

1. Attainment of Course Outcomes

Course outcomes are statements that specify what a learner will know or be able to do as a result of a learning activity. Outcomes are usually expressed as knowledge, skills, or attitudes. It is a measurable, observable, and specific statement that clearly indicates what a student should know and be able to do as a result of learning. It describes what students are able to demonstrate in terms of knowledge, skills and values upon completion of a course/a span of several courses. Program Outcomes (Pos) describe what a program is expected to accomplish. Pos describe what students should know and be able to do at the end of the programme. Pos are to be in line with the graduate attributes as specified in the NBA. Program Specific Outcomes (PSOs) are statements that describe what the graduates of a specific engineering program should be able to do. Clear articulation of course outcomes, Pos and PSOs serves as the foundation for evaluating the effectiveness of the teaching and learning process.

Course correlation matrix shows the learning relationship (Level of Learning Achieved) between Course Outcomes and Program Outcomes of a course. This matrix strongly indicates whether the students are able to achieve the course objectives/outcomes. The matrix can be used for any course and is a good way to evaluate a course syllabus/content/structure. The below table (Table No: 1 Process for mapping the values for CO-PO Matrix) gives information about the action verbs used in the Pos and the nature of Pos, stating whether the Pos are technical or non-technical, with an understanding of the intention of each PO and the Bloom's level to which each of these action verbs in the Pos correlates to. After understanding the Pos, write the COs for a course and correlate the COs with the Pos.

Type	Pos	Pos action Verbs	Pos Blooms Levels	COs Bloom's Level(s)
Technical Skills	PO1	Apply	L3	L1 to L4 »»» Theory Courses, L1 to L5 »»» Laboratory Courses, L1 to L6 »»» Mini Project and Major Project
	PO2	Identify	L2	
		Formulate	L6	
		Review	L2	
	PO3	Design	L3, L6	
		Develop	L3, L6	
	PO4	Analyze	L4	
		Interpret	L2, L3	
		Design	L6	
	PO5	Create	L6	
		Select	L1, L2, L6	
		Apply	L3	
	PO6	Apply	L3	
		Assess	L5	
Transferable Skills	PO7	THUMB RULE		
	PO8	If L1 Action Verbs of a CO »»» Correlates with any of PO7 to PO12 »»» then assign 1		
	PO9			
	PO10			
	PO11	If L2 to L3 Action Verbs of a CO »»» Correlates with any		

	PO12	of PO7 to PO12 »»» then assign 2 If L4 to L6 Action Verbs of a CO »»» Correlates with any of PO7 to PO12 »»» then assign 3
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Table No 1 Process for mapping the values for CO-PO Matrix

Note:

- The first six Pos are purely technical in nature, while the other Pos are transferable skills.
- The CO level is set between 1 and 4 for the theory courses. The CO level is set between 1 and 5 for the laboratory courses. The CO level is extended upto 6th level only for mini projects and major projects.
- For a given course, the course faculty member has to involve all other faculty members who teach that course and ask them to come up with the CO-PO mapping. The course faculty member has to take the average value of all of these CO-PO mappings and finalize the values, or the course faculty member can go with what the majority of the faculty members prefer. While matching COs with non-technical Pos, correlate the action verbs used in the COs with the thumb rule given in the table and map the values.

Procedure followed while assigning the values by mapping COs to Pos.

- Select action verbs for a CO from different Bloom’s levels based on the importance of the particular CO for the given course.
- Stick on to single action verbs while composing COs and use for multiple action verbs if the need arises.
- Values to CO-PO (technical Pos in particular) matrix are assigned by
 - ❖ Judging the importance of the particular CO in relation to the Pos. If the CO matches strongly with a particular PO criterion then 3 is assigned, if it matches moderately then 2 is assigned or less than 1 is assigned else marked with “ – ” symbol.
 - ❖ If an action verb used in a CO is repeated at multiple Bloom’s levels, then reconsider which Bloom’s level is the best fit for that action verb.

For measuring the attainment of Course Outcomes, various tools are used. The process of CO attainment is described in Figure 1.

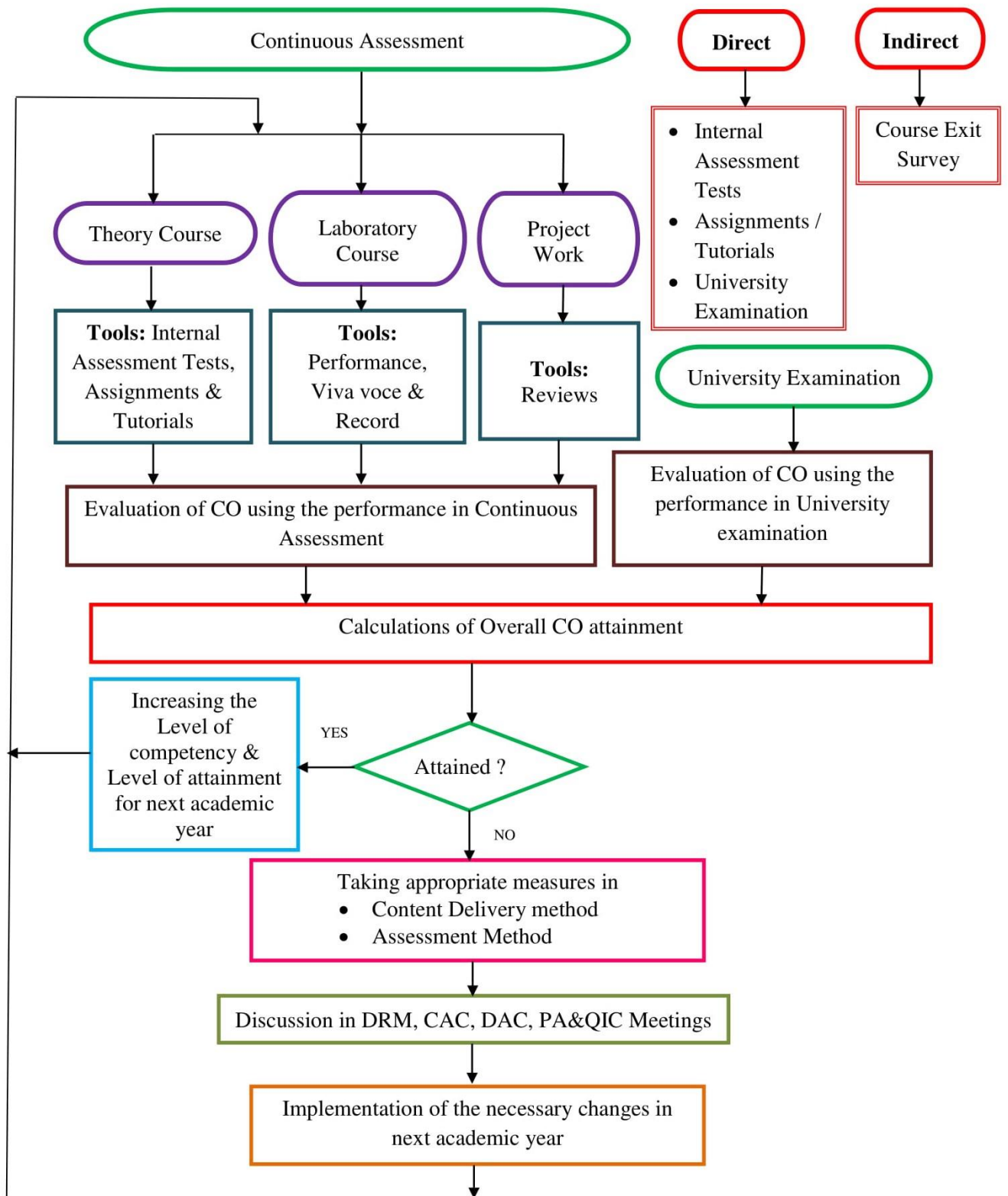
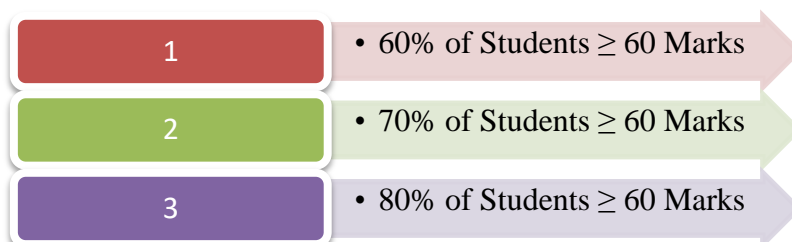


Figure 1 Process for CO Attainment

Direct Assessment:

Evaluation Methods	Process
Internal Assessment Tests	Three Internal Assessment Tests are conducted per semester to evaluate the attainment of course outcomes. Each question is mapped with COs and blooms level.
Assignments & Tutorials	The tutorials and assignments are given to the students based on the subject nature. For four credit papers tutorials are mandatory. Tutorial and Assignment sheets are prepared by the faculty member with COs and levels.
Continuous Assessment & Model Exam (Laboratory Course)	The evaluation criteria for each experiment are based on performance, viva-voce and record mark. The attainment of COs is calculated through continuous assessment and model practical performance.
Project Reviews	<ul style="list-style-type: none">• Three reviews are conducted periodically to monitor and evaluate the progress of the project using project rubrics.• Viva-Voce is conducted at the end of the semester as per University norms.
University Examination	At the end of each semester, final examination is conducted for Theory and Laboratory courses by Anna University, in which question paper covers the entire syllabus and all the Cos are covered in the question papers.

Attainment Level:



Theory courses:

For each theory course, faculty member calculates the course outcome attainment using University Examination and Internal Assessment Test. The attainment level will be calculated based on the average performance levels of both University Examination and Internal Assessment Test. The evaluation process of Internal Assessment Tests/Assignments/Tutorials/Group Discussion is counted for 40% and the remaining 60% will be given for university examination. 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	40%	Thrice in a Semester
	University Examination	60%	Once in a Semester

Laboratory Courses:

For laboratory courses, the course outcome will be calculated based on performance, viva-voce, record work and model practical examination with the weightage of 40% for Continuous Internal Assessment and 60 % weightage for University Practical Examination. 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 in order to improve attainment level for the laboratory course.

Assessment Tool		Weightage	Frequency
CO Attainment	Continuous Internal Assessment	40%	Every Week
	University Practical Examination	60%	Once in a Semester

Project Work Assessment:

For project work, Continuous Internal Assessment is based on the performance in the three reviews. The Course Attainment is calculated based on the three reviews and project Viva voce.

- Project review is conducted every month to review the progress of the project and the second review will be conducted in the presence of an industry expert.
- Suggestions are given to the students for their continuous update and improvement.
- Evaluation of each review is based on the parameters discussed in teaching learning process.

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	40%	Every Month
University Assessment	Viva-Voce	60%	Once in a Semester

CO Attainment Calculation:

The course outcomes for all the courses are calculated in terms of percentage using the formula.

$$\text{COx in \%} = \frac{\text{Marks obtained by the students in COx}}{\text{Maximum Marks allotted in COx}} \times 100$$

Where, x= [1 to N], N= Number of COs.

Each course outcome is calculated for all the students based on marks obtained by the students.

$$\text{CO}_x \text{ Attainment in } \% = \frac{\text{no. of Students scored more than or equal to 60\% of Marks in CO}_x}{\text{no. of Students}} \times 100$$

Where, $x = [1 \text{ to } N]$, $N = \text{Number of Course Outcomes}$

CO Attainment level is defined based on the following criteria:

CO _x Attainment Level	3	80% of the Students scoring more than or equal to 60% of Marks in CO _x
	2	70% of the Students scoring more than or equal to 60% of Marks in CO _x
	1	60% of the Students scoring more than or equal to 60% of Marks in CO _x

After calculating the attainment levels of each COs from the performance of Internal Assessment Test 1, 2 & 3, the attainment level of Internal Assessment Test is calculated with ratio of sum of all COs attained by total number of COs as shown below:

$$\text{IAT Attainment Level} = \frac{\text{Sum of all COs attained by students}}{\text{Total Number of COs}}$$

Based on university grade, the attainment level of COs is calculated. The attainment level is decided based on the following criteria.

University Attainment Level	3	80% of the Students scoring more than or equal to 50% of Marks in University Exam
	2	70% of the Students scoring more than or equal to 50% of Marks in University Exam
	1	60% of the Students scoring more than or equal to 50% of Marks in University Exam

Overall CO Attainment:

The Overall Attainment for a course is sum of 40% of Internal Assessment Test Attainment Level and 60% of University Attainment Level.

$$\text{Overall CO Attainment} = \left(\frac{\sum_i^n}{n} \right)$$

Where $n = \text{number of course outcome.}$

Sample Calculation:

$$\text{CO}_x \text{ in } \% = \frac{\text{Marks obtained by the students in CO}_x}{\text{Maximum Marks allotted in CO}_x} \times 100$$

Where, x= [1 to N], N= Number of COs

Reg. No of the student: 953615106001	CO1 in % = $\frac{11.5}{18} \times 100 = 63.88 \%$
	CO2 in % = $\frac{28}{32} \times 100 = 87.50 \%$
	CO3 in % = $\frac{12}{18} \times 100 = 66.67 \%$
	CO4 in % = $\frac{44.5}{65} \times 100 = 68.46 \%$
	CO5 in % = $\frac{9.5}{17} \times 100 = 55.88 \%$

Reg. No of the student: 953615106005	$\text{CO1 in \%} = \frac{29.5}{33} \times 100 = 89.39 \%$ $\text{CO2 in \%} = \frac{16}{17} \times 100 = 94.12 \%$ $\text{CO3 in \%} = \frac{16}{18} \times 100 = 88.89 \%$ $\text{CO4 in \%} = \frac{64}{65} \times 100 = 98.46 \%$ $\text{CO5 in \%} = \frac{17}{17} \times 100 = 100 \%$
Reg. No of the student: 953615106007	$\text{CO1 in \%} = \frac{12.5}{18} \times 100 = 69.44 \%$ $\text{CO2 in \%} = \frac{26.5}{32} \times 100 = 82.81 \%$ $\text{CO3 in \%} = \frac{24}{33} \times 100 = 72.73 \%$ $\text{CO4 in \%} = \frac{47.5}{50} \times 100 = 95 \%$ $\text{CO5 in \%} = \frac{17}{17} \times 100 = 100 \%$
Reg. No of the student: 953615106062	$\text{CO1 in \%} = \frac{30}{33} \times 100 = 90.91 \%$ $\text{CO2 in \%} = \frac{17}{17} \times 100 = 100 \%$ $\text{CO3 in \%} = \frac{18}{18} \times 100 = 100 \%$ $\text{CO4 in \%} = \frac{45.5}{50} \times 100 = 91 \%$ $\text{CO5 in \%} = \frac{31}{32} \times 100 = 96.87 \%$

After calculating each course outcomes in terms of percentage, the attainment level of the course is shown below table.

CO1	1	60% of Students scored more than or equal to 60 Marks
CO2	2	70% of Students scored more than or equal to 60 Marks
CO3	2	70% of Students scored more than or equal to 60 Marks
CO4	3	80% of Students scored more than or equal to 60 Marks
CO5	2	70% of Students scored more than or equal to 60 Marks

Internal Attainment is calculated as follows:

$$\text{IAT Attainment Level} = \frac{\text{CO1} + \text{CO2} + \text{CO3} + \text{CO4} + \text{CO5}}{5}$$

$$\text{IAT Attainment Level} = \frac{1 + 2 + 2 + 3 + 2}{5} = 2$$

University Attainment is calculated as follows:

The university attainment level can be calculated as follows:

University Attainment level	1	60% of Students scored more than or equal to 50 Marks
	2	70% of Students scored more than or equal to 50 Marks
	3	80% of Students scored more than or equal to 50 Marks

In this subject 96.36 % of the students scored more than or equal to 50% of the mark in university examination, so the University Attainment Level is 3.

The Overall Attainment for the course is calculated as follows.

$$\text{Overall CO Attainment} = \left(\frac{\sum_{i=1}^n \text{CO}_i}{n} \times 0.4 \right) + (\text{UA} \times 0.6)$$

Where n = number of course outcome.

$$\text{Overall CO Attainment} = (0.4 \times 2) + (0.6 \times 3) = 2.6$$

$$\text{Overall CO Attainment} = 2.6$$

1.2 Record the attainment of Course Outcomes of all courses with respect to set attainment levels

The attainment level for each course is decided by the respective faculty member. The attainment of COs for all subjects from I year, II year, III year and IV year for the batch 2013-2017, 2014-2018, 2015-2019 and 2016-2020 are assessed by having 60% weightage for university examination and 40% weightage to internal assessment tests.

Set Attainment Level Calculation:

- The set attainment level for the first batch (2013-2017) has been fixed as 1.5 for theory courses and 2 for Laboratory courses/Project.
- The set attainment level for the batch 2014-2018 has been fixed by taking average grade point analysis value of the university examinations obtained by the 2013-2017 batch students.
- The set attainment level for the batch 2015-2019 has been fixed by taking average value of average grade point analysis value of university examination obtained by the previous two batch students.
- The set attainment level for the batch 2016-2020 has been fixed by taking average value of average grade point analysis value of university examination obtained by the previous three batch students.

The table 1 shows the methodology Target attainments (Set Attainment Level) for all the courses.

Batch	Target Attainment
2013-2017 (AGPA ₁)	1.5 for Theory Courses & 2 for Laboratory Courses/Projects
2014-2018 (AGPA ₂)	$AGPA_1 \times 0.3$
2015-2019 (AGPA ₃)	$\left(\frac{AGPA_1 + AGPA_2}{2}\right) \times 0.3$
2016 - 2020	$\left(\frac{AGPA_1 + AGPA_2 + AGPA_3}{3}\right) \times 0.3$

Table 2 Targets for Course outcomes

2. Attainment of Program Outcomes and Program Specific Outcomes

2.1 Describe assessment tools and processes used for measuring the attainment of each of the Program Outcomes and Program Specific Outcomes

For measuring the attainment of Program Outcomes and Program Specific Outcomes various tools are used. The process for measuring the attainment of each PO & PSO is described in Figure 2.

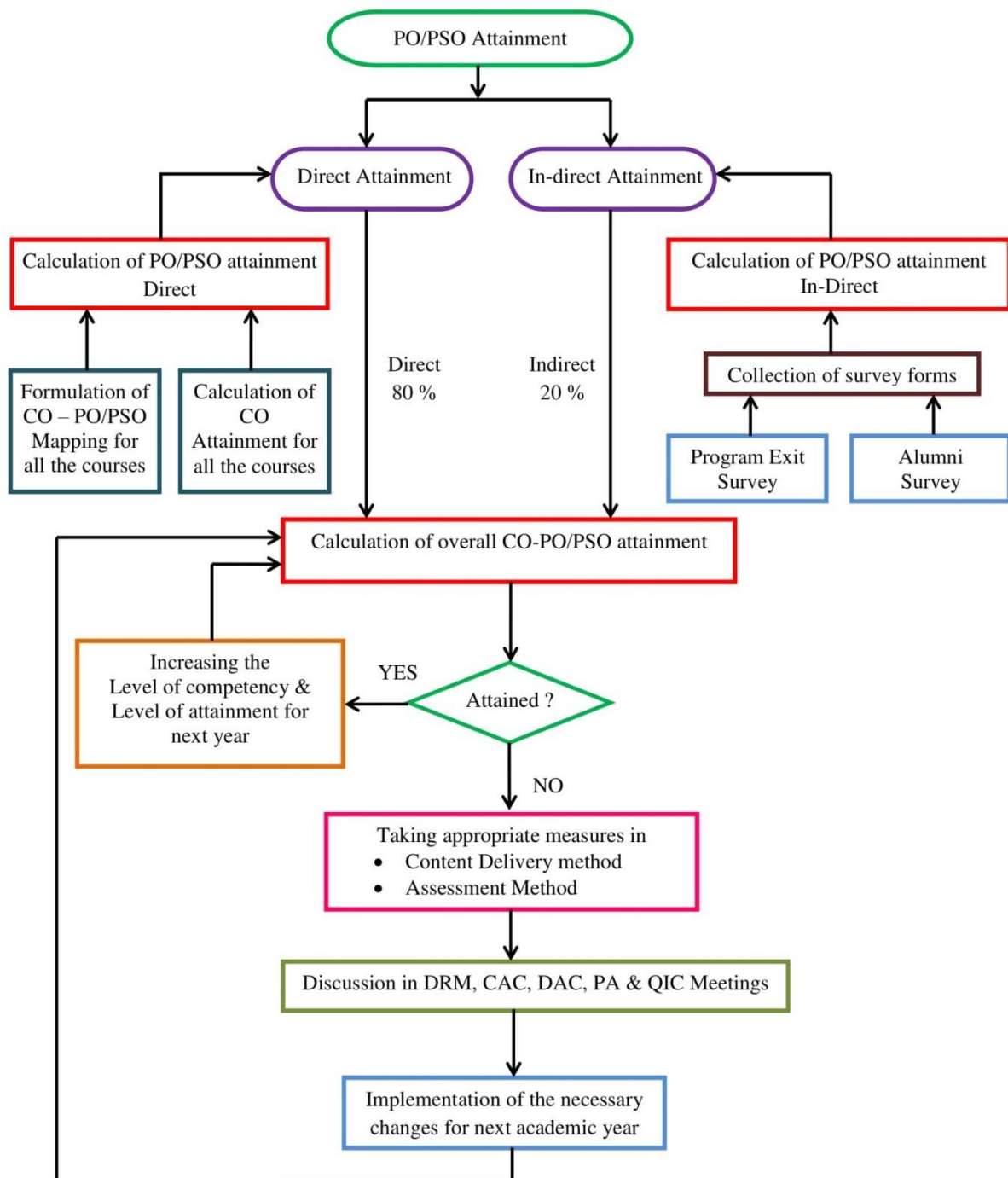


Figure 2 Process for PO/PSO Attainment

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 University Examination. Indirect assessment is based on Program Exit Survey, Alumni Survey and Course Exit Survey (Theory and Practical).

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. PO will be evaluated by the CO-PO Mapping with the attainment value for each course. For each course, every faculty member decides the competency level and attainment level.

The following table 3 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• University Examination	<ul style="list-style-type: none">• Assignments / Tutorials / online quizzes are given periodically for the entire course to attain the specific POs.• Three Internal Assessment Tests are conducted per semester to evaluate the student performance.• University Examination is conducted once in a semester as per Anna University Schedule
	<ul style="list-style-type: none">• Performance• Viva Voce• Record• Presentation• Group Discussion	<ul style="list-style-type: none">• Student Contribution in laboratory is evaluated based on the performance, Viva Voce, Presentation and Record Work.• Model Practical examination is conducted for 100 marks for a duration of 3 hours.• University Examination is conducted once in a semester as per Anna University Schedule
	<ul style="list-style-type: none">• Project Reviews	<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 reviews are conducted for the students to identify the area of project.• Three reviews are conducted periodically to monitor and evaluate the progress of the project.• Viva-Voce is conducted at the end of the semester .

Table 3 Direct Assessment

Course level PO & PSO Attainment Calculation:

The PO & PSO attainment for the course is calculated using the following formula.

$$CO \text{ Attainment Ratio of Course}(x) = \frac{CO \text{ Attainment of Course}(x)}{3(\text{Maximum attainment Value})}$$

Where, $x = [1 \text{ to } N]$, $N = \text{Number of Courses}$.

$$POm \text{ Attainment of course}(x)$$

$$= CO \text{ Attainment Ratio of Course}(x) \times POm \text{ Mapping Value of Course}(x)$$

Where, $m = [1 \text{ to } 12]$

PSOm Attainment of course(x)

= CO Attainment Ratio of Course(x) X PSOm Mapping Value of Course(x)

Where, $m = [1 \text{ to } M]$, $M = \text{Number of Program Specific Outcomes}$.

Program level PO & PSO Direct Attainment Calculation:

The PO & PSO attainment for Program is calculated using the following formula.

$$\text{POm Direct Attainment} = \frac{\sum_{i=1}^x \text{POm Attainment of course}(i)}{x}$$

Where, $m = \text{Program Outcomes varies from 1 to 12}$

$x = \text{Number of Courses mapped with POm}$

$$\text{PSOm Direct Attainment} = \frac{\sum_{i=1}^x \text{PSOm Attainment of course}(i)}{x}$$

Where, $m = \text{Program Specific Outcomes varies from 1 to 4}$

$x = \text{Number of Courses mapped with PSOm}$

Indirect Assessment:

The following tools are used to assess the indirect assessment of attainment of COs, POs and PSOs. The assessment tools listed in table 3.3.1.2 are used for both CO, PO – PSO attainment calculation.

S.No.	Tools used for Assessment processes	Batch 2013-17	Batch 2014-18	Batch 2015-19	Batch 2016-20
POs, PSOs Indirect Assessment Tools					
1	Program Exit Survey	-	✓	✓	✓
2	Alumni Survey	✓	✓	✓	✓
CO Attainment Indirect Assessment Tool					
3	Course Exit Survey	-	-	-	✓

Table 4 Indirect Assessment Tools

Course Exit Survey (Theory & Practical):

The course exit survey is process of collecting reviews on each course from the students at the end of each semester. It helps to improve the overall aspect of the course in future semesters. The survey covers the overall view about teaching and learning of the respective course. The survey form reveals the following attributes

- Course Content- Quality of the content provided, incorporation of Outcome Based Education
- Course Delivery- Experience about the teaching methodologies, ICT tools, NPTEL resource utilization
- Course Assessment- Methodology of evaluation, feedbacks on assignments and tutorials
- General suggestions for improvement

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 with 5 likert scale questions. The survey helps in identifying

- Perception on the overall quality of teaching, learning and mentoring.
- Opinion about the support provided by the programme in projects, modern tools and softwares.
- Support provided for extra-curricular and co-curricular activities.
- Exposure to the competitive exams and personality development programmes.
- Insight on imparting skills like entrepreneurship and societal responsibility through NSS, YRC, NGO and Club's
- Improvement on facilities.

PO & PSO Attainment Calculation of PES:

Question Level Calculation:

$$Q(x) \text{ in } \% = \frac{\text{no. of Students provided more than or equal to 3 Marks in } Q(x)}{\text{no. of Students}} \times 100$$

Where, $x = [1 \text{ to } 25]$, $Q[x] = x^{\text{th}}$ Questions in Program Exit Survey

Question Level Attainment:

Program Exit Survey (PES) Question Level Attainment	3	80% of the Students provided more than or equal to 3 Marks in Survey Question
	2	70% of the Students provided more than or equal to 3 Marks in Survey Question
	1	60% of the Students provided more than or equal to 3 Marks in Survey Question

Table 5 PES Attainment level

$$POm \text{ Attainment of PES} = \frac{\sum_{i=1}^x Q(x) \text{ Attainment mapped with } POm}{x}$$

Where, $m = [1 \text{ to } M]$, $M = \text{Number of Program Outcomes}$.
 $x = \text{Number of Questions mapped with } POm$

$$PSOm \text{ Attainment of PES} = \frac{\sum_{i=1}^x PO(x) \text{ Attainment mapped with } PSOm}{x}$$

Where, $m = [1 \text{ to } M]$, $M = \text{Number of Program Specific Outcomes}$.
 $x = \text{Number of POs mapped with } PSOm$

Alumni Survey:

The alumni survey is conducted through the survey questionnaire after graduation towards the achievement of POs and PSOs. Survey form is structured with six sections with respect to,

- Personal information.
- Employment/higher studies/entrepreneurship- details.

- Technical, professional, communication and general skills at present towards RIT contribution.
- Experience at RIT in projects, extra-curricular, co-curricular activities, personality development, sports, NSS and YRC facilities.
- Suggestions for further improvement.
- Suggestions for bridging curriculum gap and other valuable inputs.

PO & PSO Attainment Calculation of AS:

Question Level Calculation:

$$Q(x) \text{ in } \% = \frac{\text{no. of Students provided more than or equal to } x \text{ Marks in } Q(x)}{\text{no. of Students}} \times 100$$

Where, $x = [1 \text{ to } 25]$, $Q[x] = x^{\text{th}}$ Questions in Alumni Survey

Question Level Attainment:

Alumni Survey (AS) Question Level Attainment	3	80% of the Students provided more than or equal to 3 Marks in Survey Question
	2	70% of the Students provided more than or equal to 3 Marks in Survey Question
	1	60% of the Students provided more than or equal to 3 Marks in Survey Question

Table 6 Alumni Survey Attainment level

$$POm \text{ Attainment of AS} = \frac{\sum_{i=1}^x Q(x) \text{ Attainment mapped with } POm}{x}$$

Where, $m = [1 \text{ to } M]$, $M = \text{Number of Program Outcomes}$.
 $x = \text{Number of Questions mapped with } POm$

$$PSOm \text{ Attainment of AS} = \frac{\sum_{i=1}^x PO(x) \text{ Attainment mapped with } PSOm}{x}$$

Where, $m = [1 \text{ to } M]$, $M = \text{Number of Program Specific Outcomes}$.
 $x = \text{Number of POs mapped with } PSOm$

Program level PO & PSO Indirect Attainment Calculation:

$$POm \text{ Indirect Attainment} = (POm \text{ Attainment of PES} \times 0.5) + (POm \text{ Attainment of AS} \times 0.5)$$

Where $m = \text{number of Program Outcomes}$

$$PSOm \text{ Indirect Attainment} = (PSOm \text{ Attainment of PES} \times 0.5) + (PSOm \text{ Attainment of AS} \times 0.5)$$

Where $m = \text{number of Program Specific Outcomes}$

Overall PO & PSO Attainment Calculation:

The Overall PO & PSO attainment is calculated by using the following formula

$$\begin{aligned} \text{Overall } POm \text{ Attainment} &= (POm \text{ Direct Attainment} \times 0.8) \\ &+ (POm \text{ Indirect Attainment} \times 0.2) \end{aligned}$$

Where m = number of Program Outcomes

Overall PSOm Attainment

= (PSOm Direct Attainment X 0.8)

+ (PSOm Indirect Attainment X 0.2)

Where m = number of Program Specific Outcomes

The following table 3.3.1.5. shows the tools and process for Indirect PO attainment.

PO Attainment	Tools	Process
Indirect	<ul style="list-style-type: none">• Program Exit Survey	On completion of program, a feedback is obtained from each student about the entire program experience.
	<ul style="list-style-type: none">• Alumni Survey	During the alumni meet, graduation day the alumni survey are collected from the graduates based on the various parameters.

Table 7 Indirect Assessment Process