** is defined as the specialization or discipline of a degree. It is the interconnected arrangement of courses, co-curricular and extracurricular activities etc. to accomplish predetermined objectives, thus leading to the awarding of a degree. For example: B.E., Mechanical Engineering.

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

The Program Educational Objectives of a program are the statements that describe the expected achievements of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after graduation.

*PEOs of the program seeking accreditation may from 3 to 5 PEOs.*

- The PEOs should be consistent with the mission of the institution.
- All the stakeholders should participate in the process of framing PEOs.
- Different surveys are to be conducted from stakeholders and to be analyzed for the formation of PEOs at department level.
- The number of PEO's should be manageable.
- The programme shall demonstrate how the PEOs are aligned with the mission of the department/ institution.
- The PEOs are reviewed periodically based on feedback of the programme' s various stakeholders
- The department PEOs will be formed by Department BoS &ratified draft will be forwarded to Academic Council and Governing Body for final approval.

## PROGRAM OUTCOMES(POs)

Program Outcomes (PO) are to be in line with the graduate attributes as specified in the Washington Accord. POs are to be specific, measurable and achievable. NBA has defined 12 POs and it is common for all the institutions in India.

## PROGRAM SPECIFIC OUTCOMES (PSOs)

Program Specific Outcomes are what the students should be able to do at the time of graduation with reference to a specific discipline. Usually there are 2-4 PSOs for a program.

## COURSE OUTCOMES (COs)

Course outcomes are those which statements that describe significant and essential learning that learners have achieved, and can be reliably demonstrated at the end of a course. Generally, 5 to 6 course outcomes are specified for each a course based on its weightage. In the Curriculum published in College website, there should be clear mention of course outcomes along with CO-PO course articulation matrix for all the courses.

## GENESIS OF OUTCOME BASED EDUCATION (OBE)

It is a process that involves the restructuring of curriculum, assessment, and reporting practices in education to reflect the achievement of higher order learning and mastery rather than the accumulation of course credits.

## WASHINGTON ACCORD

It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering.

The induction of India in the Washington Accord in 2014 with the permanent signatory status of The National Board of Accreditation (NBA) is considered a big leap forward for the higher education system in India. It means that an Engineering graduate from India can be employed in any of the other countries who have signed the accord. For Indian Engineering institutions to get accredited by NBA according to the pacts of the accord, it is compulsory that engineering institutions follow the Outcome Based Education (OBE) model.

Outcome-Based Education (OBE) model is being adopted in engineering colleges now-a-days as per AICTE guidelines. This model is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skills, and attitudes. Its focus remains on evaluation of outcomes of the program by stating the knowledge, skill and behaviour, a graduate is expected to attain upon completion of a program after 4 – 5 years of graduation. In the OBE model, the required knowledge and skill sets for a particular engineering degree are predetermined and the students are evaluated for all the required parameters (outcomes) during the course of the program. Accreditation is mandatory for any institution in view of Global recognition.

The OBE framework and Outcome Based Accreditation are shown in Fig 1.1 and Fig. 1.2.

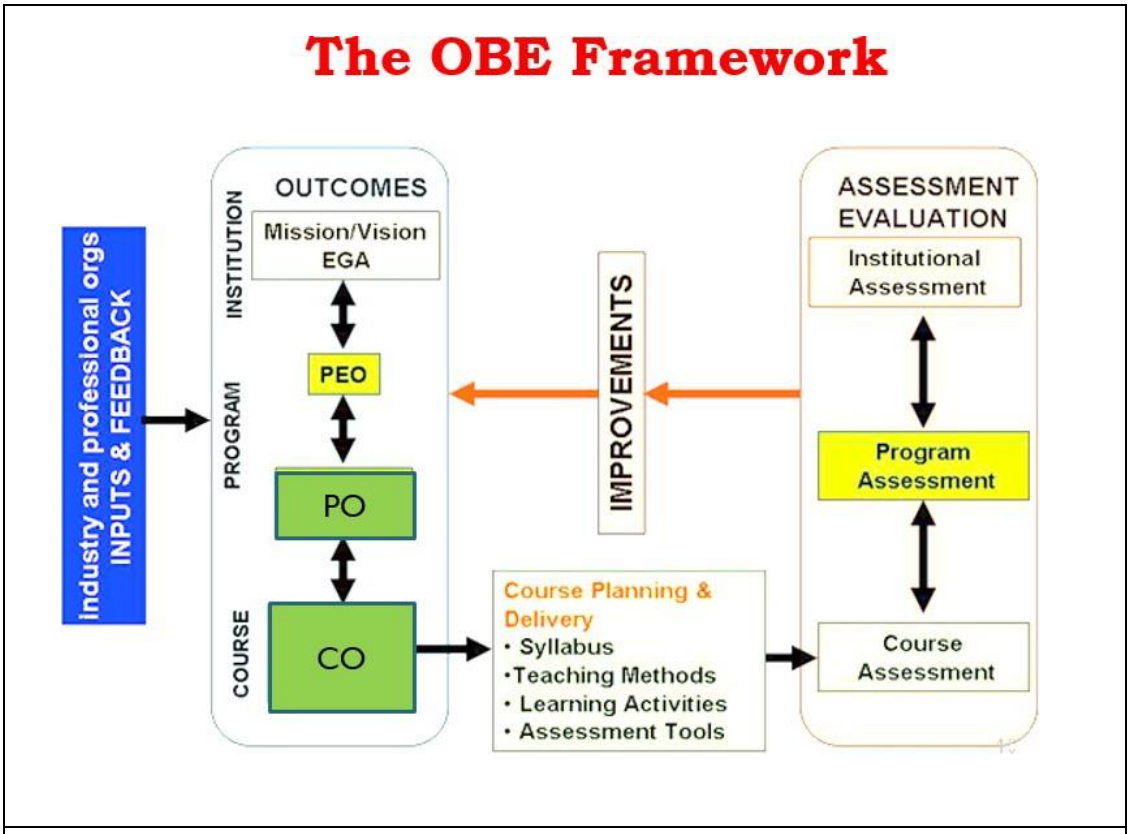



Fig. 1.1: OBE Framework

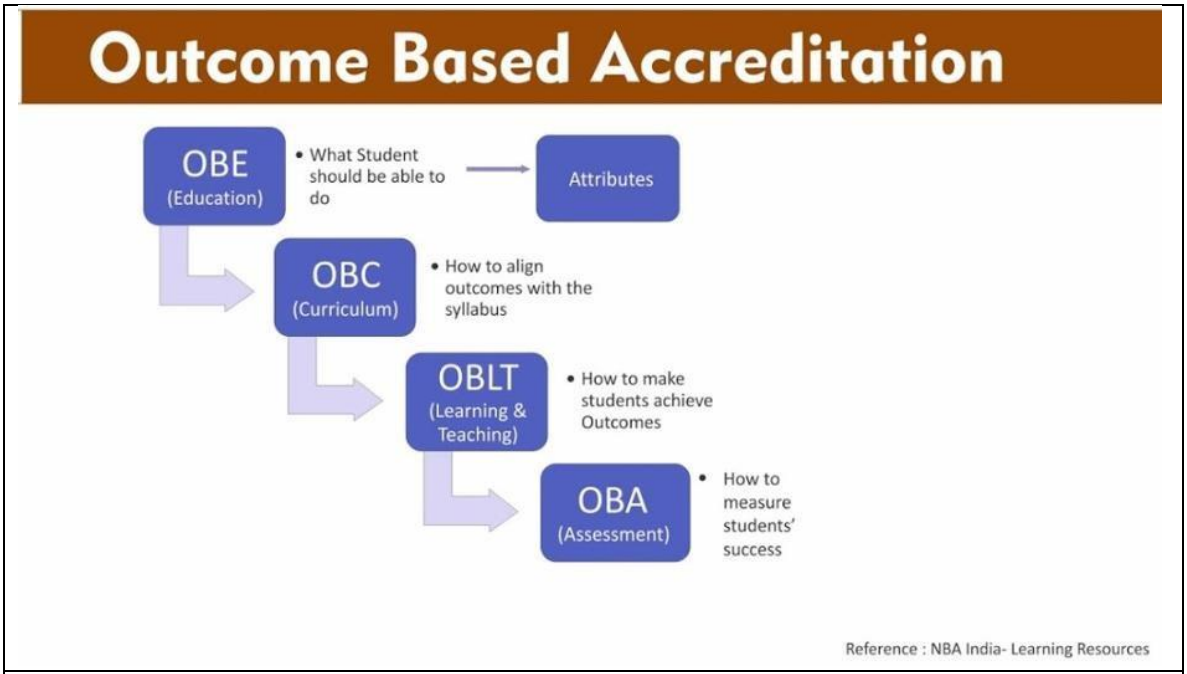



Fig. 1.2: OBE Accreditation

## PROCESS OF DEVELOPMENT AND ATTAINMENT OF OBE ELEMEMNTS

There are two important phases in the OBE framework namely Development Phase and Attainment Phase.

**Development Phase:**

In the first phase, OBE elements will be developed and arranged in a systematic manner so that dissemination of vision of the organization will be reach the root level (single course) of the operations.

- In the present case of an academic institution, Vision of the organization (time horizon: 10 years) is developed to next level by defining Program Educational Objectives (PEOs).
- Vision of the organization is transformed into next stage of PEOs through Mission statements.
- A mapping matrix between Mission statements and PEOs is prepared.
- By attaining the PEOs, it is assured that the Vision of the organization is fulfilled in real case.
- PEOs attainment is to be analyzed after 3-5 years from the graduation of the student. Hence, it is to be transformed to next level i.e., program level by defining Program Outcomes(POs) and Program Specific Outcomes(PSOs).
- POs and PSOs attainment is to be analyzed at the end of graduating program indicating that the time horizon is equal to duration of the program itself i.e.4 years. After the student is graduated from the organization, immediately POs and PSOs attainment is to be calculated.
- As POs and PSOs are confined to program, it is necessary to develop another level i.e., Course level. In this level, POs and PSOs are mapped with Courses through their Course Outcomes.
- A CO-PO-PSO articulation matrix is developed to assess the PO attainment through Course Outcome Attainment of all the courses.

In this way, Vision of the Organization is developed to the root level i.e., Course level.

**Attainment Phase:**

- In the second phase, i.e., Attainment Phase, initially Course Outcomes attainment is calculated for each course. All courses attainments will lead to PO/PSO attainment through CO-PO-PSO articulation matrix. PO/PSO attainment will lead to attainment of PEOs as an analysis of 3 or 4 batches of graduating students.
- PEO attainment will lead to attainment of fulfilment of Mission statements through PEO-Mission statements mapping matrix.
- Attainment of Mission statements reveals the realization of Vision of the organization.

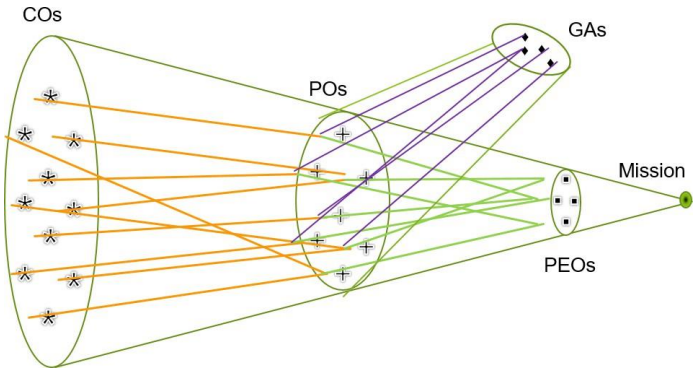



**Fig 1. 3 Integration of all the OBE components**

## TRADITIONAL EDUCATION Vs OUTCOME BASED EDUCATION

The difference between traditional education and outcome-based education lies in the approach through various parameters i.e., role of a teacher, focus on the teaching- learning process, output in measurable terms etc. All the comparative parameters are shown in Fig 1.4 and Table 1.1

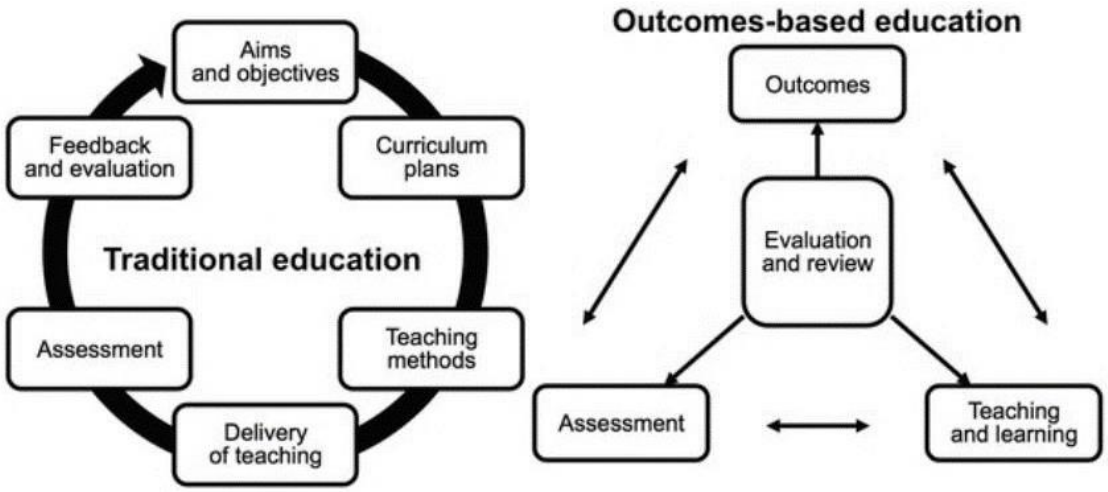



**Fig. 1.4: Traditional Education Vs Outcome Based Education**

**Table 1.1: Traditional Teaching Approach Vs Outcome Based Approach**

| Traditional Teaching Approach | Outcome Based Approach |
|---|---|
| Teacher-centered | Learner/Student centered |
| Teacher's role as instructor | Teacher's role as partner /facilitator |
| Focus on Teacher's input | Focus on learner's output |
| Rigid and controlling | Flexible and empowering |
| Emphasis on products | Emphasis on progress and overall learning |
| Course objectives / Syllabus is seen rigid and non-negotiable | Learning outcomes / Learning programmes are seen as guides that allows teachers to be innovative and creative in achieving learning outcomes |
| Norm-referenced assessment | Criterion reference assessment |
| Content based and content delivery | Ability building and Skills development |

**Spady, W. D**, in his book, "Outcomes Based Education: Critical Issues and Answers" highlighted the following seven beliefs and features as:

1 All students can learn and succeed, but not on the same day in the same way.
2 Success breeds success.
3 Schools control the conditions of success
4 It emphasizes authentic, achievable, and assessable learning outcomes
5 It is primarily concerned with what students' culminating capabilities at graduation time. It centers curriculum and assessment design around higher order exit outcomes
6 It is accountable to the stake holders, the learners, the teachers, the employers, and the public
7 It leads to the change of schooling, including the curriculum, instruction and assessment

The fundamental phase of Outcome based educations starts from identifying the different levels of learning, which is easily identifiable using Blooms' Taxonomy which will be explained in the next section 1.2.

## 1.2 BLOOM'S TAXONOMY

Bloom's Taxonomy provides an important framework to not only design curriculum and teaching methodologies but also to design appropriate examination questions belonging to various cognitive levels. Bloom's Taxonomy of Educational Objectives developed in 1956 by Benjamin Bloom was widely accepted by educators for curriculum design and assessment.

In 2001, Anderson and Krathwohl modified Bloom's Taxonomy to make it relevant to the present-day requirements. It attempts to divide learning into three types of domains (cognitive, affective and behavioural) and then defines the level of performance for each domain. Conscious efforts to map the curriculum and assessment to these levels can help the programs to aim for higher-level abilities which go beyond remembering or understanding, and require application, analysis, evaluation or creation.

Revised Bloom's taxonomy in the cognitive domain includes thinking, knowledge, and application of knowledge. It is popular framework in engineering education to structure the

assessment as it characterizes complexity and higher-order abilities. It identifies six levels of competencies within the cognitive domain which are appropriate for the purposes of engineering educators. Bloom's Taxonomy is hierarchical, meaning that learning at the higher level requires those skills which are attained at a lower level.

## ACTION VERBS FOR ASSESSMENT

Choice of action verbs in constructing assessment questions is important to consider. Quite often, the action verbs are indicators of the complexity (level) of the question. Over the time, educators have come up with taxonomy of measurable verbs corresponding to each of the Bloom's cognitive levels.
These verbs help us not only to describe and classify observable knowledge, skills and abilities but also to frame the examination or assignment questions that are appropriate to the level we are trying to assess.

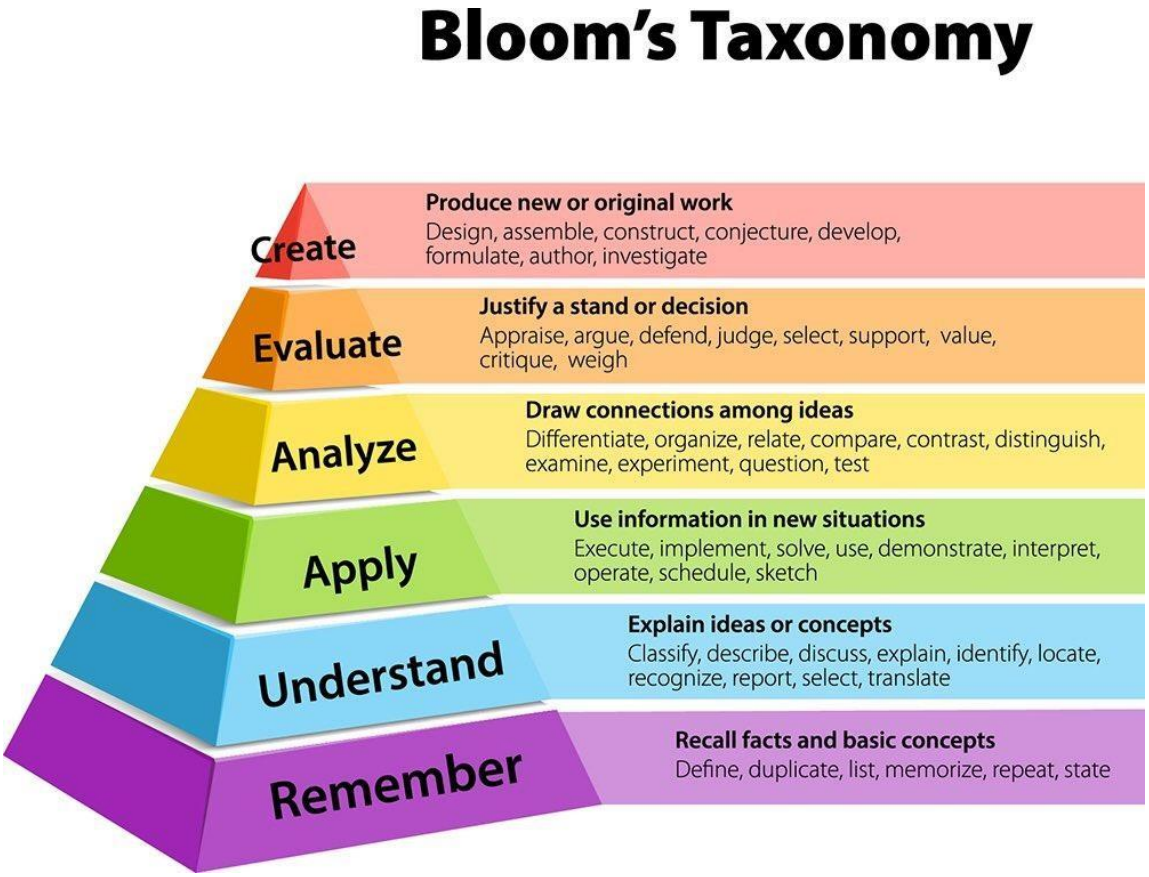



Fig 1.5: Bloom's Taxonomy

A suggestive list of skills/ competencies to be demonstrated at each of the Bloom's level and corresponding cues/ verbs for the examination/ test questions are given in Table 1.2.

**Table 1.2: Bloom's Taxonomy – Skills and Verbs**

| S. No | Level | Skill Demonstrated | Question/Verbs for tests |
|---|---|---|---|
| 1 | Remember | • Ability to recall of information like facts, conventions, definitions jargon, technical terms, classifications, categories and criteria.<br>• Ability to recall methodology and procedures, abstractions, principles and theories in the field.<br>• Knowledge of dates, events, places<br>• Mastery of subject matter | List, define, tell, describe, recite, recall, identify, show, label, tabulate, quote, name, who, when, where etc. |
| 2 | Understand | • Understanding information<br>• Grasp meaning<br>• Translate knowledge into new context.<br>• Interpret facts, compare, contrast.<br>• Order, group infer causes.<br>• Predict consequences | Describe, explain, paraphrase, restate, associate, contrast, summarize, differentiate, interpret, discuss |
| 3 | Apply | • Use information.<br>• Use methods, concepts, laws, theories in new situations.<br>• Solve problems using required skills or knowledge.<br>• Demonstrating correct usage of a method or procedure | Calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, experiment, show, examine, modify |
| 4 | Analyse | • Break down a complex problem into parts.<br>• Identify the relationship and interaction between the different parts of complex problem.<br>• Identify the missing information, sometimes the redundant information and the contradictory information, if any. | Classify, outline, break down, categorize, analyze, diagram, illustrate, infer, select |
| 5 | Evaluate | • Compare and discriminate between ideas.<br>• Assess value of theories, presentations make.<br>• Choices based on reasoned argument verify value evidence recognize subjectivity use of definite criteria for judgements | Assess, decide, choose, rank, grade, test, measure, defend, recommend, convince, select, judge, support, conclude, argue, justify, compare, summarize, evaluate |
| 6 | Create | • Use old ideas to create new ones.<br>• Combine parts to make(new) whole.<br>• Generalize from given facts relate knowledge from several areas predict, draw conclusions | Design, formulate, build, invent, create, compose, generate, derive, modify, develop, integrate |

It may be noted that some of the verbs in the above table are associated with multiple Bloom's Taxonomy level. These verbs are actions that could apply to different activities.

## 1.3 PROCESS CYCLES

In Outcome based education(OBE), CO, PO, PEO process cycles are to be defined /framed cautiously. The various inputs and process changes are shown in the figure below.

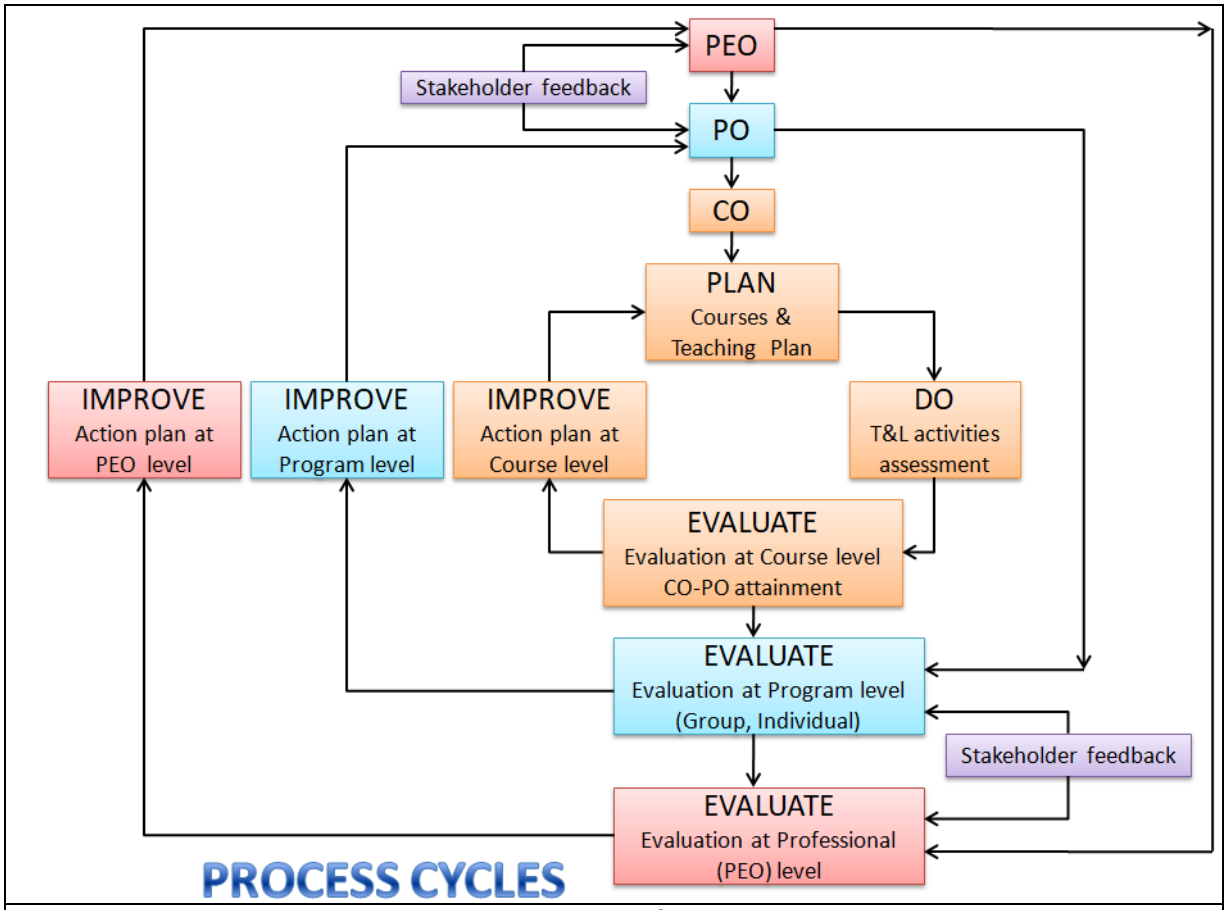



Fig 1.6: Process cycles of CO, PO and PEO

### COURSE OUTCOME PROCESS CYCLE

The process cycle of Course Outcomes originates from the initial stage of defining the course outcomes, preparation of syllabus in tune with course outcomes, preparation of teaching plan or lecture plan and associated teaching-learning methodologies. This stage is primarily termed as Planning stage.

After planning stage, it is necessary to execute the methodologies and assess their actual achievement i.e., CO & PO direct and indirect assessment through various activities, both curricular and co-curricular activities. Direct assessment always deals with the teaching activities with the involvement of instructor and learner in the same place either in the classroom or in a laboratory or a project area.

After execution, it is important to evaluate the assessment results i.e., Compare CO- PO attainment values against the targets set. This CO attainment analysis has to be at a course level not program level.

After the comparison of CO attainment against the set targets, gap analysis is to be prepared, by which the action plan either to improve the Teaching-learning methodologies (if not achieved) or to modify the Teaching-learning methodologies ( if achieved).

After the modification or improvement of the teaching –learning methodologies, the process becomes cyclic, i.e. again planning is to be carried out for modified methodologies in the next program cycle.

**PROGRAM OUTCOME PROCESS CYCLE**

The process cycle of Program Outcomes originates from the initial step of defining/ adopting the PO statements. Initially PO statements are given by NBA in India. The program outcomes will be active through Course outcomes only. CO statements are to be written in the light of PO statements only through CO-PO mapping. The PO assessment (Direct) will be purely extracted from CO assessment only.

After the Course outcome attainment calculation, PO attainment (Direct) will be calculated initially for each single course. A single course contribution towards attainment of Program Outcomes(1 to 12) will be calculated as weighted average of Course outcome attainments and mapping levels. Consolidated PO attainment (Direct) will be the arithmetic average of PO attainments of all the Mapped courses.

For example, out of 50 courses, if 5 courses are mapped to PO8, and their attainments in PO8 are 1.20, 1.34, 2.45, 2.56 and 2.67 respectively. Then the PO attainment for PO8 will be arithmetic average of 1.20, 1.34, 2.45, 2.56 and 2.67 which results 2.044. Similarly, all the PO attainments will be calculated.

After evaluating PO attainments, it is necessary to analyze the academic gap i.e., difference between the Target level for each PO and attainment for each PO (both at Course level and Group/batch level). After analysis, action plan needs to be initiated to improve the PO attainment in the next academic period by considering the feedback from the existing analysis. At this juncture, the feedback from the stakeholders also to be considered in the improvement of Curriculum for the next academic period.

**PROGRAM EDUCATION OBJECTIVES PROCESS CYCLE**

We all know that the educational objectives of an engineering degree program are the statements that describe the expected achievements of graduates in their career, and what the graduates are expected to perform and achieve during the first few years after graduation.

The PEOs, may be guided by global and local needs, vision of the Institution, long term goals etc. For defining the PEOs the faculty members of the program must continuously work with all stakeholders: Employers, Industry, Students, Parents and the Alumni. PEOs can be written in different frameworks or perspectives i.e. Career, Technical competency and behavior.

PEO attainment calculation is a difficult task in the Indian context. PEO attainment calculation is the measurement of realization of the efforts of the institution in making the vision and mission statements in real terms of measurement.

Depending on the context, we need to calculate the PEO attainment. It can also be designed in line with Program Outcomes i.e., Direct assessment through PO-PEO mapping and Indirect assessment through the Feedback from various stakeholders i.e., Alumni, Parents,

Employers and Industry.

After the evaluation of PEOs, it is necessary for the Institution to initiate an action plan to improve/update the Curriculum and Teaching-learning processes from the next academic period.

## 1.4. COURSE OUTCOMES(COs) ASSESSMENT

Course outcomes attainment is to be calculated after teaching learning process is completed through various pedagogical elements of assessment i.e., Class, Seminar, Workshop etc. CO attainment is to be calculated based on the evaluation results obtained from different assessment criteria i.e., Sessional Examinations, Semester End Examinations, Assignments, Quiz etc. by the faculty.

Attainment of course outcome will be the ratio of actual result obtained to the expected result based on the targets set for that course. Complete process of CO attainment will be discussed in the next section.

## 1.5. PROGRAM OUTCOME (PO) & PROGRAM SPECIFIC OUTCOME (PSO) ASSESSMENT

Program Outcomes (PO) and Program Specific Outcomes (PSOs) assessment is having two parts i.e., Direct assessment and Indirect assessment. Direct assessment will be through CO-PO mapping matrix. Every course will have contribution towards Program outcomes through the CO-PO mapping matrix. Indirect assessment of PO will be done through various surveys and activities.

PO attainment is dependent on the attainment of Course outcomes only. Initially, we need to ascertain the correlation of a course outcome with each PO/PSO at different levels, which is denoted as CO-PO-PSO mapping. After CO-PO-PSO mapping is completed, CO attainment will be the input for PO/PSO attainment calculation, which will be discussed in detail in the next section.

### CO-PO-PSO MAPPING

- The process of attainment of COs, POs starts from writing appropriate COs for each course of the program.
- Then, a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).
- A mapping matrix is prepared in this regard for every course in the program including the elective courses.

**Example:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | - | - | 1 | - | 2 | - | - | - | - | 2 | - |
| CO4 | - | 1 | 1 | 1 | - | - | - | - | - | - | 1 | - | 1 | - |
| CO5 | 1 | 1 | - | - | 1 | - | - | 1 | - | - | - | - | 1 | 3 |

**BRIDGING THE GAP for CO**

In the outcome-based education, it is mandatory to upgrade or modify the Teaching- Learning Process (TLP) from time to time according to the course outcome attainment. Starting from definition of course outcome to attainment of course outcome, teaching learning process includes many stages. Initially Course instructor will set a target or threshold percentage i.e., 1.8 in present case.

After the CO attainment is calculated, the activities to be completed are

- Gap analysis
- Action plan

Both of the above need to be made ready in order to bridge the attainment gap.

**BRIDGING THE GAP for PO/PSO**

Similar to the academic learning gap in case of course outcome, program outcome gap will be also be calculated based on the fact that Graduate Attributes Gaps need to be identified and remedial action need to be initialized.

As Program outcome attainment also has Direct and Indirect Components, Final PO/PSO attainment will be calculated as a Weighted Average. The weightages for Direct PO/PSO and Indirect PO/PSO components will be 80% and 20% respectively.

Consolidated gaps will go into the academic calendar as various activities.

# 2. PROCESSES ADOPTED

## 2.1. FRAMING VISION, MISSION, PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The various processes to formulate Vision and Mission of the Institute and Department, Program Educational Objectives, Program Outcomes and Program Specific Outcomes will be explained below.

### PROCESS OF FRAMING VISION AND MISSION

- Collect the basic inputs i.e., Vision and Mission of Affiliating University and other premier institutes.
- Involve all stakeholders to get inputs.
- Gap analysis or SWOC analysis
- Graduate Attributes
- Discussion, brainstorming by Programme Assessment Committee (PAC) to prepare Draft copy.
- After the final draft copy is ready it is to be reviewed by Academic Council
- After reviewed by Academic council, it is to be approved by Governing body.
- If the Governing body approves, the College will publish and disseminate Vision and Mission statements to all the stakeholders. Else, it is to be sent to the Academic council to review again and make modifications.

The entire process of framing Vision and Mission is shown in Fig. 2.1.

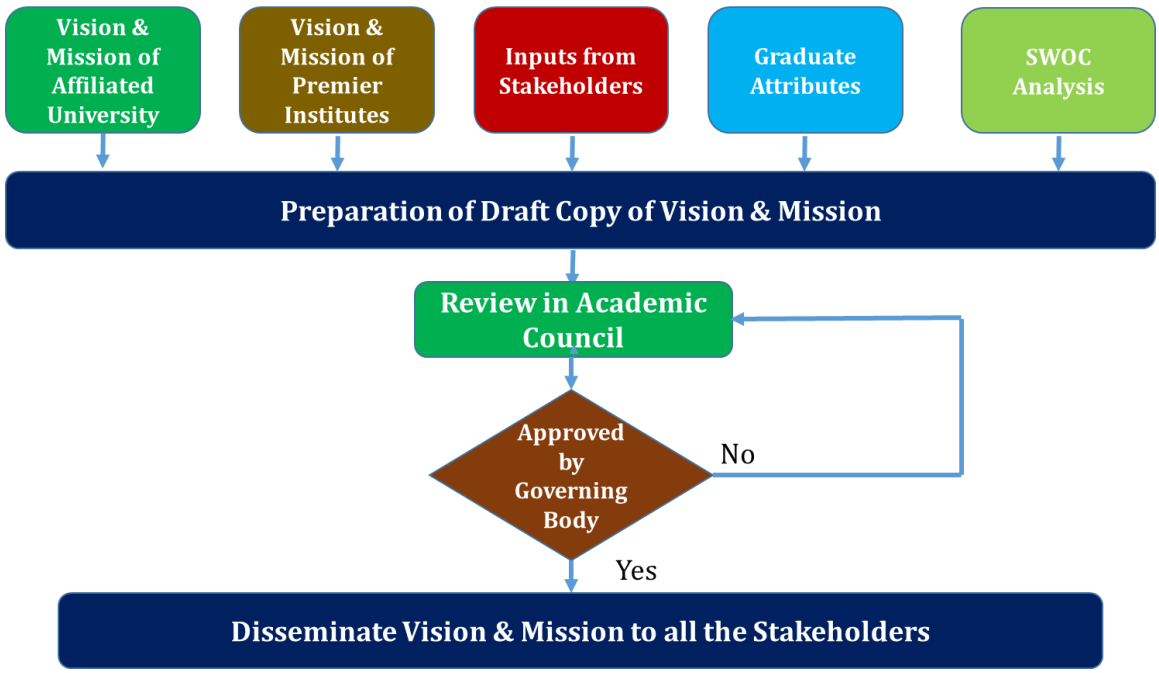



**Fig.2.1: Process of framing Vision and Mission of the Institute**

## PROCESS FOR FRAMING VISION &MISSIONOF THE DEPARTMENT

Vision and Mission of the department are to be framed by taking various inputs i.e., Vision and Mission of the Institute, Department SWOC Analysis and opinions of the stakeholders (internal and external) and executing various phases as under.

1. Collect the various inputs for Brainstorming sessions by the departments' faculty members.
2. After Brainstorming sessions, PAC will prepare Draft copy of Vision and Mission,
3. The draft copy is to be verified and modified by Department Advisory Committee (DAC).
4. The draft copy after modification from DAC has to be approved by Principal.
5. If Principal approve the draft copy, it is to be ratified by Academic Council and Governing Body. Else, it is to be sent to DAC to review and refine the draft copy.
6. After the final ratification by the Academic Council and Governing body, college will display, publish and disseminate Vision and Mission of the department to all the stakeholders.

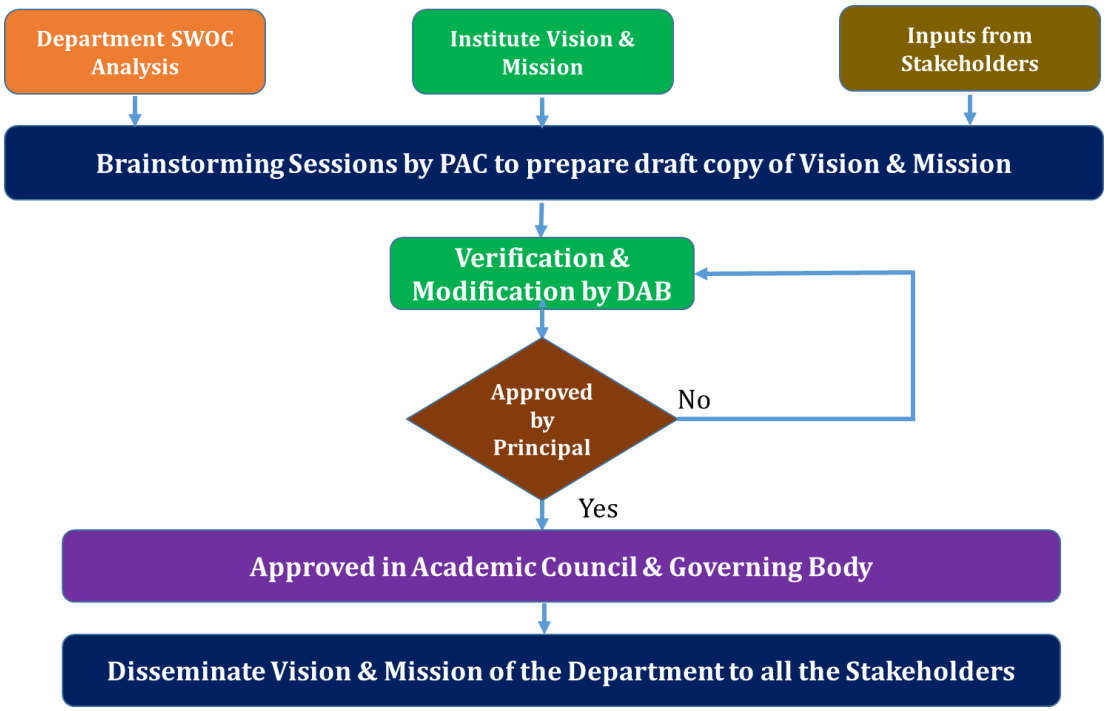



**Fig.2.2: Process for framing Vision & Mission of the Department**

Before disseminating the Vision and Mission statements to the stakeholders, we need to crosscheck important points which are presented here.

**VISION STATEMENT**

- Is the statement addressing "What the department would like to become?" such as best, leader, recognized state/nation level for etc.
- Is the statement addressing "What the department is striving for?" such as reputation, excellence in … etc.
- Does it indicate what the programs will look like in future?
- Is inspirational word present?
- is it giving desired direction?
- Is it aligned to the Institute vision?

**MISSION STATEMENT(S)**

- Is the statement indicates the primary functions or activities of the department? (providing good infrastructure)
- Is the statement indicates the primary functions or activities of the department? (providing good education or T-L-E)
- Is the statement indicates the primary functions or activities of the department? (providing co-curricular & extra-curricular activities)
- Is the statement indicates the primary functions or activities of the department? (providing good resources, collaborations etc)
- Is the statement has mention about the identified stakeholders or their expectations?
- Is it distinctive having speciifics? Or generic statements?
- Does it states what is the pursose of the programs?
- is it easily memorable?
- Is it aligned to the Institute mission?

**PROCESS FOR FRAMING PROGRAM EDUCATIONAL OBJECTIVES(PEOs)**

Program Educational Objectives(PEOs) are to be framed by taking various inputs i.e., Vision and Mission of the Institution & Department, Department SWOC Analysis, Graduate Attributes and opinions of the stakeholders (internal and external) and executing various phases as under.

1. Collect the various inputs for brainstorming sessions in the department committee to prepare draft copy of PEOs
2. The draft copy is to be verified and modified by Program Assessment Committee (PAC)
3. The modified draft copy of PEOs is then sent to Principal for approval.
4. If the draft copy is approved by Principal, it is to be ratified by Academic council and governing body. Else, document is to be sent to PAC to update the draft copy.
5. The draft copy, after Principal's approval is to be ratified by Academic council and Governing body.
6. After the ratification by Academic council and governing body, college will display, publish and disseminate the PEOs to all the stakeholders.

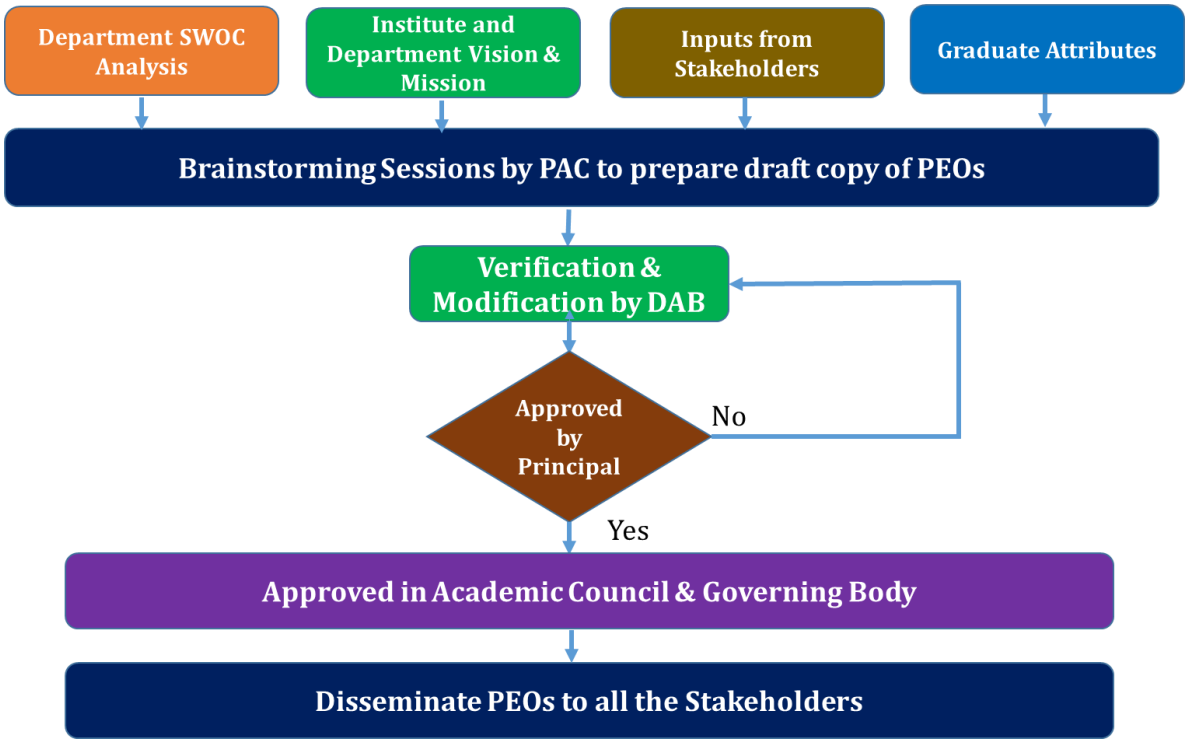



**Fig.2.2: Process for framing PEOs of the Department**

Before disseminating the PEO statements to the stakeholders, we need to crosscheck important points which are presented here.

- Is the statement indicates the accomplishments of GRADUATES only?
- Is any PEO addressing Preparation (Employment/Higher Studies)?
- Is any PEO addressing Core Competence (Discipline knowledge)?
- Is any PEO addressing Breadth / Interdisciplinary aspect (’T’ Shaped Engineer)?
- Is any PEO addressing Professionalism - 3Ps (Professional value, professional knowledge, professional development)?
- Is any PEO addressing Life long learning (Environment)?

Similarly, before finalizing PSO statements, we need to crosscheck important points which are presented here.

- Is the statement indicate the skill, knowledge, values, attitude?
- Is PSO addressing specific outcomes the given generic PO?
- Is PSO addressing the specific accomplishments of the students?
- Is PSO addressing the specific facilities required by the students?
- Is PSO addressing the specific facuty/expert support required by the students?

## 2.2 GUIDELINES FOR WRITING COURSE OUTCOMES

Course Outcomes (COs) will be formed for each course in all the programs. All the instructors dealing a particular course will formulate the Course Outcomes.

- COs will be formed by the instructors dealing the same course and authority for approving COs will be department BoS.
- 5-6 COs can be framed per course, and COs are formed by considering the learning levels of Bloom's Taxonomy.

**Structure of Course Outcomes:**

A Course Outcome must have the following characteristics.

1. Specific
2. Measurable
3. Attainable

A well written Course Outcome will have the following 3 components as.

1. Condition
2. Performance
3. Criterion

We can map the characteristics and components as > Specific –Condition, Measurable-Performance and Attainable –Criterion.

In view of the above characteristics and components, instructor(s) have to prepare the Course outcomes.

Course Outcome statement may be broken down into two main components:

- **An action word** that identifies the performance to be demonstrated.
- **Learning statement** that specifies what type of learning will be demonstrated in the performance;

Examples of good action words to include in course outcome statements:

- Compile, identify, create, plan, revise, analyze, design, select, utilize, apply, demonstrate, prepare, use, compute, discuss, predict, assess, compare, rate, critique, outline, evaluate.

**Examples:**

A well-written course outcome will be as explained under.

At the end of the course, student is able to:

1. **Apply** laws of physics (e.g. Hooke's law, etc.,) to compute different types of response (stress and deformation) in the given materials. (PO1)
2. **Analyze** structural elements for different force systems to compute design parameters (BM and SF) (PO2)
3. **Design** compression elements using engineering principles to resist any given loads. (PO3)
4. **Conduct** experiments to validate physical behavior of materials/ components. (PO4)
5. **Prepare** laboratory reports on interpretation of experimental results (P10)

## ROLE OF COMPETENCIES AND PERFORMANCE INDICATORS

Program Outcomes give useful guidance at 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. A real observability and measurability of the POs at course

level is very difficult. To connect high-level learning outcomes (POs) with course content, course outcomes and assessment, there is a necessity to bring further clarity and specificity to the program outcomes. This can be achieved through the following two- step process of identifying Competencies and Performance Indicators (PI).

**Identify Competencies to be attained**:

- For each PO define competencies –different abilities implied by program outcome statement that would generally require different assessment measures. This helps us to create a shared understanding of the competencies we want our students to achieve. They serve as an intermediate step to the creation of measurable indicators.

- Example: Program Outcome (Attribute 3) Design: 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.

**Competencies**

- Demonstrate an ability to define a complex open-ended problem in engineering terms.
- Demonstrate an ability to generate a diverse set of alternative design solutions
- Demonstrate an ability to select the optimal design scheme for further development
- Demonstrate an ability to advance an engineering design to defined end state

**Define Performance Indicators**

For each of the competencies identified, define Performance Indicators (PIs) that are explicit statements of expectations of the student learning. They can act as measuring tools in assessment to understand the extent of attainment of outcomes. They can also be designed to determine the appropriate achievement level or competency of each indicator so that instructors can target and students can achieve the acceptable level of proficiency.

- Example: For the Competency -2

**Demonstrate an ability to generate a diverse set of alternative design solutions**

Performance Indicators:

- Apply formal idea generation tools to develop multiple engineering design solutions
- Build models, prototypes, algorithms to develop a diverse set of design solutions
- Identify the functional and non-functional criteria for evaluation of alternative design solutions.

It should be noted that, when we consider the program outcome, it looks like, it can be achieved only in the Capstone project. But if we consider the competencies and performance indicators, we start seeing the opportunities of addressing them (and hence PO) in various courses of the program. Once the above process is completed for the program, the assessment of COs for all the courses are designed by connecting assessment questions (used in various assessment tools) to the Performance Indicators. By following this process, where examination questions map with Performance Indicators, we get clarity and better resolution for the assessment of COs and POs.

The process is clearly shown in Fig. 2.2.3.

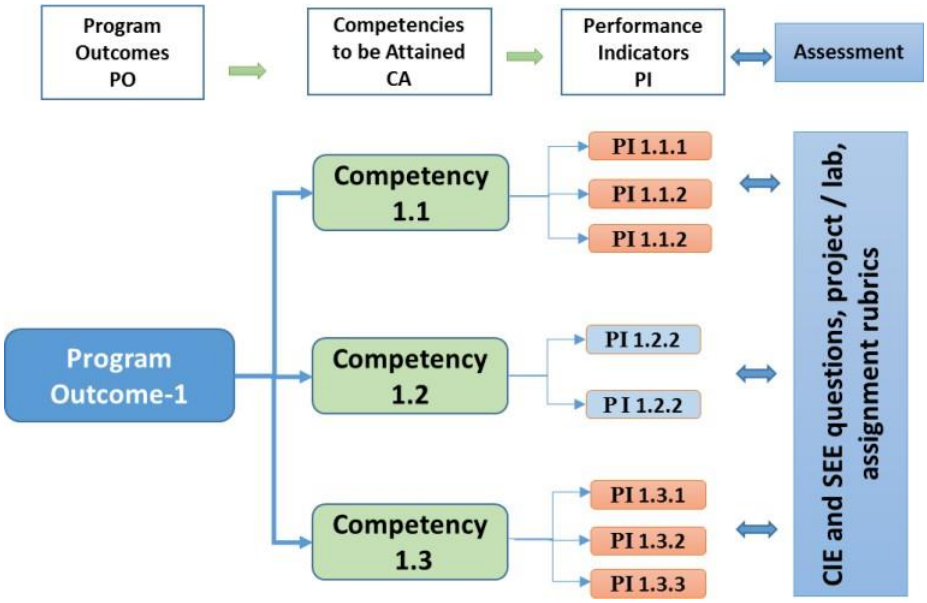



Fig. 2.2.3: Competencies and Performance Indicators

The following table gives a suggestive list of competencies and associated performance indicators for each of the PO.

| **PO 1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems. | | |
|---|---|---|
| **Competency** | **PI #** | **PI Description** |
| 1.2 Demonstrate competence in mathematical modelling | 1.2.1 | Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems |
| | 1.2.2 | Apply the concepts of probability, statistics and queuing theory in modeling of computer based system, data and network protocols. |
| 1.5 Demonstrate competence in basic sciences | 1.5.1 | Apply laws of natural science to an engineering problem |
| 1.6 Demonstrate competence in engineering fundamentals | 1.6.1 | Apply engineering fundamentals |
| 1.7 Demonstrate competence in specialized engineering knowledge to the program | 1.7.1 | Apply theory and principles of computer science engineering to solve an engineering problem |
| **PO 2: Problem analysis:** Identify, formulate, research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. | | |
| **Competency** | **PI #** | **PI Description** |
| 2.5 Demonstrate an ability to identify an formulate complex engineering problem | 2.5.1 | Evaluate problem statements and identifies objectives |
| | 2.5.2 | Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem |
| | 2.5.3 | Identifies mathematical algorithmic knowledge that applies to a given problem |
| 2.6 Demonstrate an ability to formulate a solution plan and methodology for an engineering problem | 2.6.1 | Reframe the computer based system into interconnected subsystems |
| | 2.6.2 | Identifies functionalities and computing resources. |
| | 2.6.3 | Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions |
| | 2.6.4 | Compare and contrast alternative solution/methods to select the best methods |
| | 2.6.5 | Compare and contrast alternative solution processes to select the best process. |
| 2.7 Demonstrate an ability to formulate and interpret model | 2.7.1 | Able to apply computer engineering principles to formulate modules of a system with required applicability and performance. |
| | 2.7.2 | Identify design constraints for required performance criteria. |
| | 2.8.1 | Applies engineering mathematics to implement the solution. |

| | | |
|---|---|---|
| 2.8 Demonstrate an ability to execute a solution process and analyze results | 2.8.2 | Analyze and interpret the results using contemporary tools |
| | 2.8.3 | Identify the limitations of the solution and sources/causes. |
| | 2.8.4 | Arrive at conclusions with respect to the objectives. |
| **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. | | |
| 3.5 Demonstrate an ability to define a complex / open-ended problem in engineering terms | 3.5.1 | Able to define a precise problem statement with objectives and scope. |
| | 3.5.2 | Able to identify and document system requirements from stake holders. |
| | 3.5.3 | Ability to review state of the art literature to synthesize system requirements. |
| | 3.5.4 | Ability to choose appropriate quality attributes as defined by ISO/IEC/IEEE standard. |
| | 3.5.5 | Explore and synthesize system requirements from larger social and professional concerns. |
| | 3.5.6 | Ability to develop software requirement specifications (SRS). |
| 3.6 Demonstrate an ability to generate a diverse set of alternative design solutions | 3.6.1 | Ability to explore design alternatives. |
| | 3.6.2 | Ability to produce a variety of potential design solutions suited to meet functional requirements. |
| | 3.6.3 | Identify suitable nonfunctional requirements for evaluation of alternate design solutions. |
| 3.7 Demonstrate an ability to select optimal design scheme for further development | 3.7.1 | Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria. |
| | 3.72 | Consult with domain experts and stakeholders to select candidate engineering design solution for further development |
| 3.8 Demonstrate an ability to advance an engineering design to defined end state | 3.8.1 | Ability to refine architecture design into a detailed design within the existing constraints. |
| | 3.8.2 | Ability to implement and integrate the modules. |
| | 3.8.3 | Ability to verify the functionalities and validate the design. |
| **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. | | |
| 4.4 Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding | 4.4.1 | Define a problem for purposes of investigation, its scope and importance |
| | 4.4.2 | Ability to choose appropriate procedure/algorithm,data set and test cases. |
| | 4.4.3 | Ability to choose appropriate hardware/software tools to conduct the experiment. |
| 4.5 Demonstrate an ability to design experiments to solve open ended problems | 4.5.1 | Design and develop appropriate procedures / methodologies based on the study objectives |
| 4.6 Demonstrate an ability to analyze data and reach a valid conclusion | 4.6.1 | Use appropriate procedures, tools and techniques to collect and analyze data |
| | 4.6.2 | Critically analyze data for trends and correlations, stating possible errors and limitations |
| | 4.6.3 | Represent data (in tabular and/or graphical forms)so as to facilitate analysis and explanation of the data, and drawing of conclusions |
| | 4.6.4 | 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 prediction and modelling to complex engineering activities with an understanding of the limitations. | | |
| **Competency** | **PI #** | **PI Description** |
| 5.4 Demonstrate an ability to identify / | 5.4.1 | Identify modern engineering tools, techniques and resources for engineering activities |

| | | |
|---|---|---|
| create modern engineering tools, techniques and resources | 5.4.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems |
| 5.5 Demonstrate an ability to select and apply discipline specific tools, techniques and resources | 5.5.1 | Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii)monitoring system performance, and (iv) creating engineering designs. |
| | 5.5.2 | Demonstrate proficiency in using discipline specific tools |
| 5.6 Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem | 5.6.1 | Discuss limitations and validate tools, techniques and resources |
| | 5.6.2 | 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. | | |
| 6.3 Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare | 6.3.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level |
| 6.4 Demonstrate an understanding of professional engineering regulations, legislation and standards | 6.4.1 | Interpret legislation, regulations, codes, and standards relevant to your discipline 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 need for sustainable development. | | |
| 7.3 Demonstrate an understanding of the impact of engineering and | 7.3.1 | Identify risks/impacts in the life-cycle of an engineering product or activity |
| Industrial practices on social, environmental and in economic contexts | 7.3.2 | Understand the relationship between the technical,socio economic and environmental dimensions of sustainability |
| 7.4 Demonstrate an ability to apply principles of sustainable design and development | 7.4.1 | Describe management techniques for sustainable development |
| | 7.4.2 | 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. | | |
| **Competency** | **PI #** | **PI Description** |
| 8.3 Demonstrate an ability to recognize ethical dilemmas | 8.3.1 | Identify situations of unethical professional conduct and propose ethical alternatives |
| 8.4 Demonstrate an ability to apply the Code of Ethics | 8.4.1 | Identify tenets of the ASME professional code of ethics |
| | 8.4.2 | 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 leader in diverse teams, and in multidisciplinary settings. | | |
| 9.4 Demonstrate an ability to form a team and define a role for each member | 9.4.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team |
| | 9.4.2 | Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal. |
| 9.5 Demonstrate effective individual and team operations-- communication, problem solving, conflict resolution and leadership skills | 9.5.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills |
| | 9.5.2 | Treat other team members respectfully |
| | 9.5.3 | Listen to other members are in difficult Maintain ssituation compos |
| 9.6 Demonstrate success in a team based project | 9.6.1 | 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 | | |
| **Competency** | **PI #** | **PI Description** |

| | | |
|---|---|---|
| 10.4 Demonstrate an ability to comprehend technical literature and document project work | 10.4.1 | Read, understand and interpret technical and non-technical information |
| | 10.4.2 | Produce clear, well-constructed, and well-supported written engineering documents |
| | 10.4.3 | Create flow in a document or presentation - a logical progression of ideas so that the main point is clear |
| 10.5 Demonstrate competence in listening, speaking, and presentation | 10.5.1 | Listen to and comprehend information, instructions, and viewpoints of others |
| | 10.5.2 | Deliver effective oral presentations to technical and non-technical audiences |
| 10.6 Demonstrate the ability to integrate different modes of communication | 10.6.1 | Create engineering-standard figures, reports and drawings to complement writing and presentations |
| | 10.6.2 | 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 own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. | | |
| **Competency** | **PI #** | **PI Description** |
| 11.4 Demonstrate an ability to evaluate the economic and financial performance of an engineering activity | 11.4.1 | Describe various economic and financial costs/benefits of an engineering activity |
| | 11.4.2 | Analyze different forms of financial statements to evaluate the financial status of an engineering project |
| 11.5 Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity | 11.5.1 | Analyze and select the most appropriate proposal based on economic and financial considerations. |
| 11.6 Demonstrate an ability to plan/manage an engineering activity within time and budget constraints | 11.6.1 | Identify the tasks required to complete an Engineering activity, and the resources required to complete the tasks |
| | 11.6.2 | Use project management tools to schedule an engineering project so it is completed on time and on budget. |
| **PO 12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. | | |
| **Competency** | **PI #** | **PI Description** |
| 12.4 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps | 12.4.1 | Describe the rationale for requirement for continuing professional development |
| | 12.4.2 | Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |
| 12.5 Demonstrate an ability to identify changing trends in engineering knowledge and practice | 12.5.1 | Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |
| | 12.5.2 | Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |
| 12.6 Demonstrate an ability to identify and access sources for new information | 12.6.1 | Source and comprehend technical literature and other credible sources of information |
| | 12.6.2 | Analyze sourced technical and popular information for feasibility, viability, sustainability, etc. |

## DO's AND DON'Ts IN WRITING COURSE OUTCOMES

- Avoid using the words which increases the scope or create ambiguity in understanding the theme of the Course outcome i.e., 'all the types of', 'good', 'best way', 'various types of', 'etc', 'like', 'such as'.
- Ensure that all the Course outcome are written with reference to 'learner' not 'instructor'.
- All course outcomes must be Action oriented.
- If the Course outcome contains two action verbs, higher knowledge level verb is to

be highlighted in the Course Outcome statement.

- Course outcome statement should be in such a way that it should reflect the scope or limitations of the study under consideration.
- Number of course outcome should be restricted to 6.

## CHECKLIST FOR VERIFICATION BY COURSE COORDINATOR

After all the course outcomes are written, Course coordinator has to verify different components. After verification, coordinator has to take a decision whether any component needs improvement or not. For this, Boolean checklist i.e., Yes /No, True/False, Update required / not required etc., Some of them are as follows.

1. Number of course outcomes
2. Is the Course outcome statement reflecting learning and activity?
3. Is the Bloom's Taxonomy followed in framing the Course outcome statement?
4. Is the CO statement having Performance component or not?
5. Is the CO statement having Condition component or not?
6. Is the CO statement having Criteria component or not?
7. Is the action part of CO being Specific?
8. Is the action part of CO being Measurable?
9. Is the action part of CO having attainable criterion?
10. Is the syllabus framed is in line with the Course outcomes statements?
11. Is the Semester end examination question paper is set as per Course outcomes and Bloom's taxonomy?

## GUIDELINES FOR CO-PO MAPPING

CO-PO mapping process is a critical part in the OBE process. It is the key process by which root level attainment of OBE process will be transformed to higher levels i.e., POs, PSOs and PEOs. All higher level processes' attainments will be based on CO-PO mapping only. Hence, CO-PO mapping is to be done with utmost care.
CO-PO mapping process is to be carried out by the Course instructors in discussion with Course coordinator and Head of the Department(HoD).

The various factors/points to be considered in CO-PO mapping process are as under.

- Check whether CO reflects the intended measurement related to any of the Program outcomes or not. Each CO has to address a subset of Program outcomes. Else, it becomes worthless in the curriculum, as it directly indicating that it is not contributing anything towards any of the Graduate attributes. In that case, it is better to redefine that Course outcome, or discard it from the syllabus.
- The number of hours allocated for each Course outcome as a percentage of total allocated hours for that Course, Bloom's taxonomy level associated primarily guides the mapping level or correlation to be 1,2 or 3.
  (1-low,2-moderate and 3-substantial or high).
- CO-PO mapping should reflect the ambitions of all the stakeholders.
- Quantitative methods can be developed to decide the mapping level 1,2 or 3. At times, we may take fractional values also i.e., 2.45, 2.56 etc.,
- CO-PO mapping process should reflect the Teaching-Learning processes followed in the content delivery of that Course.

- If there is any change in the curriculum or TLP, CO-PO mapping matrix need to be modified.
- CO-PO mapping matrix is to be supported by the justification statements, why mapping level is 1, 2 or 3 for that combination of CO and PO.
- If more number of faculty are dealing the same course, CO-PO matrix is to be prepared by every faculty.

**CHECKLLIST FOR CO-PO MAPPING**

After CO-PO mapping is completed, Course coordinators has to check the reliability of mapping process under various parameters. Some of them are as follows.

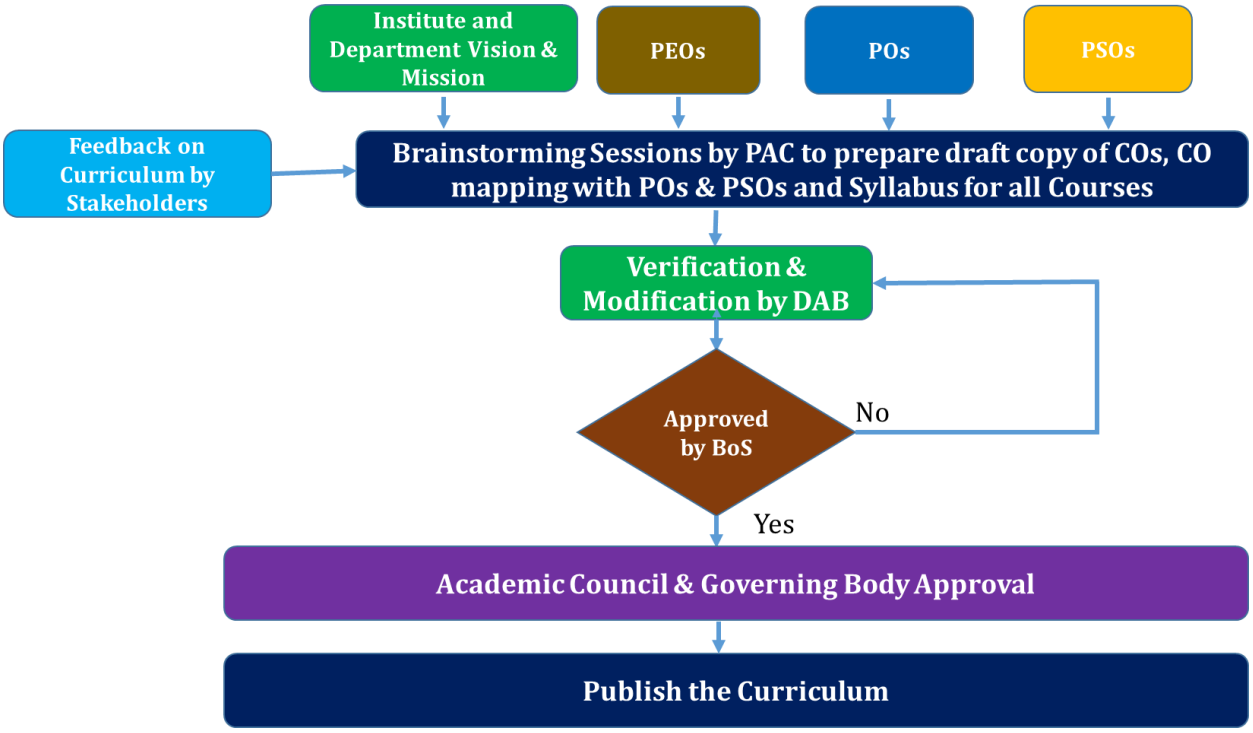
1. Does each CO mapped to at least one PO at Level 3 or HIGH?
2. Does the CO verb is aligned to the highest mapped PO?
3. Does each Course Outcome (CO) mapped to ≤ 5 POs?
4. Does the entire Course mapped to ≤ 5 POs?
5. Does each CO-PO mapping justification sentence written using syllabus topics?
6. Does the CO-PO mapping table with justification available in Course file?
7. Does the Course wise PO mapping has appropriate level of mapping?
8. Is there any Course outcome left behind without being mapped to any of the PO or PSO?

## 2.3. PROCESS OF CURRICULUM DESIGN

To realize the Vision and Mission statements of an institution, it is necessary to design the curriculum to be inline. After finalizing the Vision and Mission of the Institute and the department, Program Educational Objectives, Program Outcomes and Program Specific Outcomes, it is necessary to frame Course Outcomes (CO) which are the root level learning objectives in the Outcome Based Education. The process of Course outcomes preparation and mapping with Program Outcomes and Program Specific Outcomes is as follows.

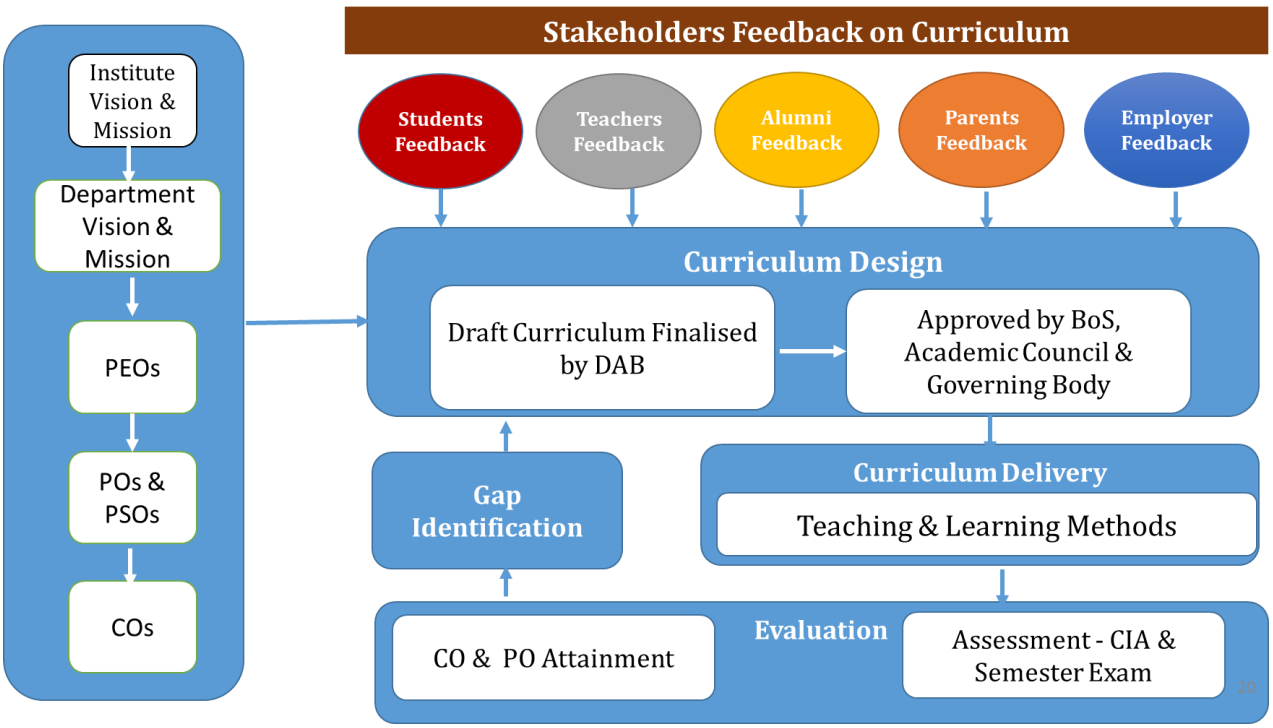
1. By taking the inputs from Vision and Mission of the Institute and Department, PEOs, POs, PSOs, Feedback on the curriculum by stakeholders, brainstorming sessions will be organized by Department Committee to prepare draft copy of course outcomes.
2. After preparing the Course outcomes, mapping with POs and PSOs is done.
3. After mapping process is completed, it is necessary to design the Course content i.e., syllabus which suits to attain the desired Course Outcomes.
4. The draft copy of the Course outcomes and mapping is verified and modified by Department Advisory Committee(DAC).
5. After the approval from DAC, it is submitted to Board of Studies(BoS) for approval.
6. If BoS approves, it is forwarded to Academic council and Governing body. If not, it is sent to DAC for updation of the document.
7. After being approved from Board of Studies, it is to be ratified by Academic Council and Governing Body.
8. After ratification from Academic Council and Governing Body, college will publish the curriculum to all the stakeholders.

The entire Curriculum Design Process is shown in the Fig. 2.3.




## ROLE OF OBE PROCESS IN THE EVOLUTION OF PROGRAM CURRICULUM

Outcome based education concepts are mainly helpful in designing the curriculum for the Programme in an effective way. Various phases of OBE process in designing the curriculum are shown in Fig. 2.4.



## 2.4 TEACHING-LEARNING PROCESS & ACTION PLAN

In Outcome based education, it is necessary to design teaching-learning process and its components in accordance with the desired course outcomes, program outcome and program specific outcomes. For a single course, course instructor(s) will plan different teaching-learning process methodologies as per the subject experience and number of times dealt that course. Initially, course instructor makes ready the action plan to be followed lecture by lecture in a single semester. In general, we call this action plan as a part of teaching learning process as 'lesson plan'. After the content delivery is completed, all assessment tests /activities are completed, CO attainment and PO/PSO attainment will be calculated. After analysis of CO and PO/PSO attainments, it is the responsibility of the course instructor to update the teaching learning process in the next semester as per the outcome of the present academic semester. Course instructor has to decide whether present teaching learning methodologies to be followed or modified or new methodology is to be introduced.

In addition to Chalk & talk, the various teaching-learning methodologies to encourage Participative, Problem solving and Experiential learning are as under:

| | |
|---|---|
| 1. Hackathons | 2. MOOCs |
| 3. Workshops | 4. Google Classroom |
| 5. Seminars | 6. Project- based learning |
| 7. Virtual Lab | 8. Real-time case studies |
| 9. Simulation | 10. Worksheets |
| 11. Role play | 12. PPT |
| 13. Review web literature | 14. Kahoot |
| 15. Video | 16. Mind map |
| 17. Demonstration | 18. Journal Review |
| 19. Activity-based learning | 20. Pogil |
| 21. Jigsaw | 22. Open book test |
| 23. Think-Pair-Share | 24. Proto-type model |
| 25. Flipped Classroom | 26. Cross words |
| 27. Plicker | 28. Research projects |
| 29. Guest lecture | 30. Language games |
| 31. Professional practice school | 32. Viva |
| 33. Group Discussion/ debate | 34. Poster presentation |
| 35. Peer learning groups | 36. Public Speaking |

## ACTION PLAN

Every course instructor prepares a group of teaching methodologies to deliver the content in the classroom. The type of methodology depends on the content, complexity of the topic and interest of the instructor. Every class content is planned well in advance with information about the textbooks and reference books to be studied. All these activities are referred to as action plan' for conducting the course in the given semester period of 16 weeks.
As a template for action plan, one course lesson plan is shown in Annexure VII.

## 2.5. CALCULATION OF CO-PO-PSO ATTAINMENT

- The process of attainment of Cos, POs starts from writing appropriate Cos for each course of the program.
- Then, a correlation is established between Cos and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).
- A mapping matrix is prepared in this regard for every course in the program including the elective courses.
- The course outcomes written and their mapping with POs are reviewed frequently by a BoS before they are finalized.

### 2.5.1. COURSE OUTCOME ASSESSMENT:

CO Attainment is calculated under two components.

- **Direct assessment**
  Direct Assessment refers to the assessment of the activities which are directly connected with an Examination or Test or Quiz where an Instructor will assess the level of attainment of the concepts by all the students of a particular section, by conducting an Examination.

- **Indirect Assessment.**
  Indirect Assessment refers to the assessment of level of agreement of the learner about the skills he derived from the Teaching-Learning process. Learner opinions will be collected through various surveys.

### 2.5.1 a) CO-DIRECT ASSESSMENT

In general, Direct Assessment will have two components.

1. Continuous Evaluation Component
2. Semester End Examination Component

In Continuous Evaluation component, instructor will have direct interaction with all the students during the Semester period. During the course time, Instructor will conduct Sessional Examination or Assignment or Quiz or Slip Test or Flash Test etc. to assess the students' attainment in getting the concepts defined in Course outcomes. After the course instruction period is completed, Semester End Examination will be conducted.

The composition of Continuous Evaluation and Semester End Examination for a Theory course is proposed as follows.

| Nature of Courses | Continuous Evaluation | Semester End Examination | Total |
|---|---|---|---|
| Theory | 40 | 60 | 100 |
| Integrated | 50 | 50 | 100 |
| Laboratory | 60 | 40 | 100 |

## DIVISION OF SUB-COMPONENTS OF CONTINUOUS EVALUATION PROCESS

### Theory Course:

The proposed Sub-Components of Continuous Evaluation Process for a theory course are:

- Continuous Internal Assessment
- Assignment
- Semester End Examination

- The composition and award of marks or grades in various assessment will be as per the resolutions of the Academic Council. It is recommended by the Academic Council that the division of marks
- In the Descriptive Test, each question is appended with its concerned Course Outcome and Bloom's taxonomy level as shown in the specimen below.

| Q. No | Question | CO | BTL |
|---|---|---|---|
| 1a | <Question 1a> | CO1 | K2 |
| 1b | <Question 1b> | CO2 | K3 |

### Laboratory Course:

The proposed Sub-Components of Continuous Evaluation Process for a laboratory course are:

- The composition and award of marks or grades in various assessment tools i.e., Day-to-day evaluation, Observation and Record, Internal Test and Semester End Examination will be as per the resolutions of the Academic Council. It is recommended by the Academic Council that the division of marks for Sessional and Semester End Examination has to be 40% + 60%.
- The marks composition of Day-to-day evaluation, Observation and Record, Internal Test and Semester End Examination in different academic regulations is as follows:

| Day-to-day evaluation | Observation & Record | Internal Test | Total |
|---|---|---|---|
| 25 | 10 | 25 | 60 |

## PROCESS TO SET TARGET PERCENTAGE ATTAINMENT FOR COURSE OUTCOMES

In Outcome based education (OBE) process, it is essential to set a primary target to be set by the Course Instructor prior to the starting of the academic sessions i.e., before the Semester instruction begins. The target setting process necessitates discussion among Course Instructors, Course Coordinator and HOD of the Department.

After discussion, committee will decide the primary targets for each Course Outcome of all the Courses in that Semester. Various factors to be considered in setting the targets are:

a. Complexity of the Concepts included in that Course Outcome (CO)
b. Number of hours to be engaged for that CO.
c. Feedback Report or Opinion from instructors who dealt that Course earlier.

d. Performance levels of the Learners based on Academic record(s).
e. Feasibility of the particular Course to have Demonstration or Equipment Exposure inside a Laboratory

## PRIMARY TARGETS FOR COURSE OUTCOMES

After the OBE process to set the targets for the Course Outcomes, it is decided to set 60% (i.e. 1.8 out of 3) as primary target for each Course Outcome. The motto behind this fixation of 1.8 out of 3 is that if we set a target at low level i.e., 1.0, attainment gaps in Teaching-Learning Process(TLP) may not be identified as we will get the Attainment in most of the cases i.e., Courses. So, to extract the inherent difficulties in TLP, it is suggested to set a target of 60% (1.8 out of 3) for each Course.

### Levels associated with CO Attainment

For any Course Outcome, if less than 60% of the students got more than Threshold percentage (1.8 or 60%) the associated level will be 1. If 60-80 % of the students got more than Threshold percentage (1.8 or 60%) the associated level will be 2. If 80% of the students got more than Threshold percentage (1.8 or 60%) the associated level will be 3.

The interpretations of levels can be taken as 1-Needs improvement, 2-Satisfactory and 3-Excellent.

| | | |
|---|---|---|
| First level | **1** | <60% students attained more than target % |
| Second level | **2** | 60- 80% students attained more than target % |
| Third level | **3** | ≥80% students attained more than target % |

## CALCULATION OF CO ATTAINMENT IN SESSIONAL EXAMINATION

After the Sessional Examination scripts of all the students are validated by the Course Instructor(s), Marks data will be stored in an Excel file enabling data retrieval to be easy enough.

In every sessional examination, there will be 3 components as mentioned earlier, namely Descriptive, Objective and Assignment. In the sessional paper, three (3) questions will be given for Descriptive Examination. Course Outcome (CO) for each question or section of a question i.e., a or b etc., will be indicated.

## CO ATTAINMENT CALCULATION FOR SEMESTER END EXAMINATION

After the Sessional Examination attainment calculation, we need to calculate the attainment for Course Outcomes from the Semester End Examination. It is necessary to collect the question wise data for each student from the Examination Cell. The targets for the Course outcomes are same as of Sessional examinations.

In the Semester End Examination, as the learner will have choice of answering the questions, internal choice will be given. Question paper consists of 10 questions having internal choice i.e., learner can answer 1 or 2, 3 or 4, 5 or 6, 7 or 8 and 9 or 10. Proper care should be taken by the Paper setter to have equal contribution to all the Course outcomes in

the Question paper.

Course Outcome attainment calculation for the Semester End Examination will also be in the similar lines of Sessional Examination Attainment calculation. The only difference is that there will be not be any choice in the sessional examination, whereas in Semester End Examination, it will be. If any Course outcome appears many times in the Question paper the final attainment value of that Course outcome will be the average of all the individual components.

### 2.5.1 b) CO- INDIRECT ASSESSMENT

Indirect assessment for a Course will be done by means of Course Exit Survey. At the end of the Semester, every student has to fill a form in which he /she has to mention the level of their ability to perform the activity defined in a Course Outcome.

The level varies from 1 to 5 based on his/her agreement of student in getting the skills mentioned in Course Outcome definition. Students' agreement level for any course outcome will be as follows.

| Level | Description | Numerical value assigned |
|---|---|---|
| 1 | Strongly Agree | 5 |
| 2 | Agree | 4 |
| 3 | Neutral | 3 |
| 4 | Disagree | 2 |
| 5 | Strongly Disagree | 1 |

### CALCULATION OF COURSE OUTCOME ATTAINMENT

Course outcome attainment calculation from Sessional Examinations, Semester End Examination and Indirect Survey is consolidated as weighted average of the individual components' contribution.

The Sessional Examinations contribute to 40% of Direct Assessment and Semester End Examination contributes to remaining 60% of Direct Assessment.

The Total Course Outcome Attainment comprises of Direct CO Attainment which is obtained through Assessment i.e., Examinations and Indirect CO Attainment which is obtained through Course Exit Survey. The composition of Direct CO Attainment and Indirect CO Attainment will be 80% and 20% respectively.

CO-Direct Attainment= (40%) CO-Sessional Attainment + (60%) CO-Semester End Examination Attainment

CO- Indirect Attainment will be directly obtained from the Course Exit Survey on a scale of '3'.

Consolidated CO Attainment= 80% of CO-Direct Attainment + 20% of CO-Indirect Attainment

The entire process of CO Assessment for a Theory course, Laboratory course and Project

course is shown in Fig. 2.4(a), Fig. 2.4(b) and Fig. 2.4(c) respectively.

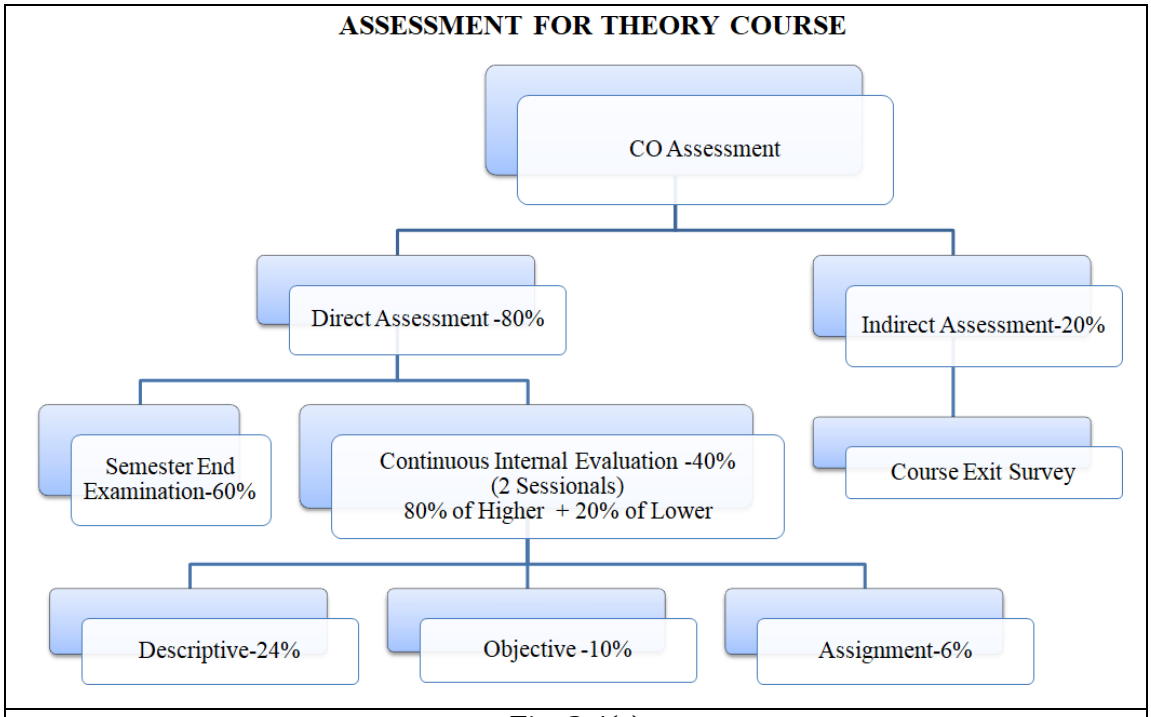



Fig. 2.4(a)

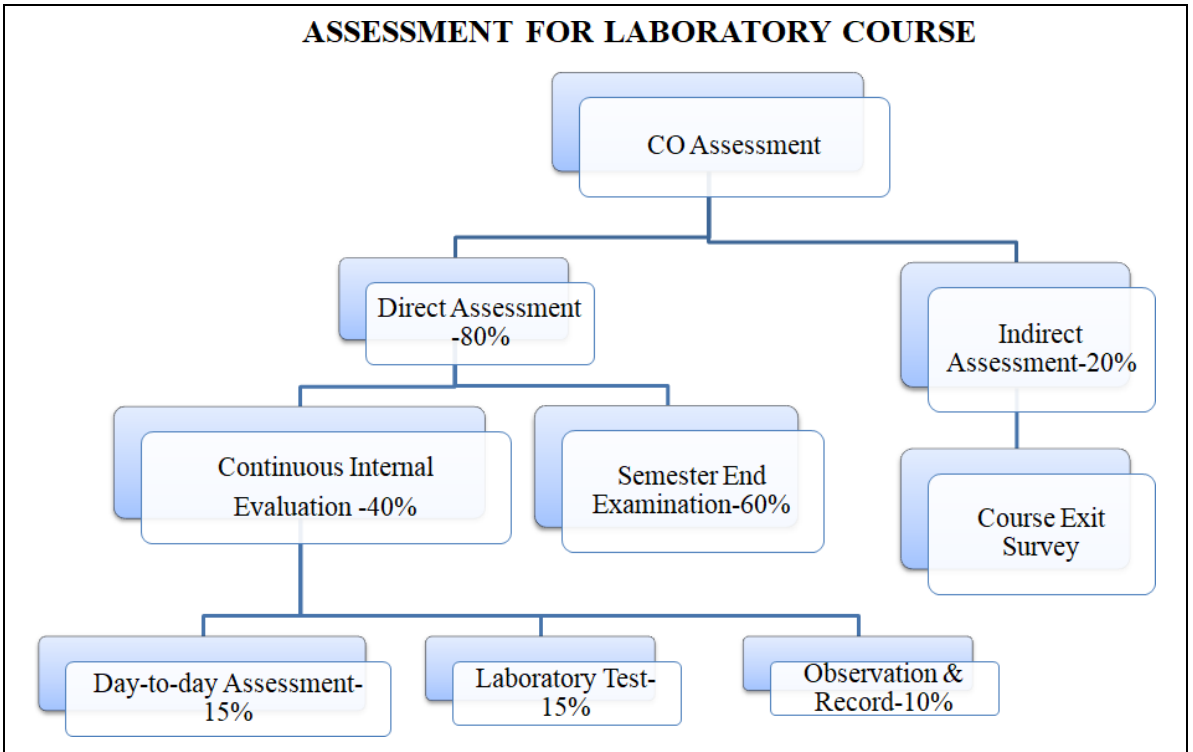



Fig. 2.4(b)

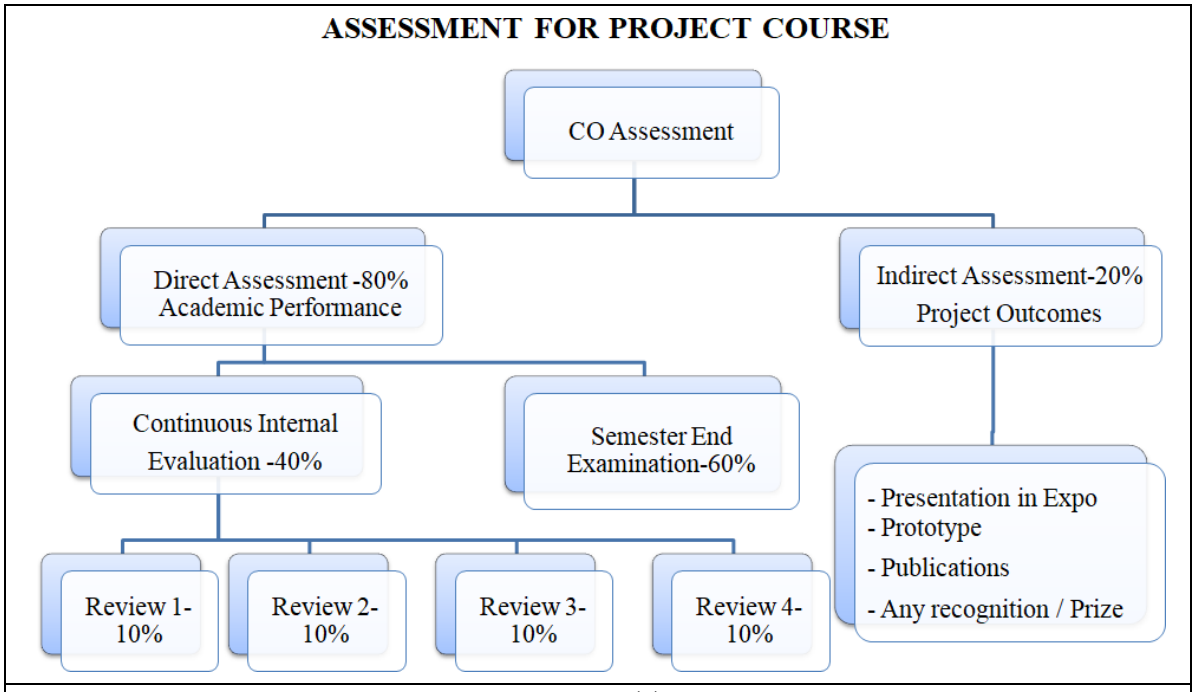



Fig. 2.4(c)

## 2.5.2. CALCULATION OF PO & PSO ATTAINMENT

The attainment of Program Outcome as well as Program Specific Outcome will be based on the relative mapping of Course Outcomes with PO and PSO. For this, primarily, CO_PO_PSO mapping has to be done properly.

Every Course Outcome by virtue of its content will induce some qualities or skills in the learners. Course instructor must disclose the skills to be induced by a particular Course Outcome in relation to PO1 to PO12.

There will be some correlation or synchronization of the skills expected from Graduate Engineer (PO) and skills induced through Instruction process (CO). We must assign some numerical values to have a measurement for comparison. It is suggested by OBE community that levels 1,2 and 3 can be assigned based on CO_PO_PSO mapping. If the synchronization is substantial or high, CO-PO mapping level is '3'.

**Example:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | - | - | 1 | - | 2 | - | - | - | - | 2 | - |
| CO4 | - | 1 | 1 | 1 | - | - | - | - | - | - | 1 | - | 1 | - |
| CO5 | 1 | 1 | - | - | 1 | - | - | 1 | - | - | - | - | 1 | 3 |

**MAPPING STRENGTH:**

- It is the numerical measure of the extent of correlation of a particular Program outcome with the Course as a total.
- It is calculated as an average of mapping values of a particular Program outcome with all the Course outcomes of a course.
- For example, the Mapping Strength of PO1 taking CO-PO-PSO mapping table above will be calculated as.
- **Mapping strength of PO1** = Average of {3, 2, 2, -, 1} = (3+2+2+1)/4

  = 2 Similarly mapping strengths of PO2 to PO12 and PSOs also can be

  calculated.

**CALCULATION OF PO & PSO ATTAINMENT**

Program Outcome Attainment and Program Specific Outcome Attainment of a Course is having two components namely, Direct Attainment and Indirect Attainment in the similar lines of Course Outcome Attainment.

- Direct Attainment refers to the attainment of PO/PSO through CO Attainment
- Indirect Attainment refers to the attainment of PO/PSO through Surveys i.e., Program Exit Survey, Alumni Survey, Parents Survey &Employer Survey and co-curricular & extra-curricular activities.

**CALCULATION OF PO-DIRECT ATTAINMENT**

Direct Program Outcome Attainment and Program Specific Outcome Attainment will be calculated directly from the Course Outcome Attainment through a formula taking inputs from CO-PO-PSO mapping table.

**PO/PSO Attainment**

**= Weighted Average of Mapped Course Outcomes**

**Example:**

- In the earlier section, for PO1. Here PO1 is mapped with CO1, CO2, CO3 and CO5 at 3, 2, 2 and 1 levels respectively.
- Let the CO attainments of CO1, CO2, CO3, CO4 and CO5 be 2.12, 2.34, 1.56, 1,23 and
- 2.56 respectively.
- Now the PO1 Direct Attainment = Weighted Average of Mapped Course Outcomes
- = Weighted Average of (2.12, 2.34, 1.56, 1.23,2.56),(3,2,2,0,1)=(2.12*3+2.34*2+1.56*2+1.23*0+2.56*1)/(3+2+2+0+1)= 2.09
- It is declared that PO1-Direct Attainment for a Course 1 is 2.09 In the same way, PO2-Direct Attainment for the Course 1 is 2.08 Similarly, attainments for other POs are also calculated.

## CALCULATION OF CONSOLIDATED PO/PSO DIRECT ATTAINMENT

The consolidated PO-Direct Attainment of all the program outcomes is calculated as an Average of (PO-Direct Attainments) of all the Courses which are mapped with those Program Outcomes.

To sum up easily, all the values are to be entered in a matrix. The final value of a Program Outcome for a list of courses will be the Arithmetic Average of all the Direct PO Attainments of the Individual Courses listed together.

**Example:**

Let PO1, Direct Attainment values for the Courses C201, C202, C304 and C403 are 1.43,2.41,1.22 and 2.67 respectively. Then Consolidated Direct PO Attainment for PO1 will be Arithmetic Average of (1.43,2.41,1,22 and 2.67) = **1.933**

## CALCULATION OF PO-INDIRECT ATTAINMENT

Indirect PO attainment calculation will be done through Survey Reports and Attainment reports from various Co-curricular and Extracurricular activities. The various surveys are.

- Program Exit Survey
- Alumni Survey
- Employer Survey
- Parents' Survey

## CO-CURRICULAR AND EXTRA-CURRICULAR ACTIVITIES

As the program outcomes PO6 to PO12 are not related to technical domain, they will be achievement to the full extent or satisfactory level skill development through academic courses. In view of this, other activities i.e., co-curricular and extra-curricular activities are conducted to enhance the skills related to PO6 to PO12. All these activities enhance the team working skills, individual decision making skills, societal involvement, environmental concern and professional ethics in the societal and industrial operations, communication skills in dealing with the group and outsiders, project and finance management in executing the activities in a better way. In the process of participating and executing the activities automatically enhance the lifelong learning skills, which is PO12.

Various committees are framed to involve students in the activities. They are.

- Alumni Coordination Committee
- Career guidance, training and placement committee
- Committee for Co- Curricular Activities
- Committee for Extension activities –NSS
- Committee for Extra- Curricular Activities
- Committee for industry institute coordination and entrepreneurship development
- Professional Societies Coordination Committee
- Sports and games

The operations of any such committee can be explained briefly as:

1. Functions/objectives of committee are defined.
2. Functions mapping with Program Outcomes (PO) articulation matrix is to be prepared.
3. Tools / rubrics to assess the levels of attainment are to be prepared.
4. After completion of the activities, attainment is to be calculated.

As an example, the operations of Cultural committee are presented.

**1. Functions/objectives of Cultural Committee**

F1. Organize Extra-curricular activities.

F2. Inculcate human values through fine arts.

F3. Plan and schedule cultural events for the academic year.

F4. Train the students to ensure the best performance in cultural events.

F5. Provide a supportive environment for the students interested in photography so as to share their creativity, knowledge, and passion for photography.

F6. Encourage students to participate in various inter-col1ege cultural events.

## 2. Functions-POs Mapping

The correlation levels of the functions of committee with the POs is shown below.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | - | - | - | - | - | 3 | - | - | - | - | - | 1 |
| F2 | - | - | - | - | - | - | - | - | 2 | - | - | 2 |
| F3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| F4 | - | - | - | - | - | - | - | - | - | - | 3 | 2 |
| F5 | - | - | - | - | - | 2 | - | 2 | - | - | - | 1 |
| F6 | - | - | - | - | - | 2 | - | - | - | 2 | - | 2 |

**3. Procedure for PO attainment through Cultural Activities:**

Program outcome(PO) attainment as its indirect component will be attained through Cultural activities. As the cultural activities are conducted involving students having different number of participants in different events, rubrics will be developed to quantify the activities data. The various parameters for rubrics are as under:

1. Number of events conducted.
2. Number of students participated in the events.
3. Number of awards received.

**Rubrics developed to assess cultural activities:**

Based on the available data of cultural activities conducted, rubrics will be applied to calculate the level of attainment for each parameter. The levels based on parameters are shown in the table below.

| S. No | Parameter | Level-1 | Level-2 | Level-3 |
|---|---|---|---|---|
| 1 | No. of events conducted | 5 | 6-10 | >10 |
| 2 | No. of Students Participated | ≤30 | 31-79 | 80-120 |
| 3 | No. of Awards received | 2 | 3-5 | >5 |

## 4. PO Attainment Calculation process

All these activities will involve students such a way that Professional Program Outcomes (PO6 to PO12) is attained successfully through these activities. An articulation matrix mapping the rubric parameter and Program Outcome is prepared. The level of attainment is shown in the table.

| | Attainment | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **T1** | No. of events conducted | | | | | | 3 | | | 2 | 2 | | |
| **T2** | No. of Students Participated | | | | | | | | | 3 | 2 | | 2 |
| **T3** | No. of Awards received | | | | | | | | | 2 | 2 | | 2 |
| **Avg. Attainment** | | | | | | | **3** | | | **2.3** | **2** | | **2** |

Based on the number of events conducted, students participated, awards received, the attainment levels for the tools and corresponding POs are identified. The attainments level for T1 with PO6 is 3 (the number of events conducted is 13) for PO6, T1 with PO9 is 2, T1 with PO10 is 2, T2 with PO9 is 3 etc. The Average attainment for each PO is calculated. i.e2.3 for PO9, 2 for PO10 and 2 for PO12.

In the same way all other committees' attainments are to be calculated and entered in a consolidated table along with Survey reports attainments.

All the survey reports and other activities will calculate the PO attainment in '3' scale. The process is similar to the Indirect Survey attainment calculation in the case of Course Outcome Indirect Survey. Consolidated Indirect PO Attainment will be the Arithmetic Average of all the survey reports mentioned above.

## CALCULATION OF OVERALL PO ATTAINMENT

Final Consolidated Program Outcome Attainment will be Weighted Sum of Consolidated Direct Attainment and Consolidated Indirect Attainment of individual Program Outcome. The weightages for Direct and Indirect components are 80% and 20% respectively.

OVERALL PO ATTAINMENT

= 80 % of Direct PO Attainment + 20% Indirect PO Attainment

In the example discussed above, for PO1, Direct Attainment is 1.933 and Indirect Attainment is 0.793.

Now, OVERALL PO ATTAINMENT = 0.8* 1.933 + 0.2 * 0.793 =1.705.

In the same way, Final PO/PSO Attainment values will be calculated for all other Program Outcomes.

The entire process of PO/PSO attainment process is shown in Fig. 2.5(a)

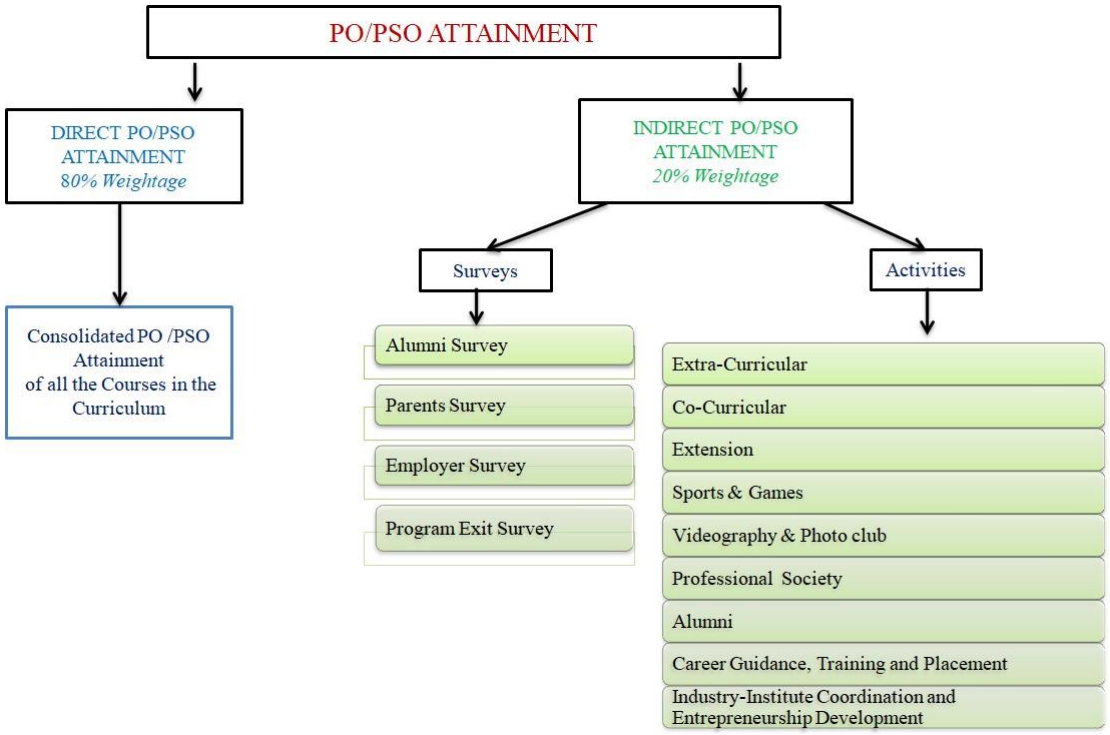



Fig. 2.5(a)

## BRIDGING THE CO ATTAINMENT GAP

In the Outcome Based Education, it is mandatory to upgrade or modify the Teaching-Learning Process (TLP) from time to time according to the Course Outcome Attainment. Starting from Definition of Course outcome to Attainment of Course outcome, Teaching Learning process includes many stages. Initially Course instructor will set a target or threshold percentage i.e., 1.8 in present case.

- After the valuation process is completed, a consolidated statement is prepared comparing the Threshold CO attainment and Actual CO Attainment. The difference between Threshold CO attainment and Actual CO Attainment will be called as 'Attainment Gap'.
- If the 'Attainment Gap' is positive, it indicates that the Teaching Learning Process (TLP) being followed for that Course is resulting well in improving the skills of the learners as desired in the definition of Course outcome. In this case, target value or threshold value of CO attainment can be improved.
- For the analysis purpose, it is recommended to continue the same target to compare two academic batch students.
- If the 'Attainment Gap' is negative, it indicates that the Teaching Learning Process (TLP) needs some corrections or modifications which will be suggested primarily by the Course Instructor who dealt that Course recently.
- Whether the attainment gap is positive or negative, the instructor has to identify the component of TLP which corresponds to that gap either positive or negative. This should be posted in the column 'Observations'.
- As a part of improvement in TLP, Course Instructor being fully aware of the Present Instruction process, Paper setting process and Paper valuation process, has to recommend or suggest the Action proposed to bridge the gap. After the results are announced, Course instructors have to get the data and analyse it for Course Outcome Gaps. Instructor has to find the gaps in the Teaching learning process of his course. The gaps in the TLP are to be filled by taking remedial action for the next batch of students for the same course. The 'action proposed to bridge the gap' needs to be dynamic in filling the earlier CO Gaps. The proposed changes in TLP should be posted in the column 'improvements'.
- The suggestions of the present Course Instructor to bridge the gap between Threshold CO Attainment and Actual CO Attainment are to be carried to the Course Instructor(s) who are going to deal with that Course in the next semester(s) by the Department OBE coordinator or HOD of the Department.
- Based on the earlier suggestions to improve the TLP, next level Course Instructors will decide the modifications in their TLP so that CO attainment gap can be reduced or made positive.

**BRIDGING THE PO/PSO ATTAINMENT GAP**

Similar to the Attainment Gap in the case of Course Outcome, Program Outcome Gap will also be calculated, and remedial action needs to be initialized. Final PO /PSO Outcome Attainment is to be compared with the Mapping Strength of the CO-PO-PSO to find the PROGRAM OUTCOME GAP. Program Outcome Gap enables us to find solutions to fill the gap through academic activities.

In the earlier section discussed, for PO1, Final Attainment value is 1.819 whereas Mapping strength is 2.00.

Now the PO gap for PO1 will be 2.00 – 1.819 = 0.181

Similarly, PO attainment gaps will be calculated for all the other program outcomes.