2025

OBE Manual

MANAKULA VINAYAGAR INSTITUTE OF TECHNOLOGY

An Autonomous Institution

Affiliated to Pondicherry University, Approved by AICTE, New Delhi,
Accredited by NBA, New Delhi and NAAC with 'A' Grade
Kalitheerthalkuppam, Puducherry- 605 107.

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Preface

Outcome Based Education (OBE) is an educational theory that can improve the quality of education delivered to young minds by means of setting a specified outcome. The outcome based education gives a very good flexibility to faculty and students in achieving their goals by adopting varied teaching and learning tools according to their capacity. The main objective is ultimately to improve the quality of the graduates. The traditional methods of teaching is augmented by addition of measurable and realizable goals and are clearly evident by adopting outcome based education.

Benefits of OBE

The Students are more clear on the goals and are more relevant for current industrial demands at the end of graduation.

OBE provides an avenue for restructuring the curriculum and assessment procedures in education and involves higher order learning and mastery than conventional educational systems.

OBE promotes more student involvement in learning and also increases responsibility among students and provides a platform to demonstrate their abilities.

OBE provides better communication between teachers and students and improves students performance as they know what is expected and what is assessed.

OBE can provide a good strategy for continuous improvement.

India, OBE and Accreditation

From 13th June 2014, India has become the permanent signatory member of the Washington Accord. Implementation of OBE in higher technical education also started in India. The National Assessment and Accreditation Council (NAAC) and National Board of Accreditation (NBA) are the autonomous bodies for promoting global quality standards for technical education in India. NBA has started accrediting only the programs running with OBE from 2013. The National Board of Accreditation mandates establishing a culture of outcome based education in institutions that offer Engineering, Pharmacy, Management program. Reports of outcome analysis help to find gaps and carryout continuous improvements in the education system of an Institute, which is very

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Vision and Mission of the Institute

Vision

To be a globally reputed Technical Institution creating Competent leaders and Skillful innovators in Science, Technology and Management.

Mission

* Providing a dynamic and creative learning environment for its students to acquire exemplary technical, analytical, professional skills.
* Imbibing a spirit of innovation and research among its students and faculty for solving critical problems.
* Promoting Innovation, Employability and entrepreneurship skills through industry academia collaboration.
* Serving the society through technical intervention and creating socially responsible Professionals.

Core Values

- Technology based Education
- Industry interaction
- Green campus
- Community development
- Global vision
- Commitment to excellence
- Social Responsibility

OBE Enactment

BEFORE SEMESTER BEGINS

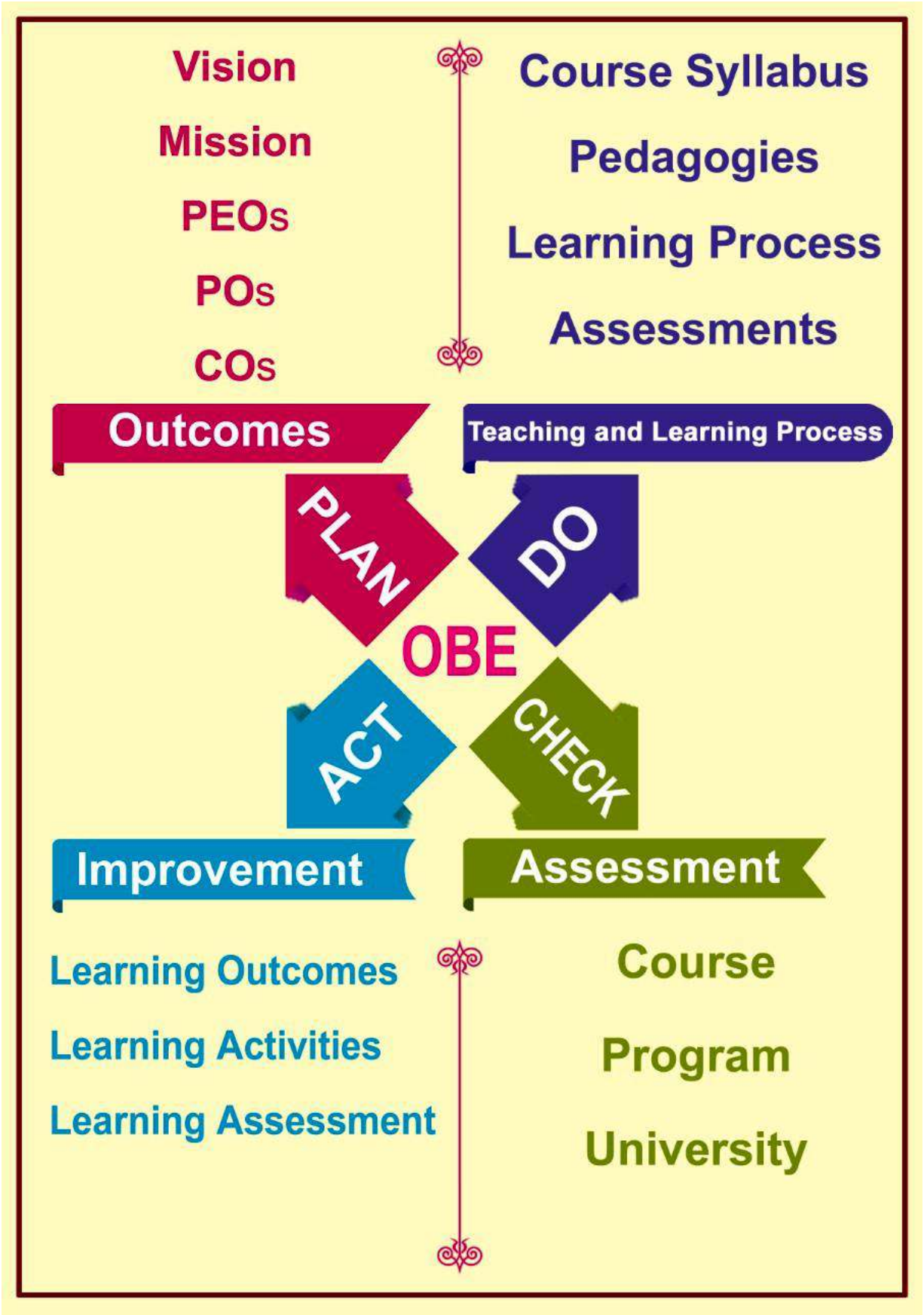
1. Subject Preference.
2. Subject allocation based on expertise.
3. Notes, Lesson plan, Course Information Sheet preparation.
4. Quality Assessment cell verification & approval of course contents.

DURING SEMESTER

1. Verification of Quality of Tests.
2. Feedback Analysis.
3. Quality circle meetings & Corrections.
4. Check on active teaching strategies by Heads.
5. Implementation of all activities.

END OF SEMESTER

1. Course exit survey.
2. Assessment & Evaluation of Co & PO attainments.
3. Academic audition quality of the contents delivered and suggestion for improvement.


Vision
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PLAN
DO
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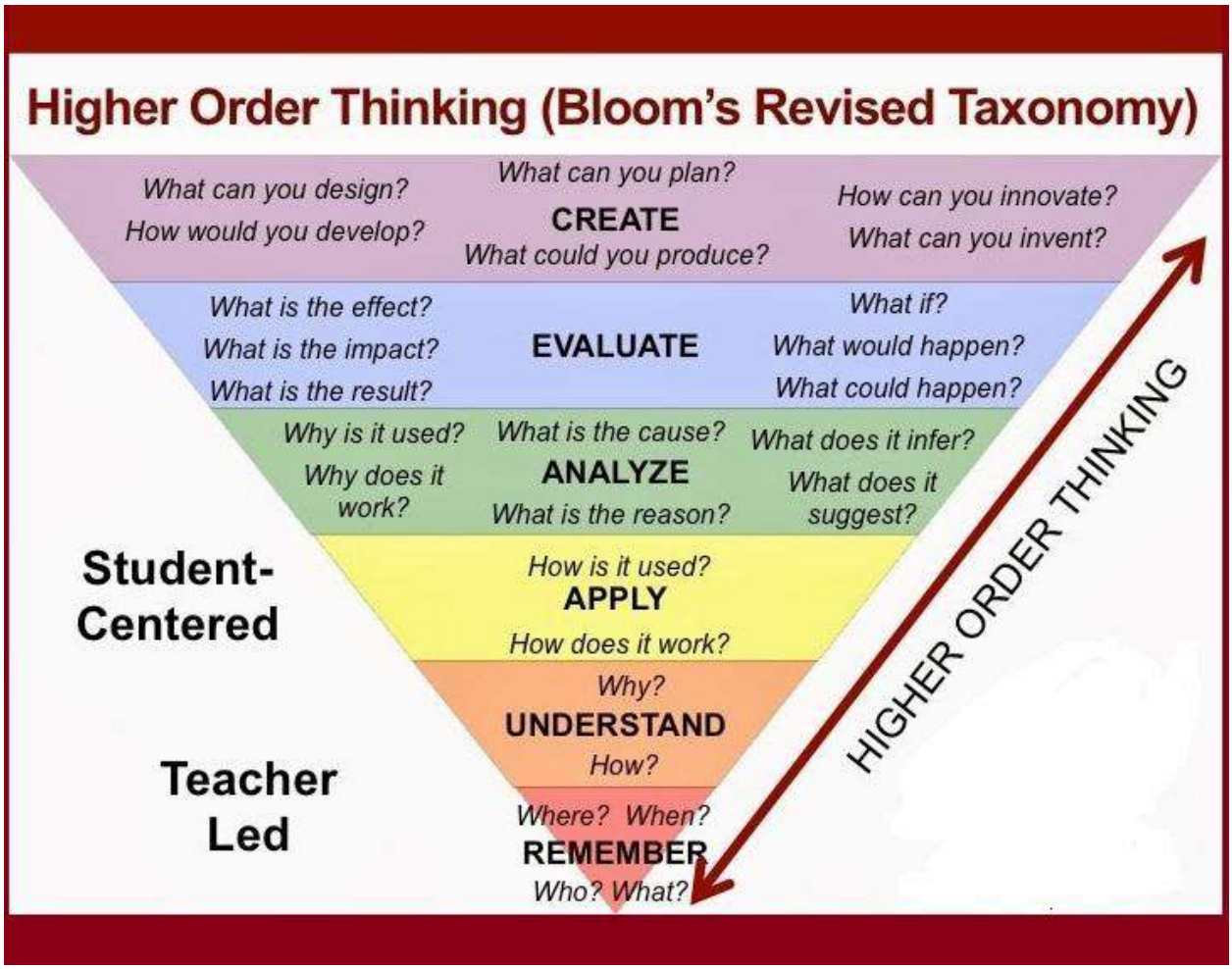
Procedure to be followed for Implementing OBE

- Every faculty member must write Course Outcomes (COs) for the subject allotted to them.
- The Course Outcomes are written with Bloom's Taxonomy action verbs indicating the cognitive level at which the faculty plans to teach based their expertise.
- CO – PO mapping has to be done using Blooms Taxonomy correlation level between written CO and POs.
- Activities and Assessment tools should be planned for each of the mapped values in CO-PO matrix.
- Faculty have to Prepare the Test items for the above CO-PO matrix based on Competency level and Performance Indicators.
- Faculty should plan and conduct activities like Quiz, Chart presentation, Assignment etc., for matrix values in the CO-PO map that is not covered by the Test Items.
- Faculty must take course Exit survey at the end of the semester for their subjects to get indirect attainment of COs.
- Faculty must calculate the CO attainments for each subject from the Internals exams results and university results. The PO attainments are calculated from CO-PO map values.
- Department will collect surveys for PO Indirect attainment and calculate the overall attainment.
- The Department Committee will verify the above process regularly.
- The scope for improvement and fixing targets for next academic years will be decided at the end of each academic year by Department Committee.

BLOOMS TAXONOMY

Understanding Various Levels of Bloom's Taxonomy



Source: teachingutopians.com

Note:

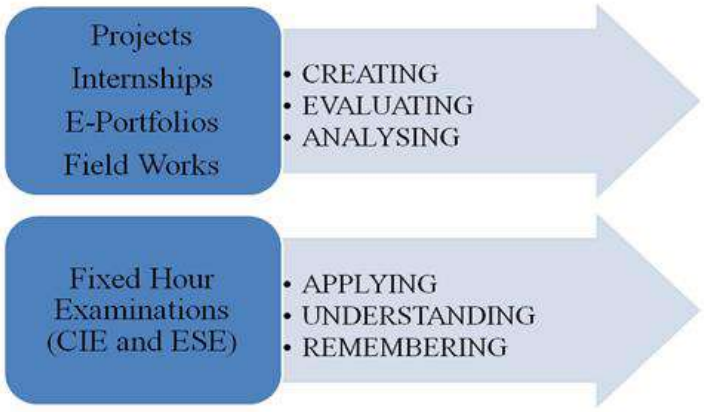
- The end semester written examinations can assess only very limited course outcomes and program outcomes.
- It means written examinations of time bound duration are not sufficient to make valid judgement about student learning.
- Therefore, some alternative assessment methods like problem solving assignments, projects portfolios etc. are required to assess the higher order skills at level 4, 5 and 6.

Top three levels i.e., Creating, Evaluating and up to some extent Analyzing are to be assessed by extended course works like projects, internship experiences and e-portfolios of students. Adoption of Bloom's Level framework should be implemented at university level for the sake of uniformity and to provide same playing field to all students regarding:

- Mapping of questions in the written examinations with Course Outcomes and then with Program Outcomes.
- Weightage of Bloom's Level attached to each question in the question paper.
- Criteria of assessment with mapping of questions in the viva-voce with Course Outcomes and then with Program Outcomes.
- Characteristics which are to be assessed.
- A rating scale which defines student's ability within each criterion.
- Mapping of scale with Course outcomes and hence Program outcomes.

Bloom's level	Description Attainment of Skill	Attainment of Skill
1	**Remembering**	Memorization of facts or knowledge attained in class or by reading the subject material.
2	**Understanding**	Explanation of previously learned material, ideas or concepts.
3	**Applying**	Use of knowledge attained for the application in another similar situation.
4	**Analyzing**	Split the information into parts and to find relationships between them and able to analyze.
5	**Evaluating**	Based on the work done and knowledge to justify the decision taken.
6	**Creating**	Develop and design a new concept or to generate a new idea while solving a problem.

Assessment Tools for Different Bloom's Levels



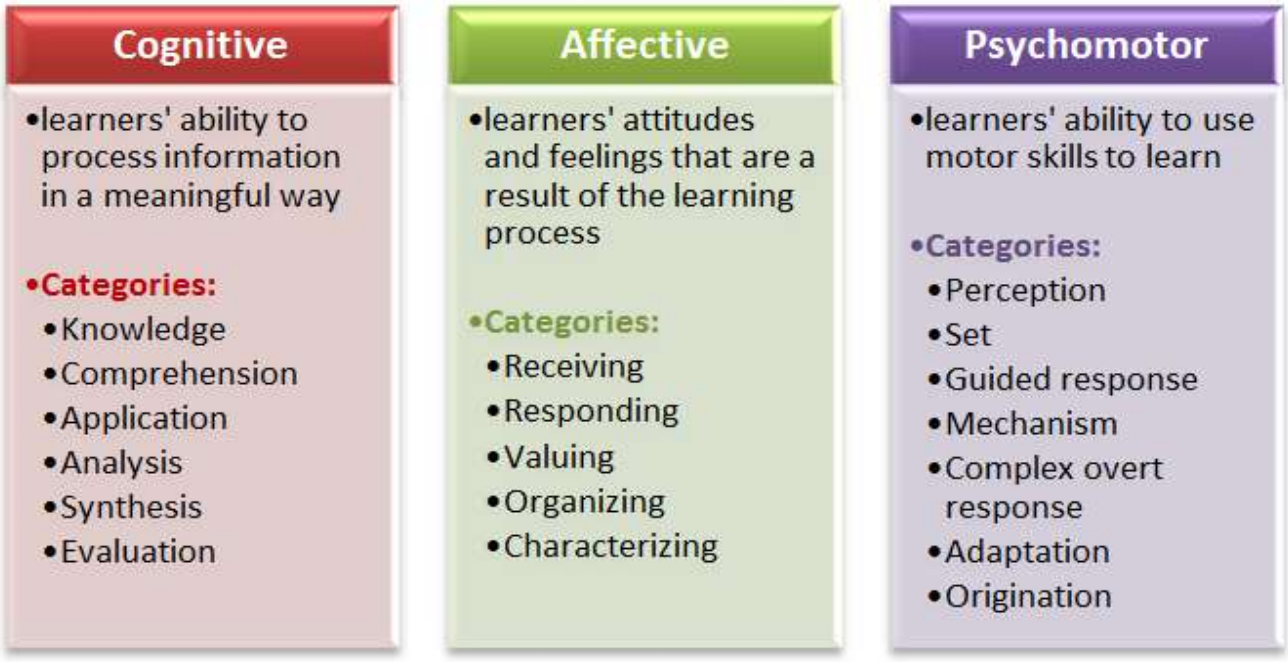
Learning Domains

"**Domains of learning**" refers to the three separate, yet interdependent components of learning outcomes achievable by human learners. These domains--cognitive, affective, and psychomotor represent various categories and levels of learning complexity and are commonly referred to as educational taxonomies.

The cognitive domain (*knowledge*) refers to knowledge attainment and mental/intellectual processes.

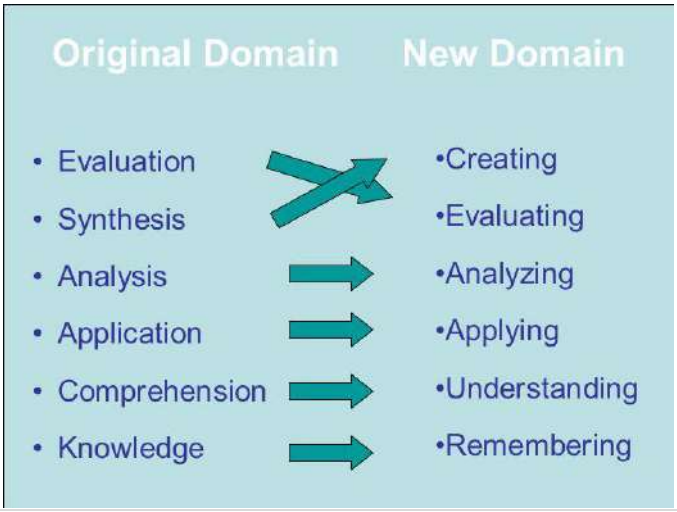
The affective domain (attitude or self) characterizes the emotional arena reflected by learners' beliefs, values and interests.

The psychomotor domain (manual or physical skills) reflects learning behavior achieved through neuromuscular motor activities.



Courtesy: https://tell.colvee.org/

The Revised Blooms Taxonomy in the cognitive Domain. This new taxonomy reflects a more active form of thinking and is perhaps more accurate.



Revised Bloom's Action Verbs for Course Outcomes

Remember	Understand	Apply	Analyze	Evaluate	Create
Arrange	Alter	Apply	Analyze	Appraise	Arrange
Cite	Classify	Change	Appraise	Argue	Assemble
Define	Convert	Choose	Ascertain	Assess	Collect
Identify	Defend	Compute	Associate	Attach	Combine
Label	Describe	Demonstrate	Breakdown	Choose	Comply
List	Discuss	Discover	Calculate	Compare	Compose
Memorize	Explain	Dramatize	Categorize	Conclude	Conceive
Match	Express	Draw	Compare	Critique	Construct
Name	Extend	Employ	Conclude	Deduce	Create
Order	Generalize	Illustrate	Contrast	Defend	Derive
Outline	Give examples	Interpret	Criticize	Estimate	Devise
Pronounce	Indicate	Manipulate	Designate	Evaluate	Expand
Quote	Locate	Modify	Determine	Judge	Extend
Recall	Paraphrase	Operate	Diagnose	Justify	Formulate
Recite	Recognize	Practice	Diagram	Predict	Generate
Recognize	Rephrase	Prepare	Differentiate	Prove	Integrate
Repeat	Restate	Produce	Discriminate	Rate	Invent
Reproduce	Reword	Schedule	Distinguish	Review	Modify
State	Rewrite	Show	Divide	Support	Originate
	Select	Sketch	Examine	Value	Plan
	Summarize	Solve	Experiment	Weigh	Prepare
	Translate	Use	Find		Project
			Infer		Rearrange
			Outline		Reconstruct
			Point out		Reorganize
			Separate		Set up
			Specify		Synthesize
			Subdivide		

Courtesy : IIT-KGP

Cognitive domain

The cognitive domain is focused on intellectual skills such as critical thinking, problem solving, and creating a knowledge base. It was the first domain created by the original group of Bloom's researchers. The cognitive hierarchy spans from simple memorization designed to build the knowledge of learners, to creating something new based on previously-learned information. In this domain, learners are expected to progress linearly through the hierarchy, beginning at "remember" and ending at "create."

A search for "Bloom's Verbs" will provide lists of synonyms to use.

Course Outcome Formation

What should an CO contain?

Course Outcome (CO) describe what students are able to demonstrate in terms of knowledge, skills, and values upon completion of a course. Clear articulation of learning outcomes serves as the foundation to evaluate the effectiveness of the teaching and learning process.

Effective, learning objectives need to be **specific, observable** and **measurable** statements

The Components of a Measurable Course Outcome.

Three essential components of a measurable Course Outcome are:

- Student learning behaviors
- Appropriate assessment methods
- Specific student performance criteria / criteria for success When writing a measurable Course Outcome, it is important to:

⇒ focus on student behavior

⇒ use simple, specific action verbs

⇒ select appropriate assessment methods

⇒ state desired performance criteria

Focus on Student Behavior.

Course Outcomes are about what students are able to demonstrate upon completion of a course. Course Outcomes are not about what the instructors can provide but what the students can demonstrate. The following are not Course Outcomes:

× Offer opportunities for students to master integrated use of information technology.

× The program will engage a significant number of students in a formalized language/cultural studies program.

× Students who participate in critical writing seminars will write two essays on critical thinking skills.

× Students will be exposed to exceptionality in learning disabilities including visual and perception disabilities.

Use Simple, Specific Action Verbs.

When writing Course Outcomes, focus on student behavior and use simple, specific action verbs to describe what students are expected to demonstrate.

The following are examples of Course Outcomes:

- Students will be able to **collect** and **organize** appropriate clinical data (history, physical exam, laboratory assessments including technology advancements in diagnostic such as PCR).
- Students will be able to **apply** principles of evidence-based medicine to determine clinical diagnoses, and formulate and implement acceptable treatment modalities.
- Students will be able to articulate cultural and socioeconomic differences and the significance of these differences for instructional planning.
- Students will be able to use technology effectively in the delivery of instruction, assessment, and professional development.
- Students will be able to evaluate the need for assistance technology for their students.

Note: Bloom's Taxonomy can be a useful resource in developing Course Outcomes.

ACTION VERBS

Concrete verbs such as "define," "apply," or "analyze" are more helpful for assessment than verbs such as "be exposed to," "understand," "know," "be familiar with."

Cognitive Learning	Action Verbs:
Remember- to recall or remember facts without necessarily understanding them	arrange, define, duplicate, label list, memorize, name, order, recognize, relate, recall, reproduce, list, tell, describe, identify, show, label, collect, examine, tabulate, quote
Understand – to understand and interpret learned information	classify, describe, discuss, explain, express, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, translate, review, restate, locate, recognize, report
Apply– to put ideas and concepts to work in solving problems	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, calculate, complete, show, examine, modify, relate, change, experiment, discover
Analyze– to break information into its components to see interrelationships and ideas	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test, separate, order, connect, classify, arrange, divide, infer
Evaluate– to judge the value of information based on established criteria	appraise, argue, assess, attach, defend, judge, predict, rate, support, evaluate, recommend, convince, judge, conclude, compare, summarize
Create – to use creativity to compose and design something original	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, rewrite, integrate, create, design, generalize

Select Appropriate Assessment Methods.

Assessment methods are tools and techniques used to determine the extent to which the stated Course Outcomes are achieved. A variety of methods, qualitative and quantitative, direct and indirect, should be used. The following are examples of direct and indirect assessment methods:

Examples of Direct Assessment Methods:	**Examples of Indirect Assessment Methods:**
Internal assessment University Examinations Certification exams Assignments Mini-projects major project Internship evaluations Grading with scoring rubrics* Comprehensive exams	Course Exit Surveys after end of each course Employer surveys Program Exit Survey

State Desired Performance Criteria.

Performance criteria express in specific and measurable/observable terms that are acceptable to a specific course or program. Note that grades alone do not provide adequate feedback to students' performance because grades represent overall competency of students and do not identify strengths and weaknesses on specific Course Outcomes. However, if the grading system is tied to rubrics, it can be a useful tool to identify areas for improvement that should be addressed. The following is not an acceptable measurable Course Outcome:

Students will be able to communicate effectively, as demonstrated by obtaining at least a "C" grade in the course.

With slight modification, the above Course Outcome can be stated in measurable terms.

✓ *Students will be able to communicate effectively, as exhibited by scoring at least 8 out of 10 for all the components within the grading criteria on the final writing assignment.*

Parts of a Course Outcome Statement

Performance: This component is a description of what learners will be able to do at the end of the learning experience. It is designated by an **action verb** so that it is ***observable***.

Conditions: The Component defines the conditions in which learners will perform the learning tasks. This is what makes your learning objective ***specific***.

Criteria: The component defines how learners will be assessed. This component of your learning objective is what makes it ***measurable***.

Example :

At the end of this lesson, you will be able to:

Bang the appropriate nail into a plank of press-board without splitting the wood.

Performance *Conditions* *Criteria*

Performance	Condition	Criteria
"What learners must be able to DO or PERFORM when they demonstrate mastery of an objective." You may answer Questions like *" What will the person be able to do after learning the topic?"* **Example** 1. *Be able to write a news article.* 2. *Construct a model car ..* 3. *Solve mathematically*	Describes the condition under which the learner performs an action. You may answer Questions like " What will you give the person to use?" "*what will be the environment?"* **Example** 1. *Using a Calculator* 2. *Using a transform in mathematics* 3. *Using a scale* 4. *In the daylight* *5. Using a tool*	The criteria will tell the level of proficiency that is expected and it will tell how the learner will perform in terms of quantity, quality, and/or time measurements. You may answer questions like "*How many?" " How fast?" " How well?"* **Example** 1. *Within 10 minutes* 2. *80% or better* 3. *In compliance with the chart* 4. *Within acceptable industrial standards.*

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes

(Revised 2025)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

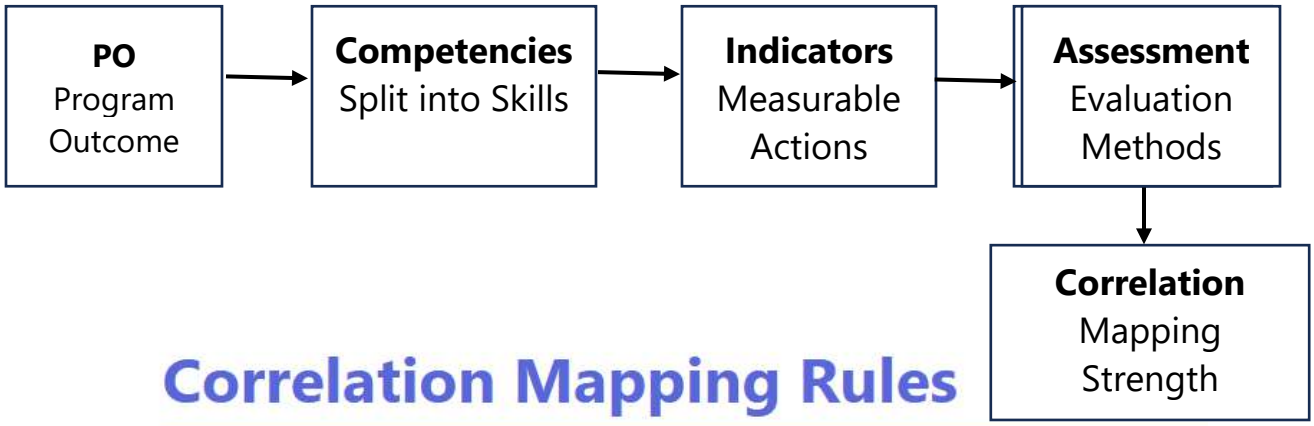
PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

CO-PO Articulation Matrix

A Guide to Mapping Course Outcomes with Program Outcomes



Correlation Mapping Rules

High Correlation

3

Coverage: 100% of competencies
Indicators: All indicators mapped
Bloom's: Appropriate levels covered
Assessment: Complete evaluation methods

Moderate Correlation

2

Coverage: ~50% of competencies
Indicators: Half indicators mapped
Bloom's: Partial level coverage
Assessment: Some evaluation methods

Low Correlation

1

Coverage: <50% competencies
Indicators: Few indicators mapped
Bloom's: Sparse coverage
Assessment: Limited methods

No Correlation

0

Coverage: No competencies
Indicators: No indicators mapped
Bloom's: Not addressed
Assessment: No assessment items

Example: PO2 - Problem Analysis

Competency 2.1: Identify and Formulate Complex Engineering Problems

Indicator 2.1.1
Articulate problem statements and identify objectives

L2: Understand

Assessment:
- Problem statement questions in Test 1
- Case study analysis assignment

Indicator 2.1.2
Identify engineering systems, variables, and parameters

L4: Analyze

Assessment:
- System analysis in Mid-term exam
- Laboratory experiment reports

Indicator 2.1.3
Identify relevant mathematical and engineering knowledge

L3: Apply

Assessment:
- Mathematical modeling questions
- Tutorial problems

Competency 2.2: Formulate Solution Plan and Methodology

Indicator 2.2.1
Reframe complex problems into sub-problems

L4: Analyze

Assessment:
- Project decomposition tasks
- Flowchart assignments

CO-PO Articulation Assessment Mapping

Course: Digital Signal Processing | CO2: Design and implement digital filters

PO	Competency	Indicators	Bloom's Level	Assessment Items	Coverage %	Correlation Score
PO1	1.1 Mathematical Modeling	1.1.1, 1.1.2	L3	Q1-Q3 (Test 1), Assignment 2	100%	3
	1.2 Basic Sciences	1.2.1	L2	Q4 (Test 1), Lab 3	100%	
	1.3 Engineering Fundamentals	1.3.1	L3	Mid-term Q2-Q4	100%	
PO2	2.1 Problem Identification	2.1.1	L2	Case Study 1	50%	2
	2.2 Solution Methodology	-	-	Not assessed	0%	
PO3	3.1 Define Requirements	3.1.1	L6	Final Project (partial)	25%	1

High (3): 100% Coverage Moderate (2): ~50% Coverage Low (1): <50% Coverage None (0): No Coverage

Step-by-Step Articulation Process

1. **Identify PO Competencies**

   Break down each Program Outcome into specific competencies (usually 2-4 per PO)

2. **Define Performance Indicators**

   Create measurable indicators for each competency (2-3 indicators per competency)

3. **Map Bloom's Levels**

   Assign appropriate Bloom's taxonomy level to each indicator

4. **Design Assessment Items**

   Create specific questions, assignments, and activities for each indicator

5. **Calculate Coverage Percentage**

   Determine what percentage of competencies and indicators are assessed

6. **Assign Correlation Score**

   Based on coverage, assign correlation score (0-3)

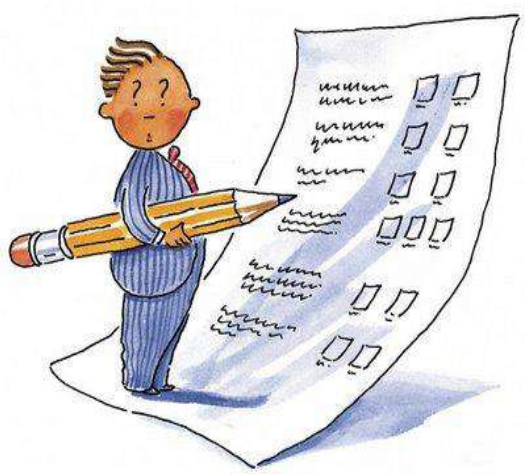
Best Practices for CO-PO Articulation

- Start with clear, measurable Course Outcomes
- Break down each PO into specific, assessable competencies
- Ensure each indicator has at least one assessment method
- Use variety in assessment types for comprehensive evaluation
- Align Bloom's levels with assessment complexity
- Document all mappings for transparency and review
- Review and update mappings based on assessment results

List of Assessment Tools

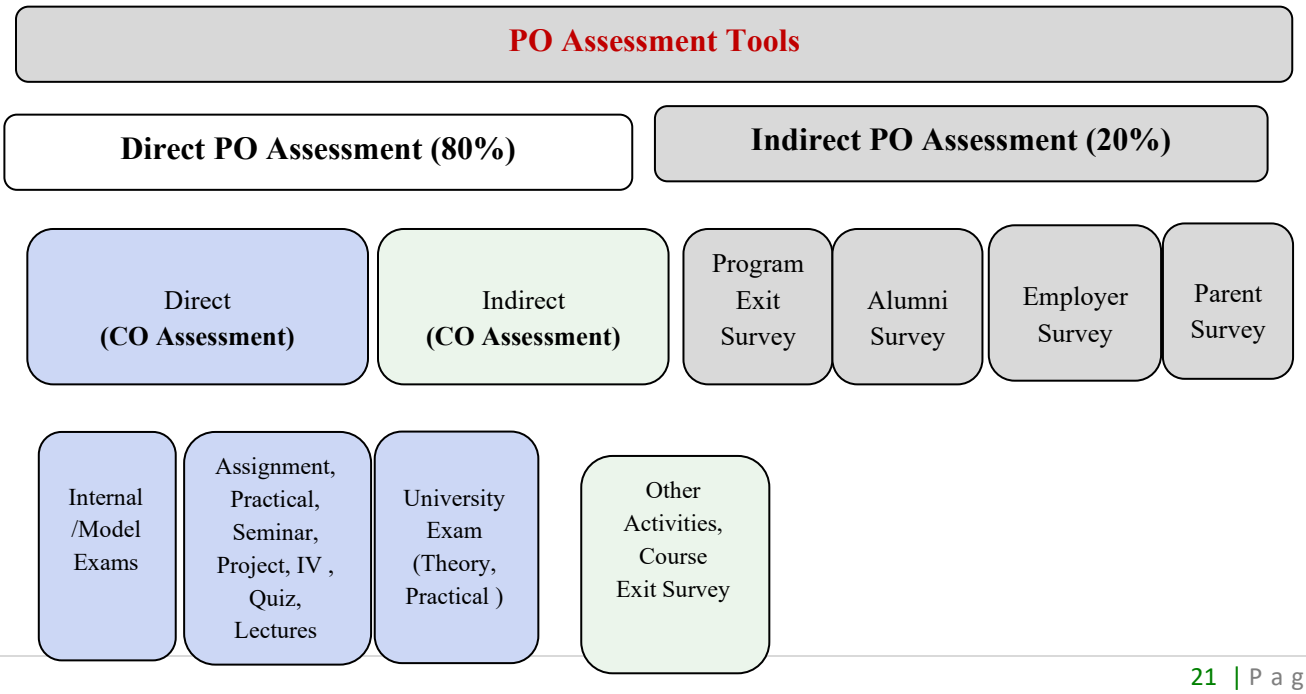
CO Assessment Tools

- ⇒ Internal Test
- ⇒ Model Test
- ⇒ University Exam
- ⇒ Practical/ Lab model exam
- ⇒ Industrial Visit
- ⇒ Workshops
- ⇒ Quiz
- ⇒ Assignment
- ⇒ Projects
- ⇒ Seminar
- ⇒ Course Exit Survey
- ⇒ External Feedback



Direct Tools : (Measurable in terms of marks and w. r. t. CO)

Indirect Tools : (Non measurable in terms of marks and w. r. t. CO)



Test Item

The Test Item is to prepare the faculty for justifying the correlation of CO –PO matrix.

The Cognitive levels have identified five Dimensions (Clark, Chopeta, 2004; Clark, Mayer, 2007):

- **Facts** - Specific and unique data or instance.
- **Concepts** - A class of items, words, or ideas that are known by a common name, includes multiple specific examples, shares common features. There are two types of concepts: concrete and abstract.
- **Processes** - A flow of events or activities that describe how things work rather than how to do things. There are normally two types: business processes that describe work flows and technical processes that describe how things work in equipment or nature. They may be thought of as the big picture, of how something works.
- **Procedures** - A series of step-by-step actions and decisions that result in the achievement of a task. There are two types of actions: linear and branched.
- **Principles** - Guidelines, rules, and parameters that govern. It includes not only what should be done, but also what should not be done. Principles allow one to make predictions and draw implications. Given an effect, one can infer the cause of a phenomena. Principles are the basic building blocks of causal models or theoretical models (theories).

Formation of Questions for Examinations

- Questions are Framed with appropriate Blooms taxonomy action verbs
- Consider the cognitive dimension for setting test items .
- The Performance Indicator is given for each Program Outcomes correlating with the cognitive Dimension. (Ref Annexure)

Example

Q.No	Questions	Marks	CO	BL	PI
1	Derive Electric field Intensity at the given point due to line charge of infinite length.	11	CO1	K5	1.1.1
2	Solve for E at a point P(1,2,1) due to a point charge of 2nC at (1,1,1) and another charge 3mC at (1,0,1)	11	CO1	K3	3.1.6
3	State Gauss's law and give examples for any two applications	11	CO1	K2	1.3.1

Calculating CO-PO Attainment

- **Fixing the target for CO attainment**
  - Last 3 batch University exam results of a particular course and % of students obtained various grades are considered.
  - Particular grade and the last 3 years cumulative % of students who obtained this grade and higher, nearer to 50 or 60% is taken as the reference.
  - The target for the attainment for the next batch is fixed 5% above the reference

Sample calculation:

Department: Information Technology
Subject name: Computer Network **Subject Code: ITT61** **Semester: IV**

Batch	Grade							Total no of students
	S	A	B	C	D	E	F	
2018-22	1	17	15	19	3	0	0	55
2019-23	6	9	27	36	8	1	0	87
2020-24	0	16	38	27	5	3	0	89
Total	7	42	80	82	16	4	0	231
Percentage	3.03	18.18	34.63	35.5	6.93	1.73	0	
Cumulative%	3	21.21	**55.84**	91.34	98.27	100		

For 2021 - 25 Batch, attainment Target may be fixed as B Grade - 60%

- **Each Course outcome attainment based on Bloom's cognitive level**
  - Individual Student's attainment for each Course Outcome is calculated from the Internal Assessment marks, Course Exit Survey and University exam results.
  - The proficiency set for the course with various grades and expected proficiency attainment levels are set for each course outcomes (CO1, CO2…) based on the Bloom's cognitive level as given in Table 1 and this may be same for all the courses.

Blooms Level	Proficiency set for the course (%)					Expected Proficiency Attainment (EPA) set for the course (%)				
	Grade S	Grade A	Grade B	Grade C		EA ≥ 80	70≤EA< 80	60≤EA<70	50≤EA<60	50>EA
Remember	100	90	80	70		90	80	75	65	55
Understand	100	90	80	70		90	80	75	65	55
Apply	90	80	70	60		80	70	65	60	50
Analyze	90	80	70	60		80	70	65	60	50
Evaluate	80	70	60	50		70	60	60	50	50
Create	80	70	60	50		70	60	60	50	50

- The Expected Proficiency Attainment (EPA) for all courses in a department gives the % of no of students to attain the targeted proficiency.
- The Expected Proficiency Attainment for all courses is set from the overall CO attainment target i.e, B Grade with 60%.
- If B Grade with 60% is taken as the target for Proficiency attainment % of attainment is minimum and hence we can take the next grade I.e., C Grade with 55%

Based on the above-given tables, the sample CO attainment (each CO) calculation for a theory course is given below.

Department: Information Technology
Subject name: Computer Network **Subject Code: ITT61** **Semester: IV**
Expected Proficiency for this course: C Grade
Expected Attainment (% of Students): 55%

CO No	Course Outcome	Blooms Level	Proficiency set for C Grade (%)	Expected Proficiency Attainment (% of Students) for 55%
1	Explain the principles of layered protocol architecture of network, service description	Understand	70	65
2	Explain conceptually, the working nature of the applications protocols such as HTTP, FTP, DNS, SMTP	Understand	70	65
3	Illustrate the working principles of reliable data transfer and explain the TCP & UDP protocols in transport layer	Apply	60	60
4	Describe the network layer design issues, IP addressing & inter and intra routing protocols	Apply	60	60
5	Demonstrate error correction and detection techniques in data link layer	Apply	60	60

Course Outcomes mapping with the students:

Normally course outcomes calculated from internal assessment marks, course exit survey and university result of a particular course. Sample course is taken to calculate the course outcomes and also given below.

Department: Information Technology

Subject name: Computer Network **Subject Code: ITT61** **Semester: IV**

S.No	Reg. No	Name	CO1	CO2	CO3	CO4	CO5
1	21TH0101	AARTHI.A	73	61	65	25	65
2	21TH0102	ABINAYA. C	60	63	40	65	60
3	21TH0106	AJAYRAJ.P	40	21	35	25	25
4	21TH0110	ANWAR BASHA. K	59	53	25	25	60
5	21TH0111	ASHOK KUMAR.M	52	66	70	25	65
6	21TH0114	BALAN. P	39	46	50	45	25
• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
57	21TH0217	YOGESHWARAN.G M	71	56	65	35	80
58	21TH0219	YUVARAJ.K	57	60	60	90	90
59	LE	SANTHAKUMAR.M	56	63	70	35	75
Average CO attainment through Internal Assessment (%)			**62.66**	**62.07**	**58.14**	**51.61**	**59.24**
Average CO attainment (60 %)			37.6	37.24	35	31	36
Course exit survey (10 %)			9.1	9	9.2	9	9.2
University Results (30 %)			29.5	29.5	29.5	29.5	29.5
Total			**76.2**	**75.74**	**73.7**	**69.5**	**74.7**

CO Attainment for The Above-Mentioned Course Through Internal Assessment Exams

CO No	Blooms Level	Proficiency set for C Grade (%)	Average CO attainment through Internal Assessment (%)	Expected Proficiency Attainment for 55 % (% of Students)	Actual Attainment as (%) of students
1	Understand	70	62.66	65	54.7
2	Understand	70	62.07	65	54.7
3	Apply	60	58.14	60	84.7
4	Apply	60	51.61	60	73.4
5	Apply	60	59.24	60	96.6

X = No of students got more than the proficiency set value for each Blooms level

Y = Actual EP Attained students strength for each CO = Class strength * EPA for each Blooms level

Actual Attainment as (%) of students for each CO = (X/Y)*100

Sample Calculations: For CO1, X = 23 students got more than the proficiency set Y = 59 * 65/100 = 38.4

Actual Attainment as (%) of students for CO1 = (23/38.4) = 54.7 %

Course Exit Survey

Please rate each of the following skills, abilities or attributes in terms of their importance, and state how well, you're understanding about the course Please rate each of the following skills, abilities or attributes in terms of their importance, and state how well, you're understanding about the course

Evaluation of CO

Scale 1 – Not Attained (Not satisfied) 2- Low attainment (Understood the CO, but skills need to be improved) 3 – Moderate (Satisfied in the attainment level of the CO) 4 – Above Moderate (Fair in the attainment level of the CO) 5 -High (Strong in the CO, acquired the skills in the specified cognitive level)

	1	2	3	4	5	Comments
1. Are you able to (CO1for the subject)						
2. Are you able to (CO2 for the subject)						
3. Are you able to (CO3 for the subject)						
4. Are you able to (CO4 for the subject)						
5. Are you able to (CO5 for the subject)						

PO Attainment through CO attainment

Illustration

Let us assume CO-PO mapping of a course, for example, **Computer Network is taken as a sample course from department of Information Technology** i.e.,

Subject name: Computer Network **Subject Code: ITT61** **Semester: IV**

CO	PO											PSO	
	1	2	3	4	5	6	7	8	9	10	11	1	2
1	3	1											
2	3	1											
3	3	2			2								2
4	3	2	1		2								2
5	3	1	1										
Average	**3**	**1.4**	**1**		**2**								**2**

Hence, final contribution of CO attainment in PO attainment can be done using the below formula,

CO Contribution = (Overall CO attainment/100) X (CO-PO Mapping weightage)

CO	PO											PSO	
	1	2	3	4	5	6	7	8	9	10	11	1	2
1	1.64	0.55											
2	1.64	0.55											
3	2.54	1.69			1.69								1.69
4	2.2	1.47	0.73		1.47								1.47
5	2.9	0.97	0.97										
Average	**2.18**	**1.05**	**0.85**		**1.58**								**1.58**

Sample calculations:

CO1- PO1 mapping attainment 54.7 x 3/100 = 1.64 (up to 2 decimal places)

CO2- PO2 mapping attainment 54.7 x 1/100 = 0.55

CO3- PO5 mapping attainment 84.7 x 2/100 = 1.69

CO4- PSO2 mapping attainment 73.4 x 2/100 = 1.47

CO5- PO1 mapping attainment 96.6 x 3/100 = 2.9

Co-curricular Activity:

Analyze the data's and collect the no of students participated in Several CO-curricular activities.

Based on the expected number of students and the actual number of students who have participated in the attainment level calculation for each program outcomes.

Collection of data for various co-curricular activities

Co-Curricular Components	Expected Number of Students participated in this Activity (%)
NPTEL/Online Certification courses	90%
Project at Industries (Internship)/Higher learning Institutions	30%
Summer Training	90%
Participation in International/National Event	10%
Student Contest	80%
Publication along with the Faculty	80%
Placement	90%
Higher Studies	10%
Industrial Visit	90%
Professional Society Activities	95%
…….	……
…….	……

PO Articulation of Co-curricular Components:

Co-Curricular Components	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
NPTEL/Online Certification courses	3	3	2		2		2	2	2	1	2	2	1
Project at Industries (Internship)/Higher learning Institutions	3	3	2		2		1	1			2	1	1
Summer Training	3				1		1	1			1		

Participation in International/National Event	3	3	2		1		1	1		1	2	1	1
Student Contest	3	3	2		2			2	1		2	1	1
Publication along with the Faculty	3	3	2		2		1	1			2	1	1
Placement	3	3	2		2						2	2	2
Higher Studies	3	3	2		2						2	2	1
Industrial Visit	3	3	1				1	1			1	1	1
Professional Society Activities	3	3	2		1		1	1			2	1	2
Etc.,													

Data Collection for PO Calculation through various co-curricular-components

Co-Curricular Components	No of students participated/ Certified/ Placed
NPTEL/Online Certification courses	59
Summer Training	55
Participation in International/National Event	15
Student Contest	35
Publication along with the Faculty	59
Placement	47
Higher Studies	5
Industrial Visit	59
Professional Society Activities	59
Etc.,	

Actual PO attainment through Co-Curricular Components

Co-Curricular Components	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
NPTEL/Online Certification courses	3	3	2		2		2	2	2	1	2	2	1
Summer Training	3				1		1	1			1		
Participation in International/National Event	2.5	2.5	1.67		0.833		0.833	0.833		0.833	1.67	0.833	0.833
Student Contest	2.24	2.24	1.49		1.49			1.49	0.745		1.49	0.745	0.745
Publication along with the Faculty	3	3	2		2		1	1			2	1	1
Placement	2.66	2.66	1.77		1.77						1.77	1.77	1.77
Higher Studies	2.5	2.5	2		2						2	2	1
Industrial Visit	3	3	1				1	1			1	1	1
Professional Society Activities	3	3	1.67		0.833		0.833	0.833			1.67	0.833	1.67
Etc.,													
Sum	24.9	21.9	13.6	0	11.93	0	6.67	8.16	2.75	1.83	14.6	10.18	9.02
Maximum score	30	27	17	0	15	0	8	10	3	2	18	12	11
Percentage	**83**	**81.1**	**80**	**0**	**79.5**	**0**	**83.4**	**81.6**	**91.7**	**91.5**	**81.1**	**84.8**	**82**

X = No of students Done a particular co-curricular component

Y = Actual Attained students strength for each CO-curricular component = Class strength *Expected Number of Students participated in this Activity (%)

Actual Attainment of students for each PO = (X/Y)

Sample Calculations:

X = 59 students Done NPTEL/Online Certification courses

Y = 59*90/100= 53-Actual Attained students strength

Actual Attainment of students for PO1 = (X/Y) = 59/53=1.11

PO1 mapping attainment = 1.11*3 = 3.33 ≈ 3

Summary of Attainment of PO/PSO in %

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
83	72	79	67	65	66	73	66	78	85	74	78	85
71	77	66	77	66	66	67	73	77	75	77	66	80
77	76	74	80	71	77	80	69	74	82	66	72	66

Percentage Level for the attainment of POs

Component	Percentage
Curricular component	60%
Co-curricular Component	20%
Graduate Exit survey	20%

Program Outcomes	Curricular	Sub Total (60%)	Co-Curricular	Sub Total (20%)	Survey	Sub Total (20%)	Total
PO1	73	43.8	70	14	84	16.8	**74.6**
PO2	72	43.2	65	13	85	17	**73.2**
PO3	75	45	65	13	86	17.2	**75.2**
PO4	68	40.8	74	14.8	84	16.8	**72.4**
PO5	52	31.2	75	15	85	17	**63.2**
PO6	45	27	64	12.8	74	14.8	**54.6**
PO7	48	28.8	80	16	65	13	**57.8**

Improvements in Attainments of CO and PO

High Attainment of CO and PO — Increase Target value

Moderate Attainment of CO and PO — Target is not changed. Conduct more activities to attain the fixed Target

Low Attainment of CO and PO — Consider reducing the Target and analyze methodologies to attain the Targets.

No Attainment of CO and PO — Reduce Target and review the entire process of OBE to achieve the low level Attainments

Improvements for Non-Technical Program Outcomes

Improvements can be done by

- Personalized learning
- Blended Learning Activities
- Competitions
- Extension activities
- Industrial Interaction
- Project based Learning
- Innovative Assignments
- Teaching Life skills

ANNEXURE

Bloom's Taxonomy Usage

Remembering

Suppose a question of following kind is put before the students,

Who was the Author of book My Experiments with Truth?

(a) Jawaharlal Nehru

(b) Mahatma Gandhi

(c) Abraham Lincoln

(d) Nelson Mandela

The answer to above question is obviously (b). To answer above question, one need knowledge and he/she should be able to recall that from his/her memory. Therefore, above question is of Bloom's Level 1,i.e Remembering. Other questions of this level can be set using the action verbs who, tell, define, recall, identify, name, when, where, list etc. The first level therefore is to test the ability of student to recall the information/knowledge he/she has gained during the course of study.

Understanding

Let us examine the following question now,

Which of the following is true aboutCOVID-19 pandemic?

(a) It happened due to high level of pollution.

(b) It occurred in non-vegetarians only.

(c) It happened due to a virus from animal.

(d) It happened due to bacteria.

We know that the answer to above question is(c) but our purpose is to know how the candidate shall reach at the correct option. It is not a pure knowledge question because it requires the understanding of the concept as well. The candidate who has the understanding of viruses, bacteria etc., shall be able to answer above question, it means it tests the skill of understanding of the candidate. Therefore, it is a question of Bloom's Level 2. Another question of Level 2 can be like; "Explain the concept by which plants are able to generate oxygen during day time."Action verbs to set the questions of Level 2 can be describe, explain, summarise, interpret, discuss etc. which test the ability of student to translate knowledge to new context and understand the information.

Applying

Let us check the following question,

The Length of one side of a rectangular table is 3.0m and it's diagonal is 5.0m long.

Applying Pythagoras theorem to find the area of table?

(a) 15 meter square

(b) 25meter square

(c) 9 meter square

(d) 12meter square

The correct answer to above question is (d) and the student can reach at correct option if he/she has ability to apply the concept of Pythagoras theorem to his/her knowledge about rectangles. Questions starting with verbs like apply, illustrate, solve, use, demonstrate, determine, modify, calculate, model etc. can be set for Bloom's Level 3. To answer the question of Level 3, the candidate has to apply the knowledge and understanding of the concept hidden inside the statement of the question. One more example of this level may be: "Write the steps to prevent an epidemic to spread in your country keeping in view the guidelines issued by World Health Organization."

Analyzing

Fourth Bloom's Level is to test the ability of Analysis. It requires the skill to break down a problem into parts and then to find a relationship of the parts and the way the parts are organised.

Let us take the following question as an example of Level 4. The Table represents the relationship between annual income and number of children below 15years of age of select families of a locality.

Sl. No	Annual Income of family	No of Children with age less than15 Years
1	Less than Rs 100,000	320
2	Rs 100,00 to Rs 500,000	200
3	Rs 500,000 to Rs 700,000	15
4	Rs 700,000 to Rs 1000,000	80
5	Above Rs 1000,000	20

From the Table, one can conclude that the families with lower income have more children. The examiner's question is which of the following assumptions would be correct to justify the conclusion?

(a) All families are able to send their children to expensive schools.

(b) The families with lower income group need fee concession for better education of their wards.

(c) The families with higher income are supporting the families in lower income group.

(d) Children belonging to the families of higher income are more intelligent than other families.

This question tests one's ability to have knowledge of value of currency, understanding of fee structure of schools and analysis of the data. Based on these abilities he/she shall tick option (b) as correct answer.

Evaluating

To achieve this level the candidate has to demonstrate the skill to compare between different ideas, make choices based on logical arguments and to make judgement by using some criteria. The action verbs for the problems to examine the student for this level may be measure, recommend, conclude, justify, assess, choose, compare, summarise, evaluate etc.

An example to clarify more is given below. A factory building work was going on smoothly with 100 workers which include 3 supervisors, one architect, 20 skilled labourers and other unskilled manpower, with this manpower the work was to finish in 45 days. The work stopped due to lockdown of the country and 70% of skilled and unskilled labourers left the job. Assess the delay in 01204356699 projects and recommend a comprehensive plan to finish the job in 90 days after opening of the lockdown with the manpower present on site. The roles of each worker are already defined..

Creating

This level is to examine the ability to create new idea using the existing concepts or to draw conclusions from a complex problem. The action verbs used to examine this skill are design, generate, develop, create, formulate, invent, compose, integrate etc. Following example is given in this reference:

In an online examination the web camera is used to monitor the candidates during examination but still some candidates cheat the examination. Develop a system using biometric credentials of candidates so that cheating can be curbed to minimum level including cheating in the form of impersonation.

Program Outcomes - Competencies - Performance Indicators

Electronics, Computer Science & Related Engineering Branches

(Mapped to Knowledge and Attitude Profile - WK)

PO1: Engineering Knowledge

Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop solutions for complex engineering problems.

Competency	Performance Indicators	WK Mapping
1.1 Demonstrate competence in mathematical foundations for engineering	**1.1.1** Apply advanced mathematical concepts including linear algebra, calculus, differential equations, probability theory, and discrete mathematics to solve engineering problems **1.1.2** Utilize numerical methods, statistical analysis, and data analytics for engineering modeling and simulation **1.1.3** Apply mathematical optimization techniques for system design and performance enhancement	WK2
1.2 Demonstrate competence in natural sciences applicable to electronics/computing	**1.2.1** Apply principles of physics including electromagnetics, quantum mechanics, and solid-state physics to electronic systems **1.2.2** Utilize concepts from chemistry and materials science for semiconductor device analysis **1.2.3** Apply thermodynamics and energy principles to computing and electronic systems	WK1
1.3 Demonstrate competence in computing fundamentals	**1.3.1** Apply programming paradigms, data structures, and algorithms to solve complex problems **1.3.2** Demonstrate proficiency in computer architecture, operating systems, and database management **1.3.3** Utilize formal methods and computational theory in system design	WK2
1.4 Demonstrate competence in engineering fundamentals	**1.4.1** Apply circuit theory, control systems, and signal processing principles **1.4.2** Utilize systems thinking and engineering design methodologies	WK3

Competency	Performance Indicators	WK Mapping
	1.4.3 Apply principles of instrumentation, measurement, and calibration	
1.5 Demonstrate specialist knowledge in electronics/computer engineering	**1.5.1** Apply advanced concepts in VLSI design, embedded systems, or software engineering **1.5.2** Utilize cutting-edge technologies in areas like IoT, AI/ML, cybersecurity, or communication systems **1.5.3** Apply domain-specific theoretical frameworks to solve industry-relevant problems	WK4

PO2: Problem Analysis

Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

Competency	Performance Indicators	WK Mapping
2.1 Demonstrate ability to identify and formulate complex engineering problems	**2.1.1** Articulate problem statements with clear objectives and constraints in electronics/computing domains **2.1.2** Identify system requirements, specifications, and design parameters **2.1.3** Recognize interdisciplinary aspects and sustainability considerations in problem formulation	WK1, WK3
2.2 Demonstrate ability to conduct literature review and research	**2.2.1** Systematically review current research literature and emerging technologies **2.2.2** Evaluate and synthesize information from multiple credible sources **2.2.3** Identify gaps in existing knowledge and potential research directions	WK8
2.3 Demonstrate ability to analyze problems using first principles	**2.3.1** Apply fundamental laws and theories to decompose complex problems **2.3.2** Develop mathematical and computational models for system analysis **2.3.3** Validate models using appropriate theoretical frameworks	WK1, WK2, WK3
2.4 Demonstrate ability to reach substantiated conclusions	**2.4.1** Analyze results using statistical methods and data interpretation techniques **2.4.2** Consider uncertainties, limitations, and assumptions in analysis	WK2, WK4

Competency	Performance Indicators	WK Mapping
	2.4.3 Draw evidence-based conclusions with consideration for sustainable development	

PO3: Design/Development of Solutions

Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for public health, safety, whole-life cost, net zero carbon, culture, society and environment.

Competency	Performance Indicators	WK Mapping
3.1 Demonstrate ability to define design requirements	**3.1.1** Identify stakeholder needs and translate them into technical requirements **3.1.2** Consider sustainability factors including energy efficiency, resource utilization, and environmental impact **3.1.3** Incorporate safety, security, and reliability requirements in design specifications	WK5
3.2 Demonstrate ability to generate creative design solutions	**3.2.1** Explore multiple design alternatives using systematic design methodologies **3.2.2** Apply innovative approaches including bio-inspired design, AI-driven optimization **3.2.3** Consider whole-life cost, maintainability, and end-of-life disposal in design decisions	WK5
3.3 Demonstrate ability to evaluate and select optimal solutions	**3.3.1** Develop evaluation criteria considering technical, economic, environmental, and social factors **3.3.2** Perform multi-criteria decision analysis and trade-off studies **3.3.3** Validate design choices through simulation, prototyping, and stakeholder feedback	WK5
3.4 Demonstrate ability to implement and validate designs	**3.4.1** Develop detailed designs with appropriate documentation and standards compliance **3.4.2** Create prototypes and conduct testing to verify design performance **3.4.3** Iterate design based on testing results and user feedback	WK5, WK6

PO4: Conduct Investigations of Complex Problems

Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modeling, analysis & interpretation of data to provide valid conclusions.

Competency	Performance Indicators	WK Mapping
4.1 Demonstrate ability to design and plan investigations	**4.1.1** Define research objectives, hypotheses, and experimental scope **4.1.2** Design experiments using statistical principles and appropriate controls **4.1.3** Select suitable measurement techniques, instruments, and data collection methods	WK8
4.2 Demonstrate ability to conduct systematic investigations	**4.2.1** Implement experimental procedures with proper calibration and quality control **4.2.2** Apply modeling and simulation techniques to complement experimental work **4.2.3** Ensure ethical compliance and safety protocols in investigations	WK8
4.3 Demonstrate ability to analyze and interpret data	**4.3.1** Apply statistical analysis, machine learning, and data mining techniques **4.3.2** Visualize data effectively and identify patterns, trends, and anomalies **4.3.3** Validate results and assess reliability, uncertainty, and limitations	WK2, WK8
4.4 Demonstrate ability to synthesize findings	**4.4.1** Draw valid conclusions based on evidence and theoretical foundations **4.4.2** Compare results with existing literature and theoretical predictions **4.4.3** Identify implications for further research and practical applications	WK8

PO5: Engineering Tool Usage

Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modeling recognizing their limitations to solve complex engineering problems.

Competency	Performance Indicators	WK Mapping
5.1 Demonstrate ability to identify and select appropriate tools	**5.1.1** Evaluate available software tools, hardware platforms, and development environments **5.1.2** Select tools based on problem requirements, accuracy needs, and resource constraints **5.1.3** Assess tool capabilities, limitations, and licensing considerations	WK2, WK6
5.2 Demonstrate proficiency in modern engineering tools	**5.2.1** Utilize CAD/CAE tools for design and simulation (e.g., MATLAB, Simulink, ANSYS, Cadence)	WK2, WK6

Competency	Performance Indicators	WK Mapping
	5.2.2 Apply programming tools and IDEs for software development and system programming **5.2.3** Use data analysis and visualization tools (e.g., Python, R, Tableau, LabVIEW)	
5.3 Demonstrate ability to create and adapt tools	**5.3.1** Develop custom software tools, scripts, and automation solutions **5.3.2** Integrate multiple tools and platforms for comprehensive solutions **5.3.3** Modify existing tools to meet specific project requirements	WK6
5.4 Demonstrate critical evaluation of tool usage	**5.4.1** Validate tool outputs against theoretical expectations and experimental data **5.4.2** Understand and communicate limitations, assumptions, and uncertainty in tool results **5.4.3** Benchmark tool performance and accuracy for different applications	WK2, WK6

PO6: The Engineer and The World

Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

Competency	Performance Indicators	WK Mapping
6.1 Demonstrate understanding of engineering's societal role	**6.1.1** Analyze the impact of engineering solutions on different stakeholder groups **6.1.2** Evaluate accessibility, digital divide, and technology adoption challenges **6.1.3** Consider cultural sensitivities and global perspectives in engineering solutions	WK7
6.2 Demonstrate awareness of environmental sustainability	**6.2.1** Assess environmental footprint including energy consumption and carbon emissions **6.2.2** Apply circular economy principles and sustainable design practices **6.2.3** Evaluate renewable energy integration and green technology solutions	WK5, WK7
6.3 Demonstrate understanding of economic implications	**6.3.1** Conduct cost-benefit analysis including externalities and social costs **6.3.2** Evaluate business models and economic viability of engineering solutions	WK5

Competency	Performance Indicators	WK Mapping
	6.3.3 Consider market dynamics, competition, and economic sustainability	
6.4 Demonstrate awareness of legal and regulatory frameworks	**6.4.1** Identify relevant standards, codes, and regulations (IEEE, ISO, FCC, etc.) **6.4.2** Understand intellectual property, data privacy, and cybersecurity regulations **6.4.3** Ensure compliance with safety standards and professional guidelines	WK7

PO7: Ethics

Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

Competency	Performance Indicators	WK Mapping
7.1 Demonstrate understanding of professional ethics	**7.1.1** Apply IEEE Code of Ethics and other professional standards **7.1.2** Identify ethical dilemmas in engineering practice and propose solutions **7.1.3** Understand responsibilities regarding public safety, environmental protection, and honest reporting	WK9
7.2 Demonstrate commitment to diversity and inclusion	**7.2.1** Promote inclusive design practices and accessibility in engineering solutions **7.2.2** Value diverse perspectives and collaborative approaches in problem-solving **7.2.3** Address bias in algorithms, AI systems, and technology deployment	WK9
7.3 Demonstrate adherence to legal and regulatory requirements	**7.3.1** Comply with international laws regarding technology transfer and export controls **7.3.2** Respect intellectual property rights and fair use principles **7.3.3** Ensure data protection and privacy compliance (GDPR, CCPA, etc.)	WK9
7.4 Demonstrate commitment to human values	**7.4.1** Consider human dignity, rights, and welfare in engineering decisions **7.4.2** Address social justice and equity issues in technology access and deployment **7.4.3** Promote transparency and accountability in engineering practice	WK9

PO8: Individual and Collaborative Team Work

Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

Competency	Performance Indicators
8.1 Demonstrate individual effectiveness	**8.1.1** Manage time effectively and meet deadlines consistently**8.1.2** Take initiative and demonstrate self-motivation in learning and problem-solving**8.1.3** Adapt to changing requirements and demonstrate resilience under pressure
8.2 Demonstrate effective team collaboration	**8.2.1** Contribute effectively to multidisciplinary teams with diverse backgrounds**8.2.2** Utilize collaborative tools and platforms for distributed teamwork**8.2.3** Provide constructive feedback and accept criticism professionally
8.3 Demonstrate leadership capabilities	**8.3.1** Facilitate team discussions and coordinate project activities **8.3.2** Motivate team members and resolve conflicts constructively **8.3.3** Delegate tasks appropriately and monitor team progress
8.4 Demonstrate cultural competence	**8.4.1** Work effectively with team members from different cultural backgrounds **8.4.2** Understand and respect different working styles and communication preferences **8.4.3** Promote inclusive team environments and equal participation

PO9: Communication

Communicate effectively and inclusively within the engineering community and society at large, including comprehensive technical documentation, effective presentations considering cultural, language, and learning differences.

Competency	Performance Indicators
9.1 Demonstrate technical writing proficiency	**9.1.1** Produce clear, comprehensive technical reports and documentation **9.1.2** Create user manuals, API documentation, and system specifications **9.1.3** Write effective proposals, research papers, and patent applications
9.2 Demonstrate oral communication skills	**9.2.1** Deliver effective presentations to technical and non-technical audiences **9.2.2** Participate actively in technical discussions and design reviews **9.2.3** Facilitate meetings and workshops effectively
9.3 Demonstrate visual and digital communication	**9.3.1** Create effective technical diagrams, flowcharts, and visualizations **9.3.2** Develop multimedia presentations and interactive demonstrations

Competency	Performance Indicators
	9.3.3 Utilize modern communication platforms and collaboration tools
9.4 Demonstrate inclusive communication	**9.4.1** Adapt communication style for diverse audiences and cultural contexts **9.4.2** Use accessible language and consider learning differences **9.4.3** Provide clear instructions and ensure mutual understanding

PO10: Project Management and Finance

Apply knowledge and understanding of engineering management principles and economic decision-making to manage projects in multidisciplinary environments.

Competency	Performance Indicators
10.1 Demonstrate project planning and scheduling skills	**10.1.1** Develop comprehensive project plans with realistic timelines and milestones **10.1.2** Utilize project management tools (Gantt charts, Kanban, Agile methodologies) **10.1.3** Identify critical path activities and manage project dependencies
10.2 Demonstrate resource management capabilities	**10.2.1** Estimate and allocate human, financial, and technical resources effectively **10.2.2** Monitor resource utilization and optimize allocation throughout project lifecycle **10.2.3** Manage vendor relationships and procurement processes
10.3 Demonstrate financial analysis skills	**10.3.1** Conduct cost estimation, budgeting, and financial planning for projects **10.3.2** Perform economic analysis including NPV, ROI, and payback period calculations **10.3.3** Evaluate financial risks and develop contingency plans
10.4 Demonstrate quality and risk management	**10.4.1** Implement quality assurance processes and performance metrics **10.4.2** Identify, assess, and mitigate technical and business risks **10.4.3** Ensure compliance with project governance and reporting requirements

PO11: Life-Long Learning

Recognize the need for and have the preparation and ability for independent and life-long learning, adaptability to new and emerging technologies, and critical thinking in the context of technological change.

Competency	Performance Indicators	WK Mapping
11.1 Demonstrate self-directed learning capabilities	**11.1.1** Identify knowledge gaps and develop learning plans to address them **11.1.2** Utilize diverse learning resources including online courses, research papers, and professional development programs **11.1.3** Set learning objectives and track progress systematically	WK8
11.2 Demonstrate adaptability to emerging technologies	**11.2.1** Stay current with technological advances in electronics, computing, and related fields **11.2.2** Evaluate and adopt new tools, methodologies, and best practices **11.2.3** Anticipate future technology trends and their implications	WK8
11.3 Demonstrate critical thinking and innovation	**11.3.1** Question assumptions and evaluate information sources critically **11.3.2** Synthesize knowledge from multiple disciplines to generate innovative solutions **11.3.3** Contribute to knowledge creation through research, publications, or patents	WK8
11.4 Demonstrate professional development commitment	**11.4.1** Participate in professional societies and continuing education programs **11.4.2** Seek mentorship opportunities and provide guidance to junior engineers **11.4.3** Maintain professional certifications and pursue advanced qualifications	WK8

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