An Empirical study on CO-PO Assessment and its Attainment for Tier II Engineering Institution: Nurturing Student Empowerment through Outcome-Centered Education

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Abstract: According to John Dewey, an American philosopher, psychologist and educational reformer, "Education is not preparation for life, education is life itself". Education involves the process of imparting knowledge, skills, and information from educators to learners through teaching, learning, and practical engagement. In light of the ever-changing dynamics of the 21st century, it is absolutely crucial to refine our approaches for assessing students' potential and competencies. Doing so will empower us to deliver top-notch education that is customized to their unique requirements, nurturing their comprehensive growth and well-rounded development.

The accreditation process places a strong emphasis on the adoption of Outcome-Based Education (OBE) as a pivotal approach for improving and guaranteeing the quality of education imparted by these Tier II engineering institutions. The effectiveness of an educational program relies heavily on the achievement of both course outcomes and program outcomes, with a comprehensive set of twelve program outcomes serving as a benchmark for assessing the quality and depth of knowledge that students should acquire over their four years of undergraduate studies. However, there appears to be a lack of understanding among engineering faculty members when it comes to assessing the attainment of Course Outcomes (CO) and Program Outcomes (PO) through calculations. This paper aims the importance of effectively aligning Course Outcomes (COs) with Program Outcomes (POs), commonly referred to as CO-PO mapping. Additionally, it emphasizes the significance of subsequently measuring and evaluating the attainment of these outcomes, as these steps are integral to the successful implementation of Outcome-Based Education (OBE).

Key words: OBE, CO, PO.

1. INTRODUCTION

The Outcome Based Education (OBE) is adopted by AICTE from Washington Accord on 13 June 2014. Outcome-Based Education (OBE) has emerged as a pivotal trend in contemporary engineering education. A formal definition of OBE can be stated as "a comprehensive approach to organizing and operating an education system that is focused on and defined by the successful demonstrations of learning sought from each student". In an Outcome-Based Education (OBE) framework, certain targets are set and teaching learning activities are properly planned and organized to achieve the targets. In alignment with an Outcome-Based Education (OBE) framework, the NBA's Graduate Attributes serve as a set of criteria that should be evident in an individual who has successfully completed an engineering program [1, 2]. These attributes encompass the knowledge, skills, and qualities that a graduate of the program should possess, indicative of their educational journey and overall growth. OBE, or Outcome-Based Education, represents an instructional approach aimed at enhancing the quality of learning and skill development in education. It necessitates a fundamental transformation of curriculum design, assessment techniques, and reporting methodologies.

The core objective of OBE is to shift the focus from mere credit accumulation towards a more comprehensive and meaningful learning experience, particularly in the context of engineering education. This entails aligning educational outcomes with the actual skills and competencies that an engineering graduate should possess. By adopting OBE, educational institutions aspire to produce graduates

who are not just credit earners but rather individuals equipped with the practical skills, knowledge, and qualities essential for success in the engineering field. This approach demands a favorable shift in the teaching and assessment techniques employed by the faculty of academic institution. Many researchers have discussed the different assessment and attainment techniques of course outcomes (COs) and program outcomes (POs) for accreditation process in engineering colleges through OBE [3, 4]. This paper introduces an approach for assessment of program quality by CO-PO mapping and attainment of course outcome (COs) of the course with Program Outcomes (POs) and Program Specific Outcomes (PSOs).

2. OBE AND NBA

Outcome-based education is an educational approach wherein the design and content of the curriculum are shaped by the desired learning outcomes that students should demonstrate upon completing the course [5]. The National Board of Accreditation (NBA) has embraced the Outcome-Based Education (OBE) approach and has established comprehensive guidelines for educational institutions to actively pursue excellence. These guidelines serve as a framework to achieve accreditation by focusing on the systematic implementation of OBE principles, ensuring that educational outcomes align with industry demands and societal needs. These guidelines are adhered to in order to establish both the program outcomes and the course outcomes.

Program Outcomes: Program Outcomes are specific statements that outline the anticipated knowledge and skills that students will possess upon completing a program. These outcomes encompass the competencies, understanding, and conduct that students develop during their enrollment in the program.

Program Specific Outcomes: Program Specific Outcomes (PSOs) are statements that describe the specific skills, knowledge, abilities, and attributes that students are expected to have gained by the time they complete a particular academic program or course of study. These outcomes are designed to align with the overall goals and objectives of the program and provide a clear framework for assessing the effectiveness of the educational process.

Course Outcomes: Course outcomes serve as a way to communicate the intended learning objectives of a course to both educators and students. They help establish a clear understanding of what students are expected to achieve by the end of the course, guiding curriculum design, lesson planning, and assessment development. These outcomes often align with broader program or institutional goals and contribute to the overall educational experience of the students.

Assessment: Assessment refers to the process of evaluating and measuring a student's knowledge, skills, abilities, characteristics, or performance in a systematic and structured manner. It is used to gather information and make informed judgments about an individual's capabilities. Assessments can take various forms, depending on the context and the purpose. This involves evaluating students' learning progress, knowledge, and skills in educational settings. It can include tests, quizzes, assignments, projects, practical and oral exams, etc.

Attainment: Attainment generally refers to the act of achieving or reaching a specific goal. It can be used to describe the successful accomplishment of a task, the acquisition of knowledge or skills, the realization of a goal, or the fulfillment of a learning outcomes.

3. OUTCOME BASED ASSESSMENT

Outcome-Based Assessment (OBA) involves collecting data to evaluate the extent to which a student is meeting predefined learning outcomes or objectives. It refers to a structured and continuous procedure of gathering, understanding, and utilizing data concerning the goals and outcomes established to uphold the mission and vision of the department and the institution. The assessment procedure is illustrated in Figure 1.

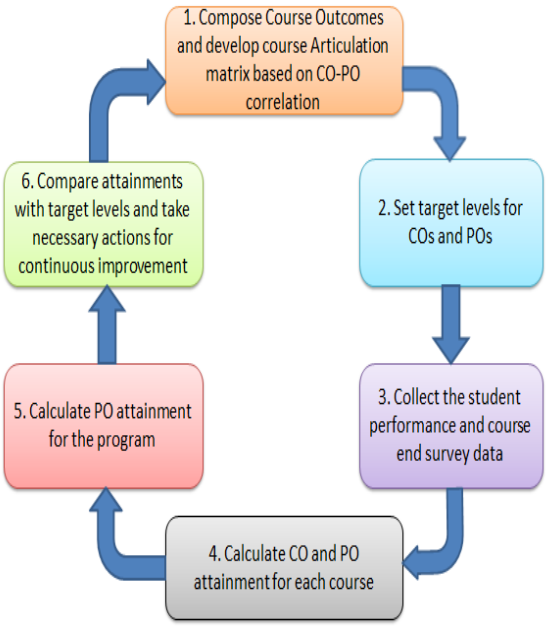


Figure 1

4. Assessment Method of Measuring COs:

The evaluation of both course outcomes across all program courses and program outcomes involves the utilization of two distinct assessment approaches: Direct Assessment and Indirect Assessment. The evaluation process allocates 90% weightage to Direct Assessment, while the remaining 10% weightage is attributed to Indirect Assessment.

A. Direct Assessment: The assessment of Course Outcomes (COs), Program Outcomes (POs), and Program Specific Outcomes (PSOs) is carried out by analyzing the performance of students across various evaluation methods such as Internal Assessment (IA) tests, assignments, university examinations, practical tests, and project work.

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

Table 1:

Direct Assessment Method			
Sr. No.	Direct Assessment Tool	Explanation of the approach	Frequency
1.	Internal Assessment Test	The Internal Assessment marks in a theory paper shall be based on two tests. It is a parameter to continuously assess the attainment of course outcomes.	At the end of 4^{th} – 5^{th} & 12^{th} week
2.	Assignments	Assignments are commonly utilized as a key evaluation tool to gauge students' understanding and grasp of the subject matter.	Once in a semester
3.	University Examination	The evaluation of semester examinations, whether in theory, practical or oral serves as the primary measure to determine the achievement of all designated course outcomes. These examinations are meticulously designed to center on the successful attainment of the predefined course objectives, employing a descriptive assessment approach.	Once in a semester
4.	Practical Examination (Internal and External)		
5.	Oral Examination (Internal and External)		
6.	Project Work (Internal and External Examination)		Once in a year
Direct CO attainment = Internal Assessment (IA) * 30% + External Assessment (EA) * 70%			
Indirect Assessment Method			
Indirect CO attainment from feedback/survey - Gathering Comprehensive Student Feedback on Course Satisfaction at Semester's End			
CO attainment = Direct CO attainment * 90% + Indirect CO attainment * 10%.			

5. CO AND PO ATTAINMENT METHODOLOGY:

The calculation of CO & PO attainments is based on evaluating students' performance across all assessments conducted in the course. The following process outlines the steps to calculate the attainments of Course Outcomes (CO) and Program Outcomes (PO):

- develop Course Articulation Matrix based CO-PO correlation
- Set attainment target levels
- Collect the students' performance data and Course End Survey data.
- Calculate CO & PO attainments for each course based on direct and indirect assessments
- Compare attainments with target levels and take necessary action for continuous improvement

Figure 2 represents the process of calculation of CO attainment through flow chart:

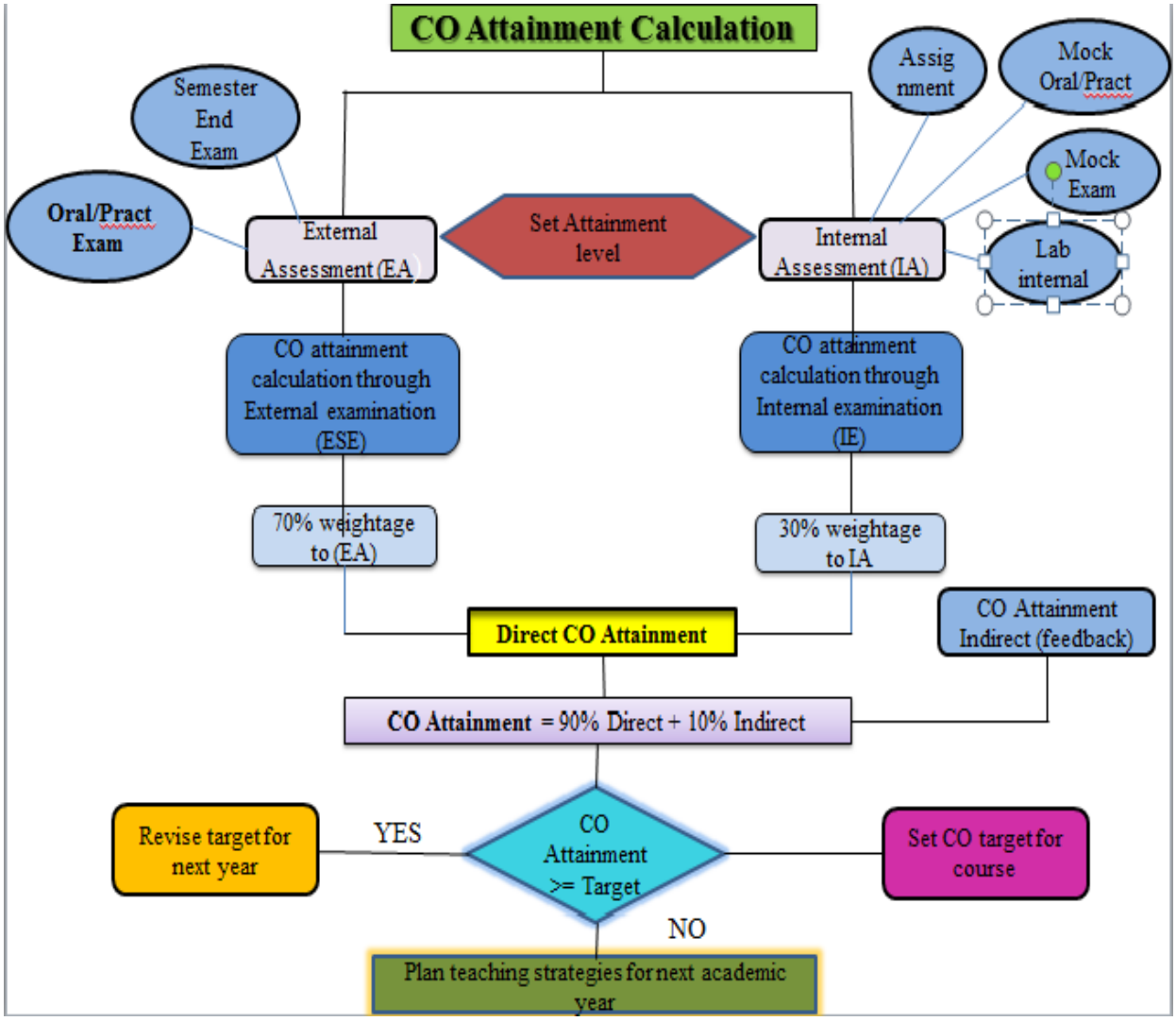


Figure 2: processes involves in calculation of CO attainment

6. CO ATTAINMENT COMPUTATIONS OF SME COURSE

The calculations for assessing the attainment of COs for the Systems in Mechanical Engineering (SME) course in the first semester of the B.E. program are outlined. An institute is affiliated with Savitribai Phule Pune University (SPPU) Pune, and follows the curriculum prescribed by the University. The course structure of the course is shown in Table 2:

Table 2: Course Structure

Program: B.E	Academic Year: 2022-23
Course Name: Systems in Mechanical Engineering (SME)	Course code: 102003.
Class: 1st year of engineering	Sem: I
Course Teacher: Prof. R. Y. Pawar	Designation: Asst. Professor

A. The course outcomes (COs) for SME course and the CO-PO/PSO Articulation Matrix for the mentioned course is shown in Table 3:

Table 3: CO - PO/PSO Articulation Matrix

CO-PO Mapping							
Faculty Name:	Prof. R. Y. Pawar	**Year of study:**	2022-23	**SEM**	I	**Odd/Even**	Odd
Course Name:	SME (2019 patt)	**Course Code:**	102003	**Class**	F.E	**Div**	B
Course Outcome: At the end of the course students will be able to						**PO**	**PSO**
CO 1	Describe and compare the conversion of energy from renewable and non-renewable energy sources					1,6,7	3
CO 2	Explain basic laws of thermodynamics, heat transfer and their applications.					1, 6	3
CO 3	List down the types of road vehicles and their specifications					1,6,7,8	1,2,3
CO 4	Illustrate various basic parts and transmission system of a road vehicle					2,3,6,7,9	1,2,3
CO 5	Discuss several manufacturing processes and identify the suitable process					2,5,6,7,9	1,2
CO 6	Explain various types of mechanism and its application					2,5,7,10,11,12	1

The CO-PO mapping has been done with correlation levels 1, 2, 3 and "--" for no correlation as defined below:

1. Slightly (Low)
2. Moderately (Medium)
3. Substantially (High)

To obtain the correlation matrix, it is recommended to follow the following procedural steps:

Step1: Identify key elements of each PO and PSO

Step2: Identify key elements of each CO

Step3: Find the co-relation levels using key elements of POs/PSOs and COs.

Using this approach, we are able to justify accurate justifications for the correlation level. This technique allows us to deliver comprehensive explanations for the correlations. This approach is explained using a case study from the SME course as shown in Table 4.

Table 4:

COURSE ARTICULATION MATRIX: CO-PO/PSO MAPPING															
Course Name: Systems in Mechanical Engineering													**Course code: 102003**		
Programme Outcomes (POs)													**PSO**		
GRADUATE ATTRIBUTES	**APPLY KNOWLEDGE**	**ANALYSIS**	**DESIGN**	**INVESTIGATION**	**MODERN TOOLS**	**SOCIETY**	**ENVIRONMENT**	**ETHICS**	**TEAM WORK**	**COMMUNICATION**	**PROJECT MANGMT & FINANCE**	**LIFE LONG LEARNING**	**PSO 1**	**PSO 2**	**PSO 3**
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	-	-	-	-	2	3	-	-	-	-	-	-	-	2
2	2	-	-	-	-	1	-	-	-	-	-	-	-	-	2
3	2	-	-	-	-	2	1	1	-	-	-	-	1	1	2
4	-	1	1	-	-	1	2	-	1	-	-	-	2	2	1
5	-	1	-	-	1	2	2	-	1	-	-	-	2	1	-
6	-	1	-	-	1	-	1	-	-	1	1	2	2	-	-

B. Set the Target:

Target for each CO is defined as " 65% of students getting more than or equal to 65% (Academic Threshold) of marks. The CO assessment tools used to measure the attainment levels may be in terms of student's performance in internal assessments such as tutorials, assignments, laboratory tests, project evaluation, project presentations, oral examinations, etc. and student's performance in End Semester Examination (ESE). The contribution of each student to the collective effort is determined through an assessment tool that evaluates their performance. The count of students who have achieved a score exceeding 65% in each Course Outcome (CO) is determined in relation to the total number of students in the assessment of that specific CO. Target is usually decided based on previous results of the course. Performance Threshold can be same for entire institute; however, Target can be varied for each program/course.

C. Course Outcome (CO) Attainment:

The CO attainment for SME course is calculated by using Direct Assessment Method. In this method, Internal Assessment (IA) can be calculated by using Assignment, Mock Internal exams, mock oral exam and Practice session as assessment tools. For calculation of External Assessment (EA), University exam is considered where assessment is done by the external assessor.

D. Evaluation of performance-oriented tools:

Assignment Assessment: The question wise marks have been entered with respect to COs for the all assignments. The total six assignments are assigned on each module with respect to COs. The assessment report of assignment is shown in Table 5.

Table 5: Assignment performance data

Roll No.	Name of Student	Assignment No. 1					50	Assignment No. 2					50	Assignment No. 3					50	Assignment No. 4					50	Assignment No. 5					50	Assignment No. 6					50
		Q.1	Q.2	Q.3	Q.4	Q.5		Q.1	Q.2	Q.3	Q.4	Q.5		Q.1	Q.2	Q.3	Q.4	Q.5		Q.1	Q.2	Q.3	Q.4	Q.5		Q.1	Q.2	Q.3	Q.4	Q.5		Q.1	Q.2	Q.3	Q.4	Q.5	
1	Student 1	7	7	8	9	9	40	7	7	8	9	9	40	8	9	8	8	8	41	9	8	8	9	8	42	8	7	8	9	9	41	8	7	8	9	9	41
2	Student 2	8	8	8	5	8	37	8	8	8	5	8	37	9	8	9	9	9	44	8	9	9	9	9	44	9	8	8	8	8	41	8	9	7	8	8	40
3	Student 3	7	7	8	8	8	38	7	8	7	8	8	38	7	8	8	7	7	37	8	7	8	7	8	38	9	8	7	8	8	40	7	7	8	9	9	40
4	Student 4	8	9	9	9	8	43	9	9	8	9	9	44	9	9	8	9	9	44	8	8	9	8	9	42	9	9	9	8	9	44	9	8	8	9	9	43
5	Student 5	7	7	7	8	8	37	7	7	7	8	8	37	8	7	8	7	7	37	8	8	7	8	8	39	7	7	7	8	8	37	9	9	8	10	10	46
58	Student 58	10	10	10	10	9	49	7	9	9	9	10	44	9	8	8	8	8	41	9	8	8	9	10	44	10	9	9	8	9	45	9	8	9	9	9	44
59	Student 59	9	10	10	10	10	49	7	8	8	8	10	41	9	8	9	8	8	42	9	8	7	8	9	41	7	7	8	9	9	40	7	7	8	9	9	40
60	Student 60	10	10	10	10	10	50	8	8	10	10	10	46	10	9	9	10	10	48	9	10	9	9	10	47	8	8	8	5	8	37	8	8	8	5	8	37

Internal Exam Assessment: The bit wise marks have been entered with respect to COs for the all internal assessment tests. According to the university's examination paper pattern, the questions have been structured to align with the Course Outcomes (COs) associated with each module. By linking the questions to the COs, the examination aims to comprehensively test the students' knowledge, skills, and application of the concepts covered in the curriculum. This method also helps in assessing the effectiveness of the teaching methods and materials in achieving the desired educational outcomes for each module.

Table 6: Internal Assessment Test 1

Roll no.	Name of Student	Q.1		Q.2		Q.3		Q.4		CO1 (15)	CO2 (15)
		1.A	1.B	2.A	2.B	3.A	3.B	4.A	4.B		
		CO 1				CO 2					
		8	7	7	8	8	7	7	8		
1	Student 1	7	7	0	0	2	7	0	0	14	9
2	Student 2	3	6	0	0	2	7	0	0	9	9
3	Student 3	0	2	7	6	5	7	0	0	15	12
4	Student 4	6	7	0	0	4	6	0	0	13	10
5	Student 5	0	0	7	7	0	0	7	1	14	8
58	Student 58	8	7	0	0	8	4	0	0	15	12
59	Student 59	8	7	0	0	7	7	0	0	15	14
60	Student 60	0	0	6	5	0	0	5	7	11	12

Table 7: Internal Assessment Test 2

Roll No.	Name of Student	Q.1			Q.2			Q.3			Q.4			Q.5			Q.6			Q.7			Q.8			CO 3 (18)	CO 4 (17)	CO 5 (18)	CO 6 (17)
		1.a	1.b	1.c	2.a	2.b	2.c	3.a	3.b	3.c	4.a	4.b	4.c	5.a	5.b	5.c	6.a	6.b	6.c	7.a	7.b	7.c	8.a	8.b	8.c				
		CO 3						CO 4						CO 5						CO 6									
		7	7	4	7	7	4	7	7	3	7	7	3	7	7	4	7	7	4	7	7	3	7	7	3				
1	Student 1	6	6	3	0	0	0	0	0	0	5	6	3	6	5	3	0	0	0	5	6	3	0	0	0	15	14	14	14
2	Student 2	6	5	2	0	0	0	6	5	2	0	0	0	6	6	3	0	0	0	7	5	3	0	0	0	13	13	15	15
3	Student 3	7	5	3	0	0	0	6	5	3	0	0	0	6	5	3	0	0	0	4	5	3	0	0	0	15	14	14	12
4	Student 4	6	4	5	0	0	0	0	0	0	4	6	3	6	1	0	0	0	0	6	5	3	0	0	0	15	13	7	14
5	Student 5	0	0	0	6	6	1	4	5	3	0	0	0	6	7	3	0	0	0	1	6	3	0	0	0	13	12	16	10
58	Student 58	6	7	3	0	0	0	5	6	3	0	0	0	6	5	4	0	0	0	0	0	0	6	6	3	16	14	15	15
59	Student 59	7	6	3	0	0	0	6	6	2	0	0	0	6	6	3	0	0	0	0	0	0	6	6	2	16	14	15	14
60	Student 60	0	0	0	6	5	4	0	0	0	7	5	3	0	0	0	6	5	3	0	0	0	6	6	3	15	15	14	15

Internal Practical/Tutorial Assessment: The marks for practical/tutorials have been recorded and associated with the respective Course Outcomes (COs) for all tasks related to each module.

Table 8: Internal Practical/Tutorial Assessment data

Roll No.	Name of Student	Group A	Group B				Group C				CO 1 (10)	CO 1 attain	CO 2 (10)	CO 2 attain	CO 3 (10)	CO 3 attain	CO 4 (10)	CO 4 attain	CO 5 (10)	CO 5 attain	CO 6 (10)	CO 6 attain
		Inds. Visit	Task 1	Task 2	Task 3	Task 4	Ex.1	Ex.2	Ex.3	Ex.4												
		CO 3 & CO4	CO 1	CO 3	CO 3	CO 2	CO 4	CO 4	CO 5	CO 5												
		10	10	10	10	10	10	10	10	10												
1	Student 1	8	8	8	9	8	9	8	8	8	8	2.40	8	2.40	8	2.50	8	2.40	8	2.40	9	2.70
2	Student 2	9	9	8	9	9	8	9	9	9	8	2.70	9	2.70	9	2.60	9	2.70	9	2.55	8	2.40
3	Student 3	7	8	7	8	7	8	8	7	8	8	2.40	7	2.10	7	2.20	7	2.20	8	2.40	8	2.40
4	Student 4	9	8	9	8	9	9	9	8	9	8	2.40	9	2.70	9	2.60	9	2.60	9	2.55	9	2.70
5	Student 5	7	8	7	9	8	9	8	9	8	8	2.40	8	2.40	8	2.30	8	2.40	8	2.40	9	2.70
58	Student 58	7	8	9	8	9	8	9	9	9	9	8	2.40	9	2.70	8	2.40	8	2.50	9	2.70	8	2.40
59	Student 59	8	8	7	8	8	8	8	8	8	8	8	2.40	8	2.40	8	2.30	8	2.40	8	2.40	8	2.40
60	Student 60	8	8	9	8	7	8	9	8	9	9	8	2.40	7	2.10	8	2.50	8	2.50	9	2.70	8	2.40

Internal Oral Exam Assessment: The module wise marks have been entered with respect to COs. In oral examination, the question aims to assess the student's understanding of the course outcomes by asking them to apply their knowledge to connect what they've learned in the course to real-world applications.

Table 9: Internal Oral Assessment

Roll No	Name of Student	CO1	CO2	CO3	CO4	CO5	CO6
1	Student 1	5	4	5	4	5	4
2	Student 2	4	5	5	4	5	4
3	Student 3	4	4	4	4	4	4
4	Student 4	4	4	5	4	5	5
5	Student 5	5	5	4	4	4	4
58	Student 58	4	5	4	4	5	4
59	Student 59	4	5	4	5	4	4
60	Student 60	4	4	5	4	5	4

Computation of Internal Assessment Tools: The direct CO attainment can be calculated by considering all the above internal assessment tools under IA (Internal Assessment). The calculation of all internal assessment tools are shown in below Table 10.

Table 10: Computation of Internal Assessment Tools

Name of Faculty : Prof. R. Y. Pawar						Year of Study		2022-23				SEM:						I					ODD/EVEN:					ODD					
Name of Course : Systmes in Mechanical Engg.						Course Code		102003				CLASS						F.E					DIV:					B					
Roll No	Name of Student	CO 1 Attainment						CO 2 Attainment						CO 3 Attainment						CO 4 Attainment						CO 5 Attainment						CO 6 Attainment					
		Assignm	Int Test	PR /T	Int. Or	Total	CO1 attai	Assignm	Int Test	PR /T	Int. Ora	Total	CO2 attai	Assignm	Int Test	PR /T	Int. Or	Total	CO3 attai	Assignm	Int Test	PR /T	Int. Or	Total	CO4 attai	Assignm	Int Test	PR /T	Int. Or	Total	CO5 attai	Assignm	Int Test	PR /T	Int. Ora	Total	CO6 attai
		50	15	10	5	80	3	50	15	10	5	80	3	50	18	10	5	83	3	50	17	10	5	82	3	50	18	10	5	83	3	50	17	10	5	82	3
1	Student 1	40	14	8	5	67	2.01	40	9	8	4	61	1.83	41	15	8	5	69	2.08	42	14	8	4	68	2.04	41	14	8	5	68	2.04	41	14	9	4	68	2.05
2	Student 2	37	9	9	4	59	1.78	37	9	9	5	60	1.80	44	13	9	5	71	2.12	44	13	9	4	70	2.10	41	15	9	5	70	2.09	40	15	8	4	67	2.01
3	Student 3	38	15	8	4	65	1.96	38	12	7	4	61	1.84	37	15	7	4	64	1.91	38	14	7	4	64	1.91	40	14	8	4	66	1.99	40	12	8	4	64	1.92
4	Student 4	43	13	8	4	68	2.04	44	10	9	4	67	2.02	44	15	9	5	73	2.18	42	13	9	4	68	2.04	44	7	9	5	65	1.94	43	14	9	5	71	2.13
5	Student 5	37	14	8	5	64	1.92	37	8	8	5	58	1.74	37	13	8	4	62	1.86	39	12	8	4	63	1.90	37	16	8	4	65	1.96	46	10	9	4	69	2.07
58	Student 58	49	15	8	4	76	2.27	44	12	9	5	70	2.10	41	16	8	4	69	2.06	44	14	8	4	70	2.10	45	15	9	5	74	2.22	44	15	8	4	71	2.12
59	Student 59	49	15	8	4	76	2.28	41	14	8	5	68	2.04	42	16	8	4	70	2.09	41	14	8	5	68	2.04	40	15	8	4	67	2.01	40	14	8	4	66	1.98
60	Student 60	50	11	8	4	73	2.18	46	12	7	4	69	2.06	48	15	8	5	76	2.29	47	15	8	4	74	2.22	37	14	9	5	65	1.95	37	15	8	4	64	1.91
Threshold , 65%		33	10	7	3	52		33	10	7	3	52		33	12	7	3	54		33	11	7	3	53		33	12	7	3	54		33	11	7	3	53	
No. of students above threshold		8	7	8	8	8		8	5	8	8	8		8	8	8	8	8		8	8	8	8	8		8	7	8	8	8		8	7	8	8	8	
% of students scoring above threshold		100	88	100	100	100		100	63	100	100	100		100	100	100	100	100		100	100	100	100	100		100	88	100	100	100		100	88	100	100	100	
CO attainment		3.00	2.63	3.0	3.0	3.00	2.93	3.0	1.9	3.0	3.0	3.0	2.78	3.0	3.0	3.0	3.0	3.0	3.00	3.0	3.0	3.0	3.0	3.0	3.00	3.0	2.6	3.0	3.0	3.0	2.93	3.0	2.6	3.0	3.0	3.0	2.93
		CO 1 Attainment						CO 2 Attainment						CO 3 Attainment						CO 4 Attainment						CO 5 Attainment						CO 6 Attainment					

The Table 10 represents a summary of the performance data in the internal assessment tool for each student across all Course Objectives (COs). The level of achievement for each student in terms of COs (Course Outcomes) is determined by evaluating their overall performance in internal assessments.

Target - Establish the predefined threshold at 65%.The target for all internal assessment tools is to achieve a score of 65% of the maximum marks available.

Number of students above threshold – It involves number of students who have achieved scores equal to or greater than the target marks.

Percentage of students scoring above target – converted number of students into percentage value.

Attainment - The ratio of students who achieved scores equal to or greater than the target marks to the total number of students who attempted the assessment and converted into attainment level. The attainment level is calculated on the basis of some criteria shown in Table 11:

Table 11:

Attainment Level	Rubrics
LEVEL 1	60% of Students scoring more than the set target (65%) of Marks
LEVEL 2	70% of Students scoring more than the set target (65%) of Marks
LEVEL 3	80% of Students scoring more than the set target (65%) of Marks

The Table 12 shows the attainment level of CO for SME course:

Table 12:

COMPUTATION OF COURSE ATTAINMENT															
Course Name: Systems in Mechanical Engineering													**Course code: 102003**		
COURSE ATTAINMENT															
Final Direct Course Attainment Calculation														**Final Indirect Course attainment calculation**	
COs	**Assign 1**	**Assign 2**	**Assign 3**	**Assign 4**	**Assign 5**	**Assign 6**	**Int Test 1**	**Int Test 2**	**PR/ Tut**	**Int Oral**	**INT Assess (IA)**	**EXT Asses (UNI)**	**Direct CO Attainment=** ((0.3*IA)+(0.7*EA))		
CO 1	3.00	-	-	-	-	-	2.63	-	3.00	3.00	2.91	2.46	2.59	2.46	
CO 2	-	3.00	-	-	-	-	1.88	-	3.00	3.00	2.72		2.54	2.57	
CO 3	-	-	3.00	-	-	-	-	3.00	3.00	3.00	3.00		2.62	2.42	
CO 4	-	-	-	3.00	-	-	-	3.00	3.00	3.00	3.00		2.62	2.79	
CO 5	-	-	-	-	3.00	-	-	2.63	3.00	3.00	2.91		2.59	2.56	
CO 6	-	-	-	-	-	3.00	-	2.63	3.00	3.00	2.91		2.59	2.82	
Attainment											**2.91**	**2.46**	**2.59**	**2.60**	
Final Direct Total Attainment(30% IA + 70% EA)											**0.87**	**1.72**			
Weightage											90%			**10%**	
Total attainment											2.33			0.26	
Overall Course Attainment											**2.59**				

The CO attainment for SME course is calculated as per considered weightage to the Direct CO attainment and Indirect CO attainment. The determination of the attainment level in external assessments is computed by means of result analysis. The Indirect CO attainment is calculated through the course end survey at the end of semester as shown in Table 14. The attainment level of students was determined by collecting their responses through Course End Semester survey and evaluating them based on the set rubrics.

Table 13:

Course Outcomes	Set Attainment Level	Attained Level	% of Attainment	Analysis
CO 1	3.00	2.53	84.23	Satisfactory
CO 2	3.00	2.55	85.13	Satisfactory
CO 3	3.00	2.52	84.03	Satisfactory
CO 4	3.00	2.71	90.20	Satisfactory
CO 5	3.00	2.58	85.90	Satisfactory
CO 6	3.00	2.71	90.23	Satisfactory

Table 14:

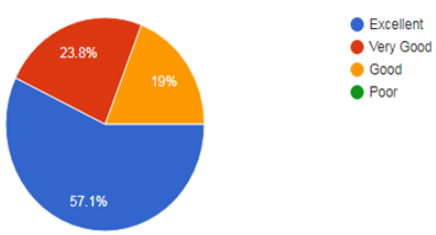
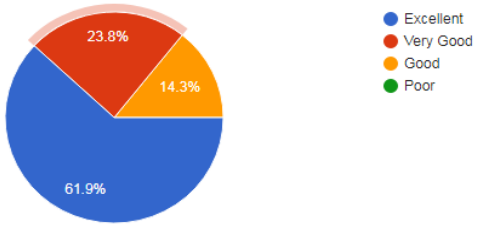
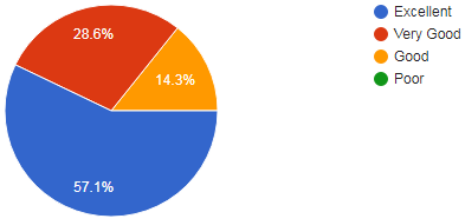
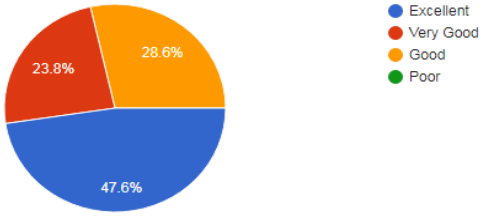
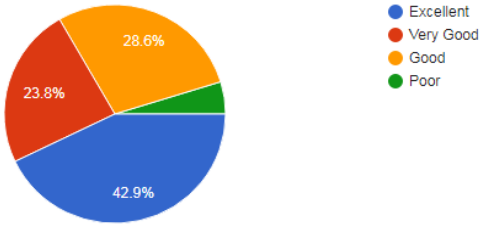
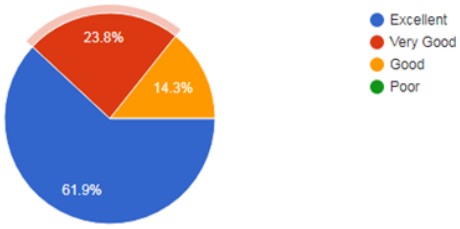
Course End Semester Survey (Indirect CO Attainment)	
1. At the end of the course are you able to describe and compare the conversion of energy from renewable and non-renewable energy sources. 	2. At the end of the course are you able to explain basic laws of thermodynamics, heat transfer and their applications. 
3. At the end of the course are you able to list down the types of road vehicles and their specifications. 	4. At the end of the course are you able to Illustrate various basic parts and transmission system of a road vehicle. 
5. At the end of the course are you able to discuss several manufacturing processes and identify the suitable process. 	6. At the end of the course are you able to explain various types of mechanism and its application. 

Table 15: PO/PSO Attainment levels

COURSE ARTICULATION MATRIX: CO-PO/PEO MAPPING															
Course Name: Systems in Mechanical Engineering													**Course code: 102003**		
Programme Outcomes (POs)													**PSO**		
GRADUATE ATTRIBUTES	APPLY KNOWLEDGE	ANALYSIS	DESIGN	INVESTIGATION	MODERN TOOLS	SOCIETY	ENVIRONMENT	ETHICS	TEAM WORK	COMMUNICATION	PROJECT MANGMT & FINANCE	LIFE LONG LEARNING	PSO 1	PSO 2	PSO 3
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	-	-	-	-	2	3	-	-	-	-	-	-	-	2
2	2	-	-	-	-	1	-	-	-	-	-	-	-	-	2
3	2	-	-	-	-	2	1	1	-	-	-	-	1	1	2
4	-	1	1	-	-	1	2	-	1	-	-	-	2	2	1
5	-	1	-	-	1	2	2	-	1	-	-	-	2	1	-
6	-	1	-	-	1	-	1	-	-	1	1	2	2	-	-
Weighted Avg.	2.33	1.00	1.00	######	1.00	1.60	1.80	1.00	1.00	1.00	1.00	2.00	1.75	1.33	1.75
Course PO/PSO attainment	1.87	0.80	0.80	######	0.80	1.28	1.44	0.80	0.80	0.80	0.80	1.60	1.40	1.07	1.40
Attainment in %	62.22	26.67	26.67	######	26.67	42.67	48.00	26.67	26.67	26.67	26.67	53.33	46.67	35.56	46.67

Table 15 represents the level of attainment of Program Outcomes (PO) and Program Specific Outcomes (PSO) in accordance with the associations outlined in Table 4, which displays the Course Articulation matrix. This highlights the correspondence between specific course and the attainment of broader program outcomes, allowing for an understanding of how individual course elements contribute to the overall attainment of desired learning outcomes. The calculation of the PO attainment level involves determining the weighted average of the Program Outcomes (POs) associated with each Course Outcome (CO). This weighted average is derived by considering the significance or weight assigned to each PO in relation to its corresponding CO. Subsequently, by factoring in the attained level of each Course Outcome (CO), the overall PO attainment level is computed. This process enables an assessment of how well the Program Outcomes (POs) have been achieved based on the performance of the Course Outcomes (COs) to which they are mapped.

PO Attainment = ((CO-PO Mapped Value) * (CO Attainment Value)) / 3

Once the calculations for CO (Course Outcome) and PO (Program Outcome) attainment have been conducted, the final step involves conducting a gap analysis. During this analysis, a comparison is made between the attainment levels of the previous year and the current year. If a discrepancy emerges between these two, appropriate actions are then formulated to enhance the attainment levels. Conversely, if no significant difference is identified, an evaluation is performed to determine whether the established targets need to be adjusted highs or low. This systematic approach ensures that performance is closely monitored and optimized, facilitating continuous improvement in the pursuit of set outcomes.

CONCLUSION

A consistent methodology for calculating the attainment of Course Outcomes (CO), Program Outcomes (PO), and Program Specific Outcomes (PSOs) should be applied to all courses within a program. This involves systematically assessing the extent to which these outcomes have been achieved by the students. The attainment matrix have been populated with assessment data, the next step is to calculate the overall attainment value for each outcome. By consistently applying this methodology to all courses within the program, you can generate accurate records of how well the program is meeting its intended course outcomes. The average attainment values for POs provide a high-level view of the program's success in achieving its broader goals, while the CO and PSO attainment values offer insights into individual courses and specific skill areas. Hence, the necessary actions must be taken to enhance the attainment levels and enhance the quality of student performance.

Ultimately, this systematic approach to assessment and attainment measurement allows educational institutions to make informed decisions about curriculum improvements and instructional strategies to enhance the quality of education they provide.

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