



CO & PO/PSO ATTAINMENT PROCESS MANUAL REV 00

This Manual has been made as a reference material for the stakeholders of AIKTC in general and the faculties & staff of Civil Engineering Department in particular.

VISION:

To be the most sought after Academic, Research and Practice based Department of Civil Engineering that others would wish to emulate.

MISSION:

Creating Exuberant Civil Engineering Professionals.

Department of Civil Engineering, School of Engineering & Technology, AIKTC, New Panvel, July 2024



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1. Abbreviations:

AICTE	All India Council for Technical Education
AIKTC	Anjuman-I-Islam's Kalsekar Technical Campus
NBA	National Board of Accreditation
CO	Course Outcomes
PO	Programs Outcomes
PSO	Programs Specific Outcomes
PAC	Program Assessment Committee
DAB	Department Advisory Board
CIA	Continuous Internal Assessment
TEE	Term End Exam
CDC	Course Domain Committee
CAGS	Course Attainment Google Sheet
TW	Term Work
TEE	Term End Examination

2. Process of Defining Course Outcomes:

The course outcomes (CO) are framed by the course owner by referring to the syllabus and considering the guidelines for the CO formation so that the CO should include i) action verbs, ii) learning statements and/or iii) criteria or condition and with consideration of appropriate Bloom's Levels. Table 1 below gives the skill expected to be demonstrated by the student at various blooms levels and the applicable action verbs at these levels as per revised bloom's taxonomy.

Table 1: Action Verbs based on Bloom's Level and Skills Demonstrated

Bloom's Levels	Skills Demonstrated	Action Verbs
1. Remember	<ul style="list-style-type: none"> Ability to recall of information like facts, conventions, definitions, jargon, technical terms, classificatns, categories, and criteria Ability to recall methodology and procedures, abstractions, principles, and theories in the field Knowledge of dates, events, places Mastery of subject matter 	List, define, tell, describe, recite, recall, identify, show, label, tabulate, quote, name, who, when, where
2. Understand	<ul style="list-style-type: none"> Understanding information Grasp meaning Translate knowledge into new context Interpret facts, compare, contrast Order, group, infer causes Predict consequences 	Describe, explain, paraphrase, restate, associate, contrast, summarize, differentiate interpret, discuss
3. Apply	<ul style="list-style-type: none"> Use information Use methods, concepts, laws, theories in new situations Solve problems using required skills or knowledge Demonstrating correct usage of a method or procedure 	Calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, experiment, show, examine, modify
4. Analyze	<ul style="list-style-type: none"> Break down a complex problem into parts Identify the relationships and interaction between the Different parts of a complex problem Identify the missing information, sometimes the Redundant information and the contradictory Information, if any 	Classify, outline, break down, derive, categorize, analyze, diagram, illustrate, infer, select

5. Evaluate	<ul style="list-style-type: none"> • Compare and discriminate between ideas • Assess value of theories, presentations • Make choices based on reasoned argument • Verify value of evidence • Recognize subjectivity • Use of definite criteria for judgments 	Assess, decide, choose, rank, grade, test, measure, defend, recommend, convince, select, judge, support, conclude, argue, justify, compare, summarize, evaluate
6. Create	<ul style="list-style-type: none"> • Use old ideas to create new ones • Combine parts to make (new) whole, • Generalize from given facts • Relate knowledge from several areas • Predict, draw conclusions 	Design, formulate, build, invent, create, compose, generate, modify, develop, integrate

The course owners have been trained through series of workshops on outcome based education (OBE) and National Board of Accreditation (NBA) and also the learning material available on internet is provided to them through website. All the courses of a given curriculum are divided into various course domains and a course domain coordinator is assigned for all the identified domains. There are members in a particular course domain committee based on the qualification, experience and subject preferences. Once the CO are made ready by the course owner, they are brainstormed in the Course Domain Committee (CDC) meetings. After approval of the CO in the course domain committee for a particular course the CO-PO mapping of the same course is discussed in the CDC.

Example of a CO is as follows:

CO1: Define index properties of soil and derive the relationships between them on the basis of three phase diagram. (L4)

Course: Geotechnical Engineering - I

Action Verb: Define index properties of soil

Learning Statement: derive the relationships between them

Criteria/Condition: on the basis of three phase diagram

3. Process of CO-PO Mapping based on Competency and Performance Indicators using AICTE examination reforms policy:

The CO-PO mapping is done based on the AICTE examination reforms policy guidelines which emphasizes on competencies and performance indicators, as shown in Fig. 1.

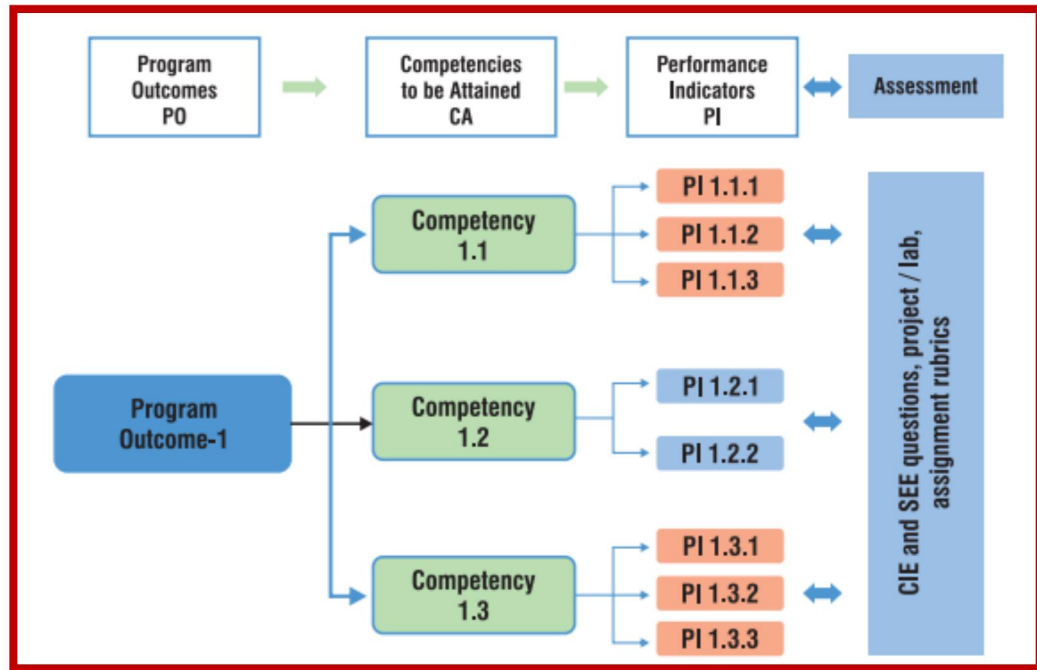


Fig. 1: The Competency and Performance Indicator based Frame work^[2]

For every CO, the course owner would map it to one or more program outcomes (PO) based on the competencies and performance indicators that he has been identified as most relevant to the CO. If any of the competencies mentioned in a particular PO are mapped with the CO then the course owner would consider the CO-PO mapping. In this way all the CO would be screened for the appropriate competencies and performance indicators and the mapping would be completed.

Example of the CO-PO mapping Process:

CO1: Express the process of measurement and design Go and No Go gauges for different types of fits for part of an assembly as per the applicable standards. (L2)														
PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
✓	✓													
Competencies and PI mapped with this CO														
PO1														
1.3.1 Apply fundamental engineering concepts to solve engineering problems														
1.4.1 Apply Civil engineering concepts to solve engineering problems.														
Justification: Students have to know the derivation process for which they are required to possess fundamental Engineering concepts related to derivation and also a clear understanding of the civil engineering concept of index properties of soil a must for the student.														

PO2

2.1.2. Identify engineering systems, variables, and parameters to solve the problems

2.1.3. Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

Justification: The students have to identify which index properties are variables and accordingly apply mathematical and engineering knowledge to derive the relationship between them.

In this way the mapping of a particular CO with PO would be done based on the competency and performance indicator frame work. This task would be undertaken by the respective course owners. The course owners would then determine the strength of CO-PO mapping based on the weightages of a CO in the curriculum as discussed below.

4. Process of Strength of CO-PO mapping using topic weightage in the curriculum:

Once the mapping of a CO with a particular PO has been identified, the course owner has to determine the strength of mapping between a CO and respective PO. This process involves a few steps to determine the strength of mapping between CO and PO which are explained as follows.

Step I: Identify the mapping between COs of a course with the POs/PSOs.

Step II: Prepare the CO-wise table given below based on the mapping

Course Outcome No.	Course Outcome	No. of hours as per syllabus	Mapped PO/PSO
CO1	Statement	8	PO1,PO2,PO4
CO2	Statement	8	PO1,PO5
CO3	Statement	6	PO1, PO3,PO10
CO4	Statement	6	PO2,PO3,PO4
CO5	Statement	6	PO12
CO6	Statement	6	PO2,PO3,PO5
Total		40	

Step III: Prepare the PO-wise table as given below based on the mapping

Mapped PO/PSO	Mapped CO	Total number of sessions	Percentage of Mapping	Mapping strength
PO1	CO1,CO2,CO3	8+8+6=22	55%	3
PO2	CO1,CO4,CO6	8+6+6=20	50%	3
PO3	CO3,CO4,CO6	6+6+6=18	45%	3
PO4	CO1,CO4	8+6=14	35%	2
PO5	CO2,CO6	8+6=14	35%	2
PO10	CO3	6=6	15%	1
PO12	CO5	6=6	15%	1

Step IV: Assign the mapping strength based on the rubric given below

Percentage of Mapping	Mapping strength
>40%	3
25% > 39%	2
5% > 24%	1
<5%	PO not addressed

For lab courses, the number of practicals, that addresses a particular CO should be an additional column in step II of the above procedure and it can be compared with the total number of practical. Accordingly the same process can be followed from step III onwards.

Course Outcome No.	Course Outcome	Experiment No.	No. of hours as per syllabus	Mapped PO/PSO
CO1	Statement	01,02	2+2=4	PO1,PO2,PO4
CO2	Statement	03,04	2+2=4	PO1,PO5
CO3	Statement	05	2	PO1, PO3,PO10
CO4	Statement	06	2	PO2,PO3,PO4
CO5	Statement	07	2	PO12
CO6	Statement	08	2	PO2,PO3,PO5
Total			16	40

The flow chart below shows the process.

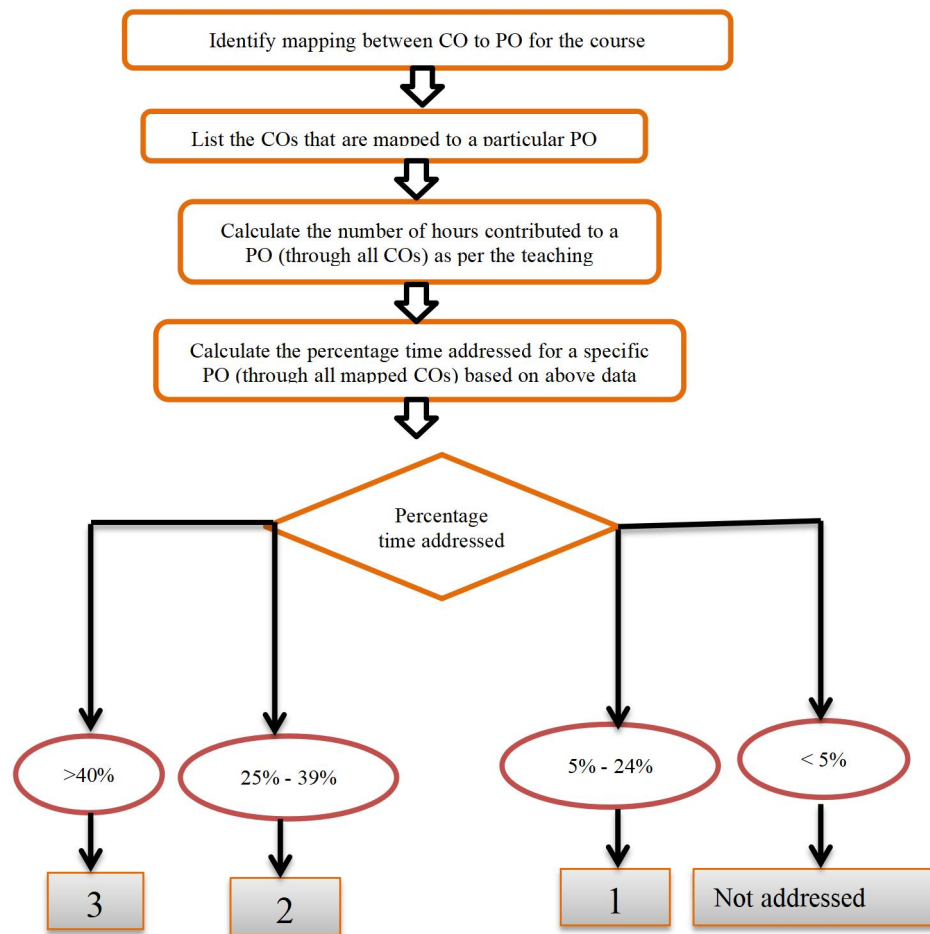


Fig. 2 Method for defining strength of mapping between CO-PO/PSO [4]

The mapping strength can directly be calculated from the sheet by putting “Y” for the mapped POs for a given CO and entering the number of hours allotted in the curriculum for a CO as shown in the below table.

COs	Hours Req for COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	8	Y	Y		Y											
CO2	8	Y				Y										
CO3	6	Y		Y							Y					
CO4	6		Y	Y	Y											
CO5	6												Y			
CO6	6		Y	Y		Y										
Total hours	40															
		22	20	18	14	14	0	0	0	0	6	0	6	0	0	0
Mapping Strength		3	3	3	2	2					1		1			

The final Mapping sheet which can be directly copied in the CAGS sheet is as shown below

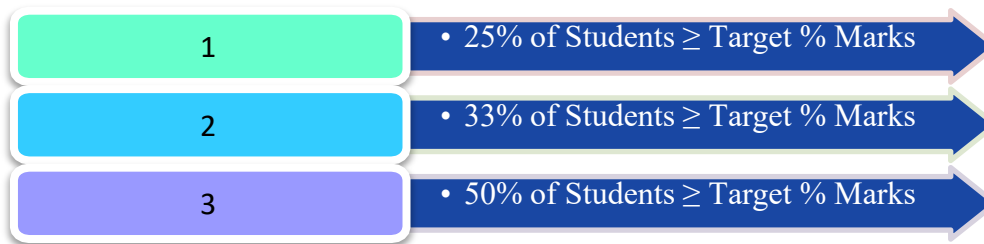
CO No.	CO Statement	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3	3		2											
CO2		3				2										
CO3		3		3							1					
CO4			3	3	2											
CO5													1			
CO6			3	3		2										
Correlation Level		3	3	3	2	2					1		1			
Course PO Attainment																

5. CO Attainment Process using Course Attainment Google Sheet (CAGS)

The CO attainment process has two types of assessments, one is direct assessment and the other is indirect assessment. Also there are two heads of evaluation, one is continuous internal evaluation (CIA) and the other is Term End Examination (TEE).

Direct Assessment:

Evaluation Methods	Process
Internal Assessment Tests	Two Internal Assessment Tests are conducted per semester to evaluate the attainment of course outcomes. Each question is mapped with CO, blooms level and performance indicator of that respective PO.
Assignments & Tutorials	The tutorials and assignments are given to the students based on the subject nature. Tutorial and Assignment sheets are prepared by the faculty member with CO and levels.
Continuous Internal Assessment (Laboratory Course)	The evaluation criteria for each experiment are based on performance, and laboratory submission records. The attainment of CO is calculated through Continuous Internal Assessment
External Practical and Oral Exam	The Evaluation of student performance is done through external practical exam or external Oral exam as per the examination scheme of the course.
Project Work	The project work progress is continuously monitored through project diary on a continuous basis. Different presentations are kept at the start of project work and during the semester for evaluating the progress of project work. Project final presentation is conducted at the end of the semester as per University norms.
University Examination/Term End Examination (TEE)	At the end of each semester, final examination is conducted for Theory and Laboratory courses by the University, in which question paper covers the entire syllabus and all the COs are covered in the question papers.

Attainment Levels:Fig. 3: The Attainment levels ^[7]**Indirect Assessment:**

Evaluation Methods	Process
Course Exit Survey	In order to know the overall learning of the students through a particular course, a course exit survey is conducted at the end of the course through Google form. It contains the rating for the CO wise student leanings on a scale of 3. The CO wise average value is considered in the calculation of indirect CO attainment.
Seminar/Workshop/Expert session/Industrial visit	Any additional activity conducted by the course owner for his course in the form of Seminar/Workshop/Expert session/Industrial visit would be evaluated through the ratings of the students given for the relevant mapped COs.

Continuous Internal Assessment (CIA) and Term End Examination (TEE):

Every Theory Course or Laboratory Practical Course or Project Work makes use of both these methods of CIA and University Exams, the details of these are as given below

Theory courses:

For each theory course, course owner calculates the attainment of course outcomes using Term End Examination (TEE) and Continuous Internal Assessment (CIA). The attainment level will be calculated based on the average performance levels of both Term End Examination (TEE) and Internal Assessment Test. The evaluation process of Internal Assessment Tests/Assignments/Tutorials/Group Discussion is counted for 20% and the remaining 80% weightage is given to Term End Examination (TEE). Based on the level of CO attainment, the faculty member will decide whether to increase the competency level or change the content delivery method, assessment methods to improve attainment level for the course.

Assessment Tool		Weightage	Frequency
CO Attainment	Internal Assessment Tests	20%	Twice in a Semester
	Term End Examination (TEE)	80%	Once in a Semester

Laboratory Courses:

For laboratory courses, the course outcome will be calculated based on Practical Exam, Oral Exam, and Term Work with the weightage of 50% for Continuous Internal Assessment (Term Work) and 50 % weightage for University Practical/ Oral Examination (In most of the cases). However this weightage may change depending on the examination scheme of that course. Based on the CO attainment level, the faculty member will decide whether to increase the competency level or enhance the practical knowledge of the students through more rigorous conduct of practical in order to improve attainment level for the laboratory course.

Assessment Tool		Weightage	Frequency
CO Attainment	Continuous Internal Assessment	50%	Every Week
	University Practical Examination	50%	Once in a Semester

Project Work Assessment:

For project work, Continuous Internal Assessment is based on the performance throughout the semester and through presentations carried out at different stages of the project. Both of these are maintained on a regular basis in the form of a project diary by the respective project guide. The faculty member will decide the competency level and attainment level for project work considering the average performance level of the students.

Assessment Tool		Weightage	Frequency
Continuous Assessment	Reviews	*50%	Every Month
University Assessment	Viva-Voce	*50%	Once in a Semester

*May change as per the Examination scheme of a program

The entire process of CO attainment through CAGS is explained through the flow chart in Fig. 4.

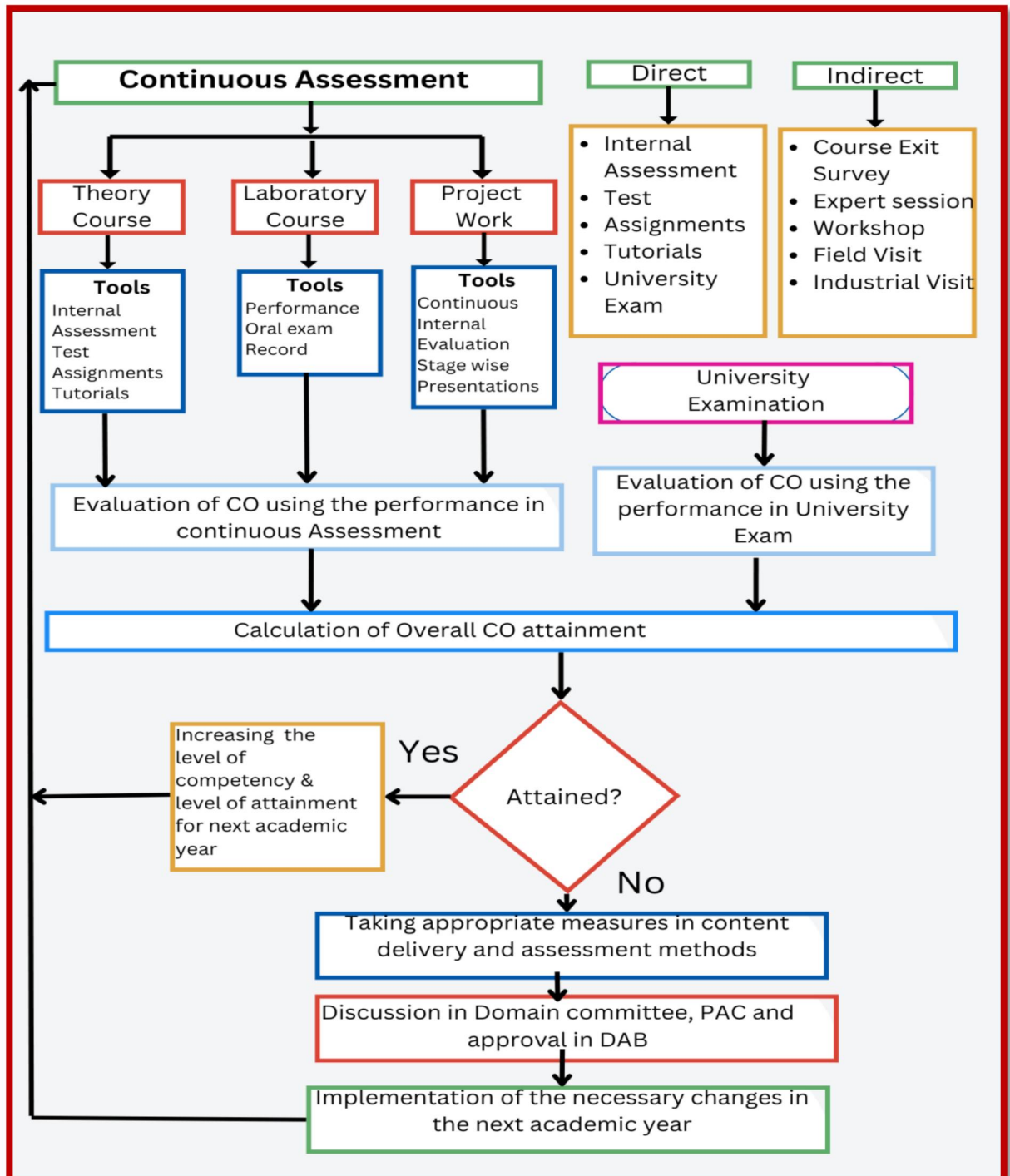


Fig. 4: Process for CO Attainment^[6]

CO attainment calculations:

Once the data of evaluation of the students is available then the CO attainment is carried out as per the below mentioned method.

Target setting: Based on the results of the last three years for the same course, the average marks of the students are calculated for all the examination occasions such as CIA and Term End Examination (TEE)s. In order to normalize the average marks, the percentage of average marks obtained by the students of a particular course for a particular assessment occasion are calculated. The average of this value for the last three years is kept as the target level of that course. The attainment levels are set at 1/4, 1/3 and 1/2 as level 1, 2 and 3 respectively that is 25%, 33% and 50% respectively. Fig. below gives an idea of the target setting.

Department of Civil Engineering				
Target Level Settings for COs				
Curriculum	2022-26		Academic year:	2023-24
Course Name	Geotechnical Engineering - I		Course Code:	CE-C503
Course Owner Name	Dr. Rohan Dasgupta		Class & Sem:	TE / V
Calculation Base				
Academic year	Average % of Marks		Average % of marks (last 3 years)	
	CIA	TEE	CIA	TEE
2023-24	58.45	33.28	67	47
2020-23	53.27	23.62		
2021-22	88.71	85.47		
Attainment Goal For CIA				
Level		% of the Students		% of Marks
3	More than or equal to	50	Scores	67
2		33		
1		25		
Attainment Goal For TEE				
Level		% of the Students		% of Marks
3	More than or equal to	50	scores	47
2		33		
1		25		

Number of students above Target: Once the target is set and the attainment levels are decided, the next process is to estimate the number of students for respective CO and for respective assessment occasions who are above the target value. The figure below gives the CO attainment values of Term Work for a Practical Laboratory Course. Here “1” appears if a student’s % marks for a respective CO in term work is above the target value and “0” if the % marks for that CO is below the target value calculated from the last three years data of student’s average percentage marks for the same course.

Example: Table below gives the target value for the course Practical laboratory course.

Department of Civil Engineering				
Target Level Settings for COs				
Curriculum	2022-26		Academic year:	2023-24
Course Name	Geotechnical Engineering - I Lab		Course Code:	CEL503
Course Owner Name	Prof. Umesh Jadhav		Class & Sem:	TE / V
Calculation Base				
Academic year	Average % of Marks		Average % of marks (last 3 years)	
	CIA	TEE	CIA	TEE
2023-24	79.5	80.57	76	71
2020-23	76.39	65.2		
2021-22	73.54	68.65		
Attainment Goal For CIA				
Level		% of the Students		% of Marks
3	More than or equal to	50	scores	76
2		33		
1		25		
Attainment Goal For TEE				
Level		% of the Students		% of Marks
3	More than or equal to	50	scores	71
2		33		
1		25		

Table below gives the marks scored by the students in Term End Exam in that Laboratory course.

Department of Civil Engineering					
Academic Year	2023-24	Curriculum	2022-26		
Course Name	Geotechnical Engineering Lab - I	Class / Sem	TE / V		
Name of Course Owner	Prof. Umesh Jadhav	Course Code	CEL503		
Term End Examination Marks					
Sr. No.	Roll No	Name	Total Marks	% of marks	Target
			25		
1	22CE05	FAHIM ISMAIL ASHFAK	15		
2	22CE06	GADKARI MOHAMMED AATIB MUSHTAQUE	16		
3	22CE07	KAZI MOHD QAMAR AZEEMUL HAQ	21		
4	22CE08	KHAN HAFEEZ ABDUL MUNAF	23		
5	22CE09	KHAN MOHD ANAS IMTIYAZ KHAN	19		
6	22CE10	KHAN MOHD KAIF ABDUL KALEEM	18		
7	22CE11	KHAN ZAID MOINUDDIN	17		
8	22CE12	MAKANDAR SOHAIL ADAM	15		
9	22CE13	MALIK AHMED RAZA MOHD VAIS	16		
10	22CE14	MD SHAHANWAZ	17		
11	22CE15	MEKRANI MOHAMMED YASIN ISHTIYAQ	20		
12	22CE16	MOHAMMAD ARIZ	23		
13	22CE17	PAGARKAR ZAYAAN SHABBIR	22		
14	22CE18	SALEMANI FAIZ FAZAL	21		
15	22CE19	SAWANT MOHAMMED SAAD AIJAZ	18		
16	22CE20	SHAIKH ABDUL MANNAN NOAMAN	17		
17	22CE21	SHAIKH ATIF ISRAR	16		
18	22CE22	SHAIKH REHAN RIYAZ	15	60	71
19	22CE23	SHAIKH SAHIL AMIN MOMEN	18	72	71

Referring to these let us take the example of the TEE of the practical course for understanding. The target for the term end exam is 71%. The students 22CE22 and 22CE23 have scored marks of 15 and 18 respectively. The total marks for the term end exam are 25 which mean that 22CE22 has scored 60% while 22CE23 has scored 72%. That's why for 22CE22 "0" is reflected in the TEE part of CO attainment sheet while for 22CE23 "1" is reflected as his % marks of TEE are more than the target value.

Department of Civil Engineering										
Academic Year		2023-24		Curriculum:		2022-26				
Course Name		Geotechnical Engineering - I Lab		Class / Sem :		TE / V				
Name of Course Owner		Prof. Umesh Jadhav		Course Code :		CEL503				
CO-Attainment										
Sr. No.	Roll No	Name	Term work (CIA)							TEE
			TW Marks	Mapped COs Attainment (Obtained vs Attempted)						Max Marks
				25	CO1	CO2	CO3	CO4	CO5	CO6
1	22CE05	FAHIM ISMAIL ASHFAK		0	0	0	0	0	0	0
2	22CE06	GADKARI MOHAMMED AATIB MUSHTAQUE	22	1	1	1	1	1	1	0
3	22CE07	KAZI MOHD QAMAR AZEEMUL HAQ	21	1	1	1	1	1	1	1
4	22CE08	KHAN HAFEEZ ABDUL MUNAF	19	0	1	1	1	0	1	1
5	22CE09	KHAN MOHD ANAS IMTIYAZ KHAN	22	1	1	1	1	1	1	1
6	22CE10	KHAN MOHD KAIF ABDUL KALEEM		0	0	0	0	0	0	1
7	22CE11	KHAN ZAID MOINUDDIN	21	1	1	1	1	1	1	0
8	22CE12	MAKANDAR SOHAIL ADAM	14	0	0	0	0	0	0	0
9	22CE13	MALIK AHMED RAZA MOHD VAIS	23	1	1	1	1	1	1	0
10	22CE14	MD SHAHANWAZ		0	0	0	0	0	0	0
11	22CE15	MEKRANI MOHAMMED YASIN ISHTIYAQ	23	1	1	1	1	1	1	1
12	22CE16	MOHAMMAD ARIZ		0	0	0	0	0	0	1
13	22CE17	PAGARKAR ZAYAAN SHABBIR		0	0	0	0	0	0	1
14	22CE18	SALEMANI FAIZ FAZAL		0	0	0	0	0	0	1
15	22CE19	SAWANT MOHAMMED SAAD AIJAZ		0	0	0	0	0	0	1
16	22CE20	SHAIKH ABDUL MANNAN NOAMAN	23	1	1	1	1	1	1	0

17	22CE21	SHAIKH ATIF ISRAR		0	0	0	0	0	0	0
18	22CE22	SHAIKH REHAN RIYAZ	20	1	1	1	1	0	1	0
19	22CE23	SHAIKH SAHIL AMIN MOMEN	20	1	1	1	1	0	1	1
20	22CE24	SHAIKHMANSOORI MEHTAB ALAM RIYASAT ALI	16	0	0	0	0	0	0	0
21	22CE25	SYED HAMMADUR RAHMAN		0	0	0	0	0	0	1

Calculating No. of “1”s for a CO for a given occasion like TEE gives us the value of No. of students above the target. From this data we can estimate the attainment level of a CO for a particular occasion.

The formula below calculates *CO* attainment for course outcome number “i” for assessment occasion “j”

Formula for *CO* attainment for course outcome number “i” for assessment occasion “j”:

$$\% \text{ of students above target for } CO_{ij} = \frac{\text{Number of students for } CO_{ij} \text{ above target}}{\text{Total number of students}}$$

In Fig. 6, the target value based on the average marks of students for the last three years is 72.51. There are 56 students above this target value out of 63 students which gives the percentage of students as 89. As per the Target settings attainment level above 50% has a value of 3 so for CO1 the attainment level is 3.

Threshold of marks in % =	72.51						
NO. of Students above the Threshold	56	56	56	0	0	0	0
% of Students above the Threshold	89	89	89	0	0	0	0
Level of Attainment through COA-04	3	3	3	0	0	0	0

Course Outcomes	CO1	CO2	CO3	CO4	CO5	CO6
-----------------	-----	-----	-----	-----	-----	-----

Fig. 6 CO attainments [8]

Considering the weightages defined for direct, indirect, CIA, TEE etc. the calculations for overall CO attainment through a particular course are shown below.

In case where there are multiple marks for a particular CO then the estimation of CO attainment of such CO would involve summation of marks scored by a student in that CO against the total marks allotted to that CO.

The weightages for internal assessments, external assessments, direct attainment and indirect attainments are as defined below

$W1$ = Weightage for internal assessment

$W2$ = Weightage for external assessment

$W3$ = Weightage for course exit survey

$W4$ = Weightage for Expert session/workshop/training/seminar

$W5$ = Weightage for direct attainment

$W6$ = Weightage for Indirect attainment

Formula for CO_i attainment:

CO_i attainment = $W5 * [W1 * \text{Attainment of } CO_i \text{ through Internal assessment} + W2 * \text{Attainment of } CO_i \text{ through External Assessment}] + W6 * [W3 * \text{Attainment of } CO_i \text{ through Course Exit Survey} + W4 * \text{Attainment of } CO_i \text{ through Expert session/workshop/training/seminar}]$

Where i is Course Outcome number

CO	Direct Attainment		Indirect Attainment		CO Attainment
	CIA	TEE	Training / Workshop / Seminar	Course Exit Survey	
CO1	2	3		1.97	2.39
CO2	3	3		1.86	2.77
CO3	2	3		1.88	2.38
CO4	2	3		1.97	2.39
CO5	2	3		1.86	2.37
CO6	2	3		1.88	2.38
Attainment	2.17	3		1.9	
Weightage IN %	50	50		100	
Total attainment by weightage	1.09	1.5	0	1.9	
Sum Of Attainment	2.59		1.9		
Weightage IN %	80		20		
Final Course Attainment	2.452				

As an example referring to the above table, for CO1, $W1=0.5$, $W2=0.5$, $W3=1$, $W4=0$, $W5=0.8$ and $W6=0.2$

The overall CO1 attainment would be $0.8[0.5*2+0.5*3] + 0.2[1*1.97+0] = 2.394$

Similarly the CO attainments of the other COs can be calculated. These COs can be compared with the target CO to see if the respective CO is attained or not. The overall CO attainment of the said course can also be calculated considering the average value of the attainments of a respective assessment occasion and its weight.

$W1$ = Weightage for internal assessment

$W2$ = Weightage for external assessment

$W3$ = Weightage for course exit survey

$W4$ = Weightage for Expert session/workshop/training/seminar

$W5$ = Weightage for direct attainment

$W6$ = Weightage for Indirect attainment

Formula for Overall CO attainment:

Referring to the table above, the overall CO attainment would be based on the average of CO attainments of all the COs for a particular assessment occasion. The formula for overall CO attainment is as follows

$CO_i \text{ attainment} = W5 * [W1 * \text{Average attainment for CIA through all COs} + W2 * \text{Average attainment for TEE through all COs}] + W6 * [W3 * \text{Average attainment for Course Exit Survey through all COs} + W4 * \text{Average attainment for Expert session/workshop/training/seminar through all COs}]$

$$0.8[0.5*2.17+0.5*3] + 0.2[1*1.9+0*0] = 2.452$$

6. PO attainment process using CAGS

PO Target Setting: The process of PO attainment starts with PO target setting. We have considered the target for the batch 2017-21 as 1.8 which is 80% of 3 (maximum possible attainment). For every next batch the target is increased by 2% up to the time the first batch gets passed out so progressively the targets would be as given in the below table

Batch	Target
2017-21	2.4
2018-22	2.45
2019-23	2.5
2020-24	2.55

The 2017-21 batch will pass out in the academic year 2021-22, in the same academic year batch 2021-25 would enter. The target for batch 2021-25 would be taken from the target attainment and actual attainment of batch 2017-21. The maximum of the two values would be considered as the target for the 2021-25 batch. Table below gives an idea of the process.

Batch	Target Attainment (At the start)	Actual Attainment/Target							
		AY 17- 18	AY 18- 19	AY 19- 20	AY 20- 21	AY 21- 22	AY 22- 23	AY 23- 24	AY 24- 25
2017-21	2.4 for all POs	1.8	NA	NA	x				
2018-22	2.45 for all PO		1.86	NA	NA	y			
2019-23	2.5 for all PO			1.92	NA	NA	z		
2020-24	2.55 for all PO				1.98	NA	NA	p	
2021-25						Max (1.8,x)	Max (1.8,x)	Max (1.8,x)	Max (1.8,x)
2022-26							Max (1.86,y)	Max (1.86,y)	Max (1.86,y)
2023-27								Max (1.92,z)	Max (1.92,z)
2024-28									Max (1.98,p)

LEGENDS USED IN THE ABOVE TABLE FOR VARIOUS BATCHES			
2017-21 batch		2021-25 batch	
2018-22 batch		2022-26 batch	
2019-23 batch		2023-27 batch	
2020-24 batch		2024-28 batch	

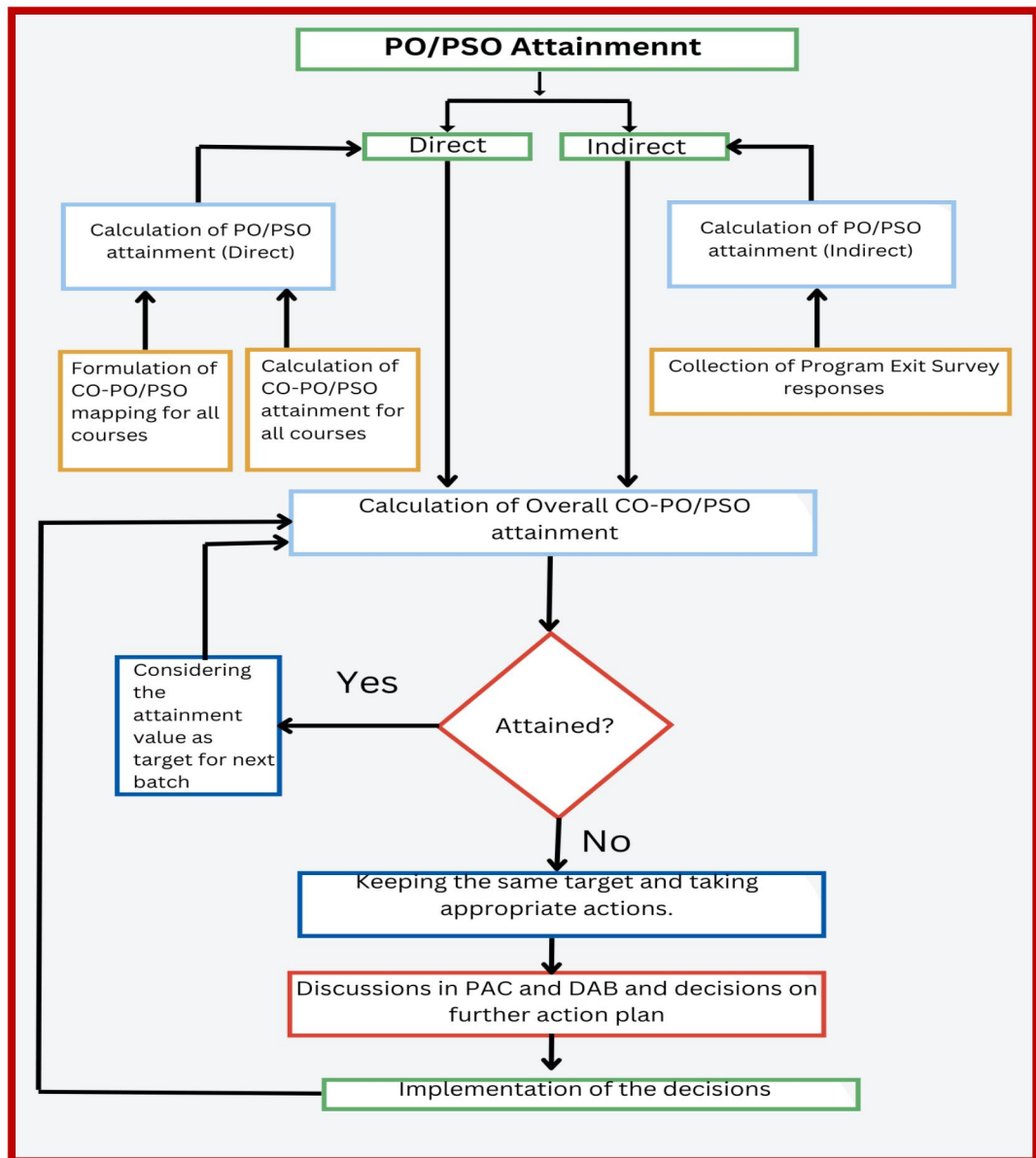


Fig.7 Process for PO/PSO Attainment ^[6]

The entire process of PO/PSO attainment is demonstrated in the above flow chart. There are direct and indirect methods of PO/PSO attainment. 80% weightage is given to direct methods of PO and PSO attainment while 20% is given to the indirect methods of PO attainment.

PO/PSO Assessment Tools:

Evaluation of attainment of POs and PSOs is based on direct and indirect assessment tools. Direct assessment of POs and PSOs is based on students' performance in Continuous Assessments and Term End Examination (TEE). Indirect assessment is based on Program Exit Survey, PO/PSO attainment through any activity directly addressing to that PO/PSO and PO/PSO attainment based on the project evaluator's feedback.

Direct Assessment:

Using Program Outcomes prescribed by NBA, the faculty member evaluates the Program Outcomes and Program Specific Outcomes through Internal Assessment Tests, Assignments / Tutorial and Group Discussion, Term End Exam etc. Each course would give its PO/PSO attainment value based on the CO-PO/PSO mapping of that course.

The following table shows the tools and process for direct PO attainment.

PO Attainment	Tools	Process
Direct (CO Attainment)	<ul style="list-style-type: none"> • Internal Assessment Test • Assignments • Tutorials • Online Quiz • Term End Examination (TEE) 	<ul style="list-style-type: none"> • Assignments / Tutorials / online quizzes are given periodically for the entire course to attain the specific POs. • Two Internal Assessment Tests are conducted per semester to evaluate the student performance. • Term End Examination (TEE) is conducted once in a semester as per University Schedule
	<ul style="list-style-type: none"> • Performance • Oral Exam • Practical Exam • Term Work • Presentation • Group Discussion 	<ul style="list-style-type: none"> • Student Contribution in laboratory is evaluated based on the performance, The work they submit, Oral Exam, Practical exam, etc. • Term End Examination (TEE) is conducted once in a semester as per University Schedule
	<ul style="list-style-type: none"> • Project work 	<ul style="list-style-type: none"> • Students are divided into batches. Each batch consists of three to four students. • Supervisors are allotted for each group. • Zeroth level presentations are conducted for the students to identify the area of project. • Periodically the project guides monitors the progress of the project and presentations are also taken by the project committee at some interval of time. • Final Project presentation is conducted at the end of the semester.

Course level PO & PSO Attainment Calculation:

The PO & PSO attainment for the course is calculated based on the CO attainment value of the mapped CO to that particular PO/PSO and its strength of mapping. It is explained with the help of an example. Table Below gives the mapping between various COs of a course to its respective PO/PSO and its mapping strength

Department of Civill Engineering																
Academic Year :		2023-24					Curriculum			2022-26						
Course Name :		Geotechnical Enginnering - I Lab					Class / Sem			TE / V						
Name of Course Owner :		Prof. Umesh Jadhav					Course Code			CEL503						
PO-Attainment																
COs No.	Course outcome	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 01	PSO 02	PSO 03
CO 01	Determine the moisture content of soil sample.	2								1						
CO 02	Determine the liquid limit of soil sample.	2								1						
CO 03	Determine the plastic limit of soil sample.	2								1						
CO 04	Determine the shrinkage limit of soil sample.	2			2					1				1		
CO 05	Determine the IS Classifciation of soil sample	2			2					1				1		
CO 06	Determine the coefficient of permiability of soil sample using constant head permiability test	2			2											
Correlation Level		2			2					1				1		
Course PO Attainment		2.45			2.38					2.46				2.38		

The CO attainment value for the same course is as given below

CO	Direct Attainment		Indirect Attainment		CO Attainment
	CIA	TEE	Training / Workshop/ Seminar	Course Exit Survey	
CO1	2	3		1.97	2.39
CO2	3	3		1.86	2.77
CO3	2	3		1.88	2.38
CO4	2	3		1.97	2.39
CO5	2	3		1.86	2.37
CO6	2	3		1.88	2.38

In general the Direct PO/PSO attainment through mapped COs is given by the below formula

$$\text{PO/PSO attainment through mapped COs} = \frac{(\sum_{i=1}^{i=n} S_i * CO_i)}{(\sum_{i=1}^{i=n} S_i)}$$

Where “i” is the CO number and Si is the strength of mapping between a particular PO/PSO and COi.

Example1:

PO1 is mapped to all the COs of the course with different mapping strengths. The attainment of PO1 through all the mapped COs would be

$$(S1*CO1+ S2*CO2+ S3*CO3+ S4*CO4+ S5*CO5+ S6*CO6)/(S1+S2+S3+S4+S5+S6)$$

$$(2*2.39+2*2.77+2*2.38+2*2.39+2*2.37+2*2.38)/(2+2+2+2+2+2)$$

2.45

Similarly the PO/PSO attainment for all the other mapped POs/PSO can be calculated.

Indirect Assessment:

The following tools are used to assess the indirect assessment of attainment of POs and PSOs. The assessment tools listed in table below are used for both PO and PSO attainment calculation.

Sr. No.	Tools used for Assessment processes	Weightage	Description
1	Program Exit Survey	40%	Taken at the end of Semester VIII in the form of a Google sheet with questions based on each PO and PSO The average response is added in the indirect PO/PSO attainment
2	Add on activity directly addressing to a PO/PSO	40%	Any add on activity conducted for PO/PSO attainment where no direct formal evaluation is done and response is collected for one or more PO/PSO
3	Project External Examiners Feedback on PO/PSO attainment	20%	The external examiners feedback for the PO/PSO attainment is taken in the given format

Program Exit Survey:

It is a process of collecting satisfaction survey on the quality of education from the perspective of graduating students upon the completion of their program. Program Exit Survey is structured on a scale of 3 and the average response is directly considered for the calculation of indirect PO/PSO attainment. An internal weightage of 40% is considered for this indirect PO/PSO attainment.

Add on activity directly addressing to a PO/PSO:

In case of any activity which is planned directly addressing a PO and without the plan of any formal evaluation through examination, then such activities are added to indirect PO attainment. An internal weightage of 40% is given to such kind of activities while the overall weightage to the indirect PO attainment is 20%.

Project External Examiners Feedback on PO/PSO attainment:

During the final project presentation of the students, feedback on PO/PSO attainment is taken from the external examiner in the specified format. The average PO wise feedback of all the students would be considered for the purpose of PO/PSO indirect attainment. An internal weightage of 20% is given to this.

Final PO/PSO attainment:

The final PO/PSO attainment has two elements one is Direct PO/PSO attainment with a weightage of 80% and the other Indirect PO/PSO attainment with a weightage of 20%.

Fig. below gives the PO/PSO attainment through direct methods.

Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
S1 2017-21 TH CE-C301 AM-III ()														
S1 2017-21 TH CE-C302 SURVEY-I (FP)	2.57	2.58	2.59	2.58	2.57	2.57	1.6	2.52	2.57		2.68	1.5		
S1 2017-21 TH CE-C303 SOM (SM)	2.57	2.57		2.63				2.52	2.52					
S1 2017-21 TH CE-C304 EG (PJ)	2.4	2.38		2.38	2.37				2.38	2.38			2.41	
S1 2017-21 TH CE-C305 FM-I (FN)	1.21	1.13	1.11											
S1 2017-21 PR CE-C302 SUR-I (FP)	2.6	2.6	2.64	2.63	2.63	2.6	1.5	2.6	2.6		2.6	1.5		
S1 2017-21 PR CE-C303 SOM (SM)														
S1 2017-21 PR CE-C304 EG (PJ)	2.46	2.47		2.46	2.45				2.46	2.46			2.46	
S1 2017-21 PR CE-C305 FM-I (FN)	2.06	2.07	2.06											
S1 2017-21 TH CE-C401 A.M-IV ()														
S1 2017-21 TH CE-C402 SURVEY-II (FP)	2.41	2.42		2.57	2.4	2.41		2.41	2.41	2.57	2.43	1.4		
S1 2017-21 TH CE-C403 S.A-I (DSP)	2.55	2.5	2.46	2.46	2.47	2.47	2.48	2.48			2.48			
S1 2017-21 TH CE-C404 BDD-I (RD)	2.48	2.49	2.49	2.49	2.47	2.48	2.48	2.49		2.48				
S1 2017-21 TH CE-C405 BMCT (SM)														
S1 2017-21 TH CE-C406 FM-II (JM)														
S1 2017-21 PR CE-C402 SUR-II (FP)	2.98	2.98		2.98	2.98	2.98		2.98	2.98	2.98	2.98	1.3		
S1 2017-21 PR CE-C403 SA-I (DSP)	1.75	1.75	1.74	1.74	1.76	1.76	1.76	1.76			1.76			
S2 2017-21 PR CE-C701 QSEV (UVJ)	2.7	2.82	2.69	2.78	2.71								2.61	2.55
S2 2017-21 PR CE-C702 TRCS (DSP)	2.07	2.07	2.07	2.07	2.28	2.28	2.28	2.28						
S2 2017-21 PR CE-C703 WRE-II (SZJ)	2.4	2.85	1.64										2.26	
S2 2017-21 PR CE-C704 1 DLO pc (JM)														
S2 2017-21 PR CE-C704 2 DLO ELE-SWM (DSS)	2	1.97	2.08	1.98									1.99	2
S2 2017-21 TH CE-C801 DDRCS (SMS)	2.5	2.5	2.5	2.5	2.45			2.5					2.5	2.5
S2 2017-21 TH CE-C802 1 ILO PM (PPG)	2.55	2.51	2.49	2.61	2.74	2.51	2.44	2.58	2.45	2.56	2.52	2.54	2.54	2.54
S2 2017-21 TH CE-C802 2 ILO FM (M0hsin Khan)														
S2 2017-21 TH CE-C802 9 ILO EM (PJ)	2.75	2.72	2.85	2.74	2.7	2.74	2.79	2.8	2.77	2.74	2.75		2.73	2.75
S2 2017-21 TH CE-C802 CM (GBM)	2.84	2.86	2.79	2.84	2.83				2.78				2.84	2.85
S2 2017-21 TH CE-C803 2 DLO IWT (DSS)	0.47	0.48	0.47	0.47	0.47				0.45				0.47	0.47
S2 2017-21 TH CE-C803 4 DLO BDE (JS)	2.8	2.8	2.79	2.79	2.8	2.8								
S2 2017-21 PR CE-C801 DDRCS (SMS)	2.3	2.4	2.3	2.333333	2.333333			2.333333					2.333333	2.333333
S2 2017-21 PR CE-C802 CM (UVJ)	2.08	2.08	2.09	2.08							2.07		2.08	2.08
S2 2017-21 PR CE-C803 2 DLO (DSS)	0.47	0.48	0.47	0.47	0.47				0.45				0.47	0.47
S2 2017-21 PR CE-C803 4 DLO BDE (JS)														
PO Attainment final	2.22	2.23	2.22	2.28	2.32	2.39	2.46	2.51	2.42	2.43	2.49	2.51	2.31	2.28

Fig. 8 Direct PO attainment through all courses [8]

Table below gives the value of Indirect PO/PSO attainments through indirect methods

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Program Exit Survey (40%)											
2.1	2.4	2.3	2.22	2.43	2.12	2.33	2.56	2.45	2.54	2.65	2.57
Add on activity directly addressing to a PO/PSO (40%)											
-	-	-	-	-	2.45	-	2.3	-	-	-	2.54
Project External Examiners Feedback on PO/PSO attainment (20%)											
2.1	2.22	2.34	2.67	2.56	2.39	2.54	2.33	2.7	2.45	2.34	2.4
Total Indirect PO attainment											
2.1	2.36	2.31	2.31	2.46	2.39	2.37	2.41	2.5	2.52	2.58	2.5

Note: If for a PO there is no attainment through any activity then the weightage of Program Exit Survey would be 0.8 instead of 0.4

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Direct PO/PSO attainment (80%)											
2.22	2.23	2.22	2.28	2.32	2.39	2.46	2.51	2.42	2.43	2.49	2.51
Indirect PO attainment (20%)											
2.1	2.33	2.32	2.4	2.48	2.46	2.41	2.42	2.55	2.50	2.52	2.5
Final PO Attainment											
2.20	2.25	2.24	2.30	2.35	2.40	2.45	2.49	2.45	2.44	2.50	2.51

These values in the last row of this table give the final attainment of different POs. The same process can be followed for the PSO attainment through direct and indirect attainment methods.

7. Post CO attainment tasks:

Once the CO attainment values of a course for a particular batch have been calculated, the next stage is to plan for the corrective action for the succeeding batches for the same course. This is done through the CO-wise action plan.

There are three occasions for this CO Wise action plan which is as shown in the table below which are Current Academic Year (CAY), Current Academic Year-1 (CAY-1), Current Academic Year+1 (CAY+1),

Academic Year	Batch	Occasion	Remarks
CAY-1	Previous	After result declaration of previous year's course	It would be CAY+1 in the last year's CAGS sheet
CAY	Current	Start of current course	Reference is CAY+1 of last year's CAGS sheet.
CAY+1	Current	After result declaration of current year's course	Action based on results

The course owner taking any course would refer the CAY+1 part of the CAGS sheet of the previous course (CAY-1) and see what actions were suggested by the course owner for the CO's based on the student's performance and CO attainment of all the COs of his batch. Based on this information, he will then prepare the actions to be taken for various COs for the course of the current batch (CAY). He will incorporate the prepared actions during the course delivery. After the result declarations and CO attainments, he would get the information of the effectiveness of the actions which were implemented. He will then suggest the new action plan for the coming batch for the same course.

Also if a particular CO is attained, then the target of that CO for the coming batch is increased by 2%. If the CO is not attained, then the target for that CO kept same.

Example:

The example below is for the course of sem III in Mechanical Engineering on Materials and Metallurgy (MEC304) for the academic year 2024-25. Action plan of CAY-1 is that of the previous year's suggestions of the course owner based on the course attainment values. CAY is the anticipated action plan which the current year's course owner would take for the same course. CAY+1 would be the suggested action plan once the results of this batch of academic year 2024-25 would be declared and one would have the CO attainment values for this batch.

Action Plan for COs					
Curriculum:	2022-26		Academic year:	2024-25	
Course Name:	Geotechnical Engineering - I		Course Code:	CEC503	
Course Owner Name:	Dr. Rohan Dasgupta		Class & Sem:	TE / V	
Action Plan					
CO No.	Course Outcome	CAY-1 Plan	CAY Plan	CAY+1 Plan	CO attainment
CO 01	Define index properties of soil and derive relationships between them using three phase diagram	Solve all derivations asked in previous years' question papers.	Flipped classroom on derivation of relationships between index properties of soil.		1.2
CO 02	Define and determine plasticity characteristics of soil	Show videos on the laboratory tests for LL, PL and SL.	Emphasize on the graphical methods.		1.35
CO 03	Classify soil samples as per IS 1948:1970	Emphasize on what is done after the classification of soil.	Focus more on IS Classification of Soils		1.21

CO 04	Determine the coefficient of permeability of soil strata under different conditions	Show videos on the laboratory tests for permeability	Show videos on the laboratory tests for permeability		1.04
CO 05	Determine total pressure, pore water pressure and effective pressure of soil strata under different conditions	Solve all problems asked in previous years' question papers.	Solve all problems asked in previous years' question papers.		1.4
CO 06	Determine optimum moisture content and maximum dry density of soil sample	Emphasize on how different factors effect the compaction of the soil.	Emphasize on the graphical methods		1.39

8. Post PO/PSO attainment tasks

Once the PO/PSO attainment of a batch has been calculated, based on the status of the attainment, some actions plans are proposed, approved and implemented for the succeeding batches. The action can be in terms of conducting additional sessions for a few courses, Arranging Expert talk, workshop, Industrial Visits, field visits or some other activity.

Example:

The final PO attainment values for a batch are as given below

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1
2.20	2.25	2.24	2.30	2.35	1.94	2.45	1.58	2.45	2.04	2.50	2.51	2.66
A	A	A	A	A	NA	A	NA	A	NA	A	A	A

From the table it can be found that PO6, PO8 and PO10 are not attained. These POs are Accordingly the suggested action plans could be as follows.

PO6: Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.

Action 1: Some expert talk by practicing engineers should be arranged so that the students would know about legal and cultural issues related to their domain.

Action 2: Site visits can be planned so that the students would know impacts of a project on society in real time. Also they would understand the safety aspects.

Action 3: The courses which are mapped to PO6 should be revisited and some improvements in the delivery and assessment can be made.

PO8: Understand and commit to professional ethics and responsibilities and norms of engineering practice.

Action 1: Some expert talk, seminar, workshop for enhancing the ethical values in the students can be arranged.

PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Action 1: Some Technical competitions can be arranged so that the students develop the written and oral communication skills.

Action 2: Students can be motivated to use language lab and available resources for improving their communication skills

Action 3: The courses which are mapped to PO10 should be revisited and some improvements in the delivery and assessment can be made.

These points would be suggested by PAC and can be approved by DAB so that these are implemented for the succeeding batches.

9. References:

1. NBA Accreditation Manual
2. AICTE Examination Reforms Policy
3. University of Mumbai Teaching and Examination schemes of applicable courses
4. NPTEL course NBA Accreditation and Teaching Learning in Engineering (NATE)
5. Video references from YouTube
6. CO, PO/PSO Attainment manuals of other institutes.
7. Minutes of the meetings held at the institute for NBA related policy/decisions
8. Course Attainment Google Sheet of selected courses