Calculation of Attainment of Course Outcomes and Program Outcomes/ Program Specific Outcomes

Outcome Based Education (OBE) requires that the desired outcomes of each course be specified and at the end of the course, evaluation has to be done to determine whether these outcomes have been achieved. The process for finding the attainment of Course Outcomes (CO's) use various tools/methods. These methods are classified into two types: Direct methods and indirect methods.

Direct methods are used to evaluate the student's knowledge and skills from their performance in the class/assignment test, internal assessment tests, assignments, semester examinations, seminars, laboratory experiments/ practical, mini projects, etc.

Indirect methods such as course exit survey reflect on student's learning. They are used as a tool for self-assessment of students' knowledge or skills. Various tools used for evaluation is listed below.

Assessment tools used:

(1) Series Tests

(2) Assignments

(3) Final University Exam

(4) Course Exit Survey

(5) Others

The use of various tools for the evaluation of course outcomes is described in the subsequent sections.

Direct evaluation tools:

Various direct assessment tools to evaluate the attainment of COs and the frequency of assessment is depicted in table 1:

Table 1. Direct assessment tools

Course type	Assessment tools	Frequency
Theory	Mid-semester exam	Twice per course
	Assignment	Twice per course
	End-semester exam	Once per course

Laboratory/ Practical		Continuous evaluation	Every lab session
		End-semester exam	Once per course
Seminar (7th semester)		Presentation	Once per semester
Project	Phase I (7th semester)	Review	Twice per semester
		Evaluation by guide	Continuous evaluation
	Phase II (8th semester)	Review	Twice per semester
		Evaluation by guide	Continuous evaluation
		Demonstration/End-semester Evaluation	Once per course

Quality/ relevance of assessment tools

Theory: Theory courses provide the students with in-depth knowledge of various topics in electronics and communication engineering and allied subjects. Course are offered as core courses and elective courses. Additionally, motivated and bright students have the option to earn extra credits through honors/minor courses offered by the university. The direct assessment of COs of theory course is done through mid-semester exams and assignments conducted by the respective faculty member teaching the course in the department.

1.) Mid-semester Exam: The mid-semester exams are conducted twice per semester known as Series test 1, and Series test 2. These tests encourage students to keep up with the course contents covered in class. The questions satisfy Bloom's taxonomy, wherein each question is mapped to the appropriate course outcome of the respective course and assessed based on the set attainment levels. The question paper for the series tests set by the respective faculty member is submitted to the Module Committee comprising of a panel of faculty members. The module committee suggests necessary modifications/improvements to be incorporated into the question paper.

2.) Assignments: Assignments are used for the continuous evaluation of the student. It can be in the form of descriptive or problem-solving assignments, oral quizzes, or MCQ. These

tools are used to assess the promptness and understanding of the subject. Student's submissions are evaluated based on work quality, time limit, and originality. The questions in the assignment are mapped to the Course outcomes of the subject.

3.) End-semester Exam: This final exam is conducted by the university once at the end of every semester to evaluate the students' performance. The questions are designed to assess students' knowledge of engineering practices, frameworks, and problem-solving skills.

Laboratory/ Practical: Lab/Practical courses provide students with first-hand experience with experiments and measurements and their application in the particular engineering field of study. Students have the opportunity to learn state-of-the-art simulation tools, get hands-on experience in measurement instruments and equipment.

1.) Continuous evaluation: Each student is expected to be regular in the lab and practice experiments by self or in groups. Student must also develop the necessary skills to analyze the experimental data and their applications. It also facilitates interaction among the students and develops the team spirit required to solve complex problems. Performance assessment is based on the ability of the student to actively participate in the successful conduct of prescribed practical work and draw appropriate conclusions. The student submits a record of experimental work performed in each class.

2.) End-semester exam: The final lab exam is conducted by the university to assess the ability of a student to perform a given task by integrating the knowledge gained from related theory courses and regular laboratory sessions. The exam includes viva voce and performing a given experiment.

Seminar: The seminar is a part of the sixth-semester curriculum. The student makes a preliminary seminar presentation on a topic of their choice and is approved by the assigned faculty. A seminar presentation is planned for 30 minutes, including a question-answer session of 5 to 10 minutes. The seminar is evaluated based on the material presented presentation by the students before an evaluation committee consisting of three faculty members, including a senior faculty member from the department. The committee generally evaluates the seminar based on the following parameters.

i)   Relevance: The seminar PowerPoint presentation generally covers the fundamentals and advanced topics in engineering. The importance of the topic is considered to assess the seminar.

ii)   Presentation: The flow of presentation and communication skills are essential tools to evaluate.

iii)   iii)Q&A: At the end of the presentation, the assessment panel and the audience ask their doubts and questions about the seminar topic. The effectiveness of the student's response to these queries is also assessed.

iv)   Report and Documentation: A seminar report is submitted at the end of the semester. This report presents the topic in a detailed manner. Students' ability to comprehend and effective writing is assessed based on the report.

Project: The Project is intended to test the innovation and engineering design abilities of the student. This tests the student's ability to apply the knowledge, experimental and analytical skills that he/she earned during the BTech program to solve real-world problems. The project work starts in the seventh semester and continues in the eighth semester.

i)   Project Phase I–7 th Semester: Students are expected to discuss the possible topics of interest with a faculty member and develop the final topic. The students are supposed to finalise the topic and complete the literature review within the first half of the seventh semester. The students are expected to submit the proposed project's relevance, literature survey, scope, objectives, time schedule, and cost estimate during the semester. Assessment tools used to evaluate project work are:

a. Mid-semester Evaluation: Mid-semester evaluation is conducted at the mid of the semester, and a group panel evaluates the work based on various parameters. The feasibility and significance of the work are two major assessment criteria. The basic understanding of the topic and presentation skills are also evaluated by the panel based on their performance.

b. End-semester Evaluation: End-semester evaluation is conducted at the end of the semester in the form of a Power Point presentation. Detailed report submission is also compulsory. At the end of the presentation, the assessment panel and the audience ask their doubts and questions about the topic. The effectiveness of the student's response to these queries is also assessed. The submitted project report is assessed.

ii)   Project Phase II –8 th Semester: The assessment tools are similar to those of the phase I evaluation in the 7th -semester. The evaluation is made in the mid-semester and at the end of the semester. Examiners examine whether the project demonstrates a high level of understanding and originality in the analysis (theoretical and /or empirical). The project topic should make a significant contribution to the knowledge base of the discipline and field of study. The topic should be innovative having the future scope and the results should be appropriate and of high quality. The end-semester evaluation committee consists of a faculty member from a sister department and an external expert, either from an academic/research institute or industry.

The weightage assigned for various assessment tools

The weightage assigned for each assessment tool for calculating the course outcome is fixed as in Table 2.

Table 2. The weightage assigned for various tools for assessment of theory and practical courses

Course type	Assessment tools	Weightage
Theory	Series tests marks	50%
	Assignments marks	10%
	University exam marks	40%
Laboratory/ Practical	Continuous internal evaluation	60%
	University practical exam and viva	40%

Methodology for calculation of COs through direct assessment tools:

The CO attainment level for a given course, for a particular batch of students is computed as follows:

In step 1, the total marks obtained by a student for a given CO in a particular evaluation tool is computed by adding the marks obtained by him/her for all questions addressing the specific CO. The Excel sheet to enter the marks obtained using each assessment tool is shown in Fig. 1. This mark is then divided by the maximum marks attainable for these specific questions. This attainment score is computed for each student in the batch.

Reg No.	Name	CO1		CO2		CO3		CO4		CO5		CO6	
		Obtained	Maximum	Obtained	Maximum	Obtained	Maximum	Obtained	Maximum	Obtained	Maximum	Obtained	Maximum

Fig. 1. Excel sheet for entering marks obtained using each assessment tool

For example, if a student obtains a total of 10 marks for all questions addressing CO1 in Series Test-1 and the maximum marks attainable for these questions were 15, the attainment score for CO1 for the particular student is 10/15 or 0.67 from the evaluation tool Series Test-1.

In step 2, step 1 is repeated for all evaluation tools which were employed to assess the student-performance corresponding to the specific CO. Then a weighted sum of all attainment scores is computed by multiplying the attainment level obtained for each evaluation tool with the weightage given to that specific tool. This is computed for each student in the batch.

For example, Series Test-1, Series Test-2, Assignment-1, Assignment-2 and University Examination are the evaluation tools used to measure the CO attainment levels for a particular theory subject. The individual weightages given to these tools are 25%, 25%, 5%, 5% and 40% respectively.

Let CO1 be addressed by the evaluation tools – Series Test 1, Assignment 1 and University Examination and let the attainment scores computed for a particular student for CO1 from these evaluation tools are 0.67, 0.80 and 0.60 respectively.

Then the (un-normalized) attainment score for CO1 for this student is computed as
CO1 attain. score= $0.67 \times 0.25 + 0.80 \times 0.05 + 0.60 \times 0.40$

In step 3, the attainment score computed for each student corresponding to a specific CO is normalized by dividing this value with the maximum attainable score from all evaluation tools addressing this specific tool (sum of the % weightages of tools addressing this CO). This will give us the Percentage CO attainment for the specific student.

For the previous example, the normalized attainment score (% CO attainment) for CO1 will   be   computed   as:

CO1   attainment   =   (0.67×0.25+   0.8×0.05+   0.60×0.40)   ÷   (0.25+   0.05+   0.40)

$$= 0.45*0.70= 56.67\%$$

In step 4, the CO attainment of each student is compared with the threshold levels set for the COs. If a student's % CO attainment for a particular CO is greater than the target set for the specific CO, he is assumed to have attained the CO. The ratio of the total number of   students who have attained the CO to the total number of students who have attended the course is computed and the value is expressed in percentage. If the value is greater than 70%, attainment level is assigned to be 3. If this value is less than 40%, attainment level is assigned to be 0. If this value is greater than 40 and less than 70%, the attainment level in a linear scale between 0 to 3 is assigned. For example, assume that 65% is the threshold level set for CO1 attainment. Let 63 students have CO1 attainment percentage more than 65% in a batch of 100 students, the attainment level for CO1 is 2.3.

Indirect evaluation tools:

Course exit survey is used to collect the responses of the student about his own student's evaluation on each of the course outcome. The questions framed corresponds to each CO. Students can choose an indicator among Excellent(E), Very Good (V), Good(G), Fair(F), or Poor(P) to rate his/her own ability. Marks 0 to 4 is assigned for responses ranging from P to E.

Methodology for calculation of COs through indirect assessment tools:

$$\text{Indirect CO attainment for a given CO} =$$

$$\frac{\begin{array}{c}(\text{Count of } 0's * 0 + \text{Count of } 1's * 1 + \text{Count of } 2's * 2 + \\ \text{Count of } 3's * 3 + \text{Count of } 4's * 4)\end{array}}{\text{Total No. of students participated in the survey}} X \frac{3}{4}$$

	Govt. College of Engineering Kannur Department of Electronics & Communication Engineering Course Exit Survey : EC204 ANALOG INTEGRATED CIRCUITS S4ECE A and B(2018 Admission)					
	Questions					
Q1	How do you rate your ability to analyze differential amplifiers, current sources and current mirrors?					
Q2	How do you rate your ability to explain equivalent circuit of op-amp, open loop op-amp configurations, feedback configurations, effect of finite open loop gain, bandwidth and slew rate on circuit performance?					
Q3	How do you rate your ability to elucidate and design the linear and non-linear applications of an opamp and second order active filers using op-amps?					
Q4	How do you rate your ability to illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.?					
Q5	How do you rate your ability to analyze impedance, transmission, and hybrid parameters of a two-port network?					
Q6	How do you rate your ability to classify and comprehend the working principle of data converters					

		Students' Responses*					
		* Mark E for Excellent, V for very good, G for Good, F for fair and P for poor against each Question number					
Roll No./Reg No.	**Name of Student**	**Question Numbers**					
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
1							
2							
3							

Fig. 2. Sample sheet for collecting the Course exit feedback from the students

Overall CO attainment:

Overall CO attainment is calculated by giving specific weightage to the direct and indirect CO attainment values. It is calculated as:

CO attainment = 0.8X + 0.2Y,

where X is the direct CO attainment, and

Y is the indirect CO attainment.

Figures 3 – 5 depicts flowcharts that summarize the CO attainment computation using direct and indirect tools for theory, lab, and project respectively.
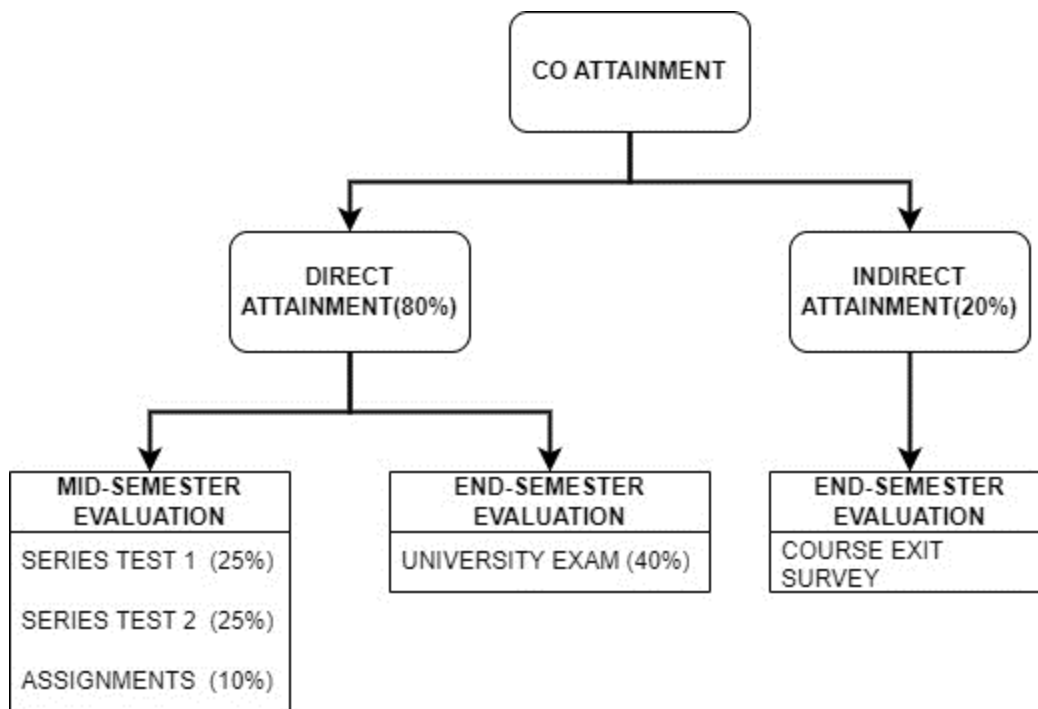
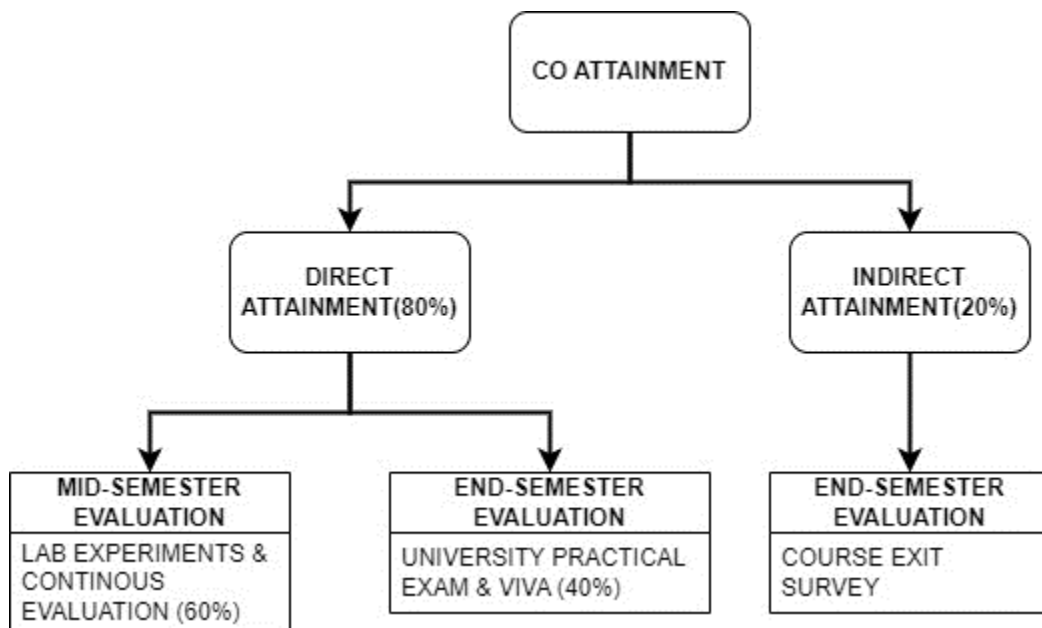Fig. 3. Assessment of course outcomes for theory courses

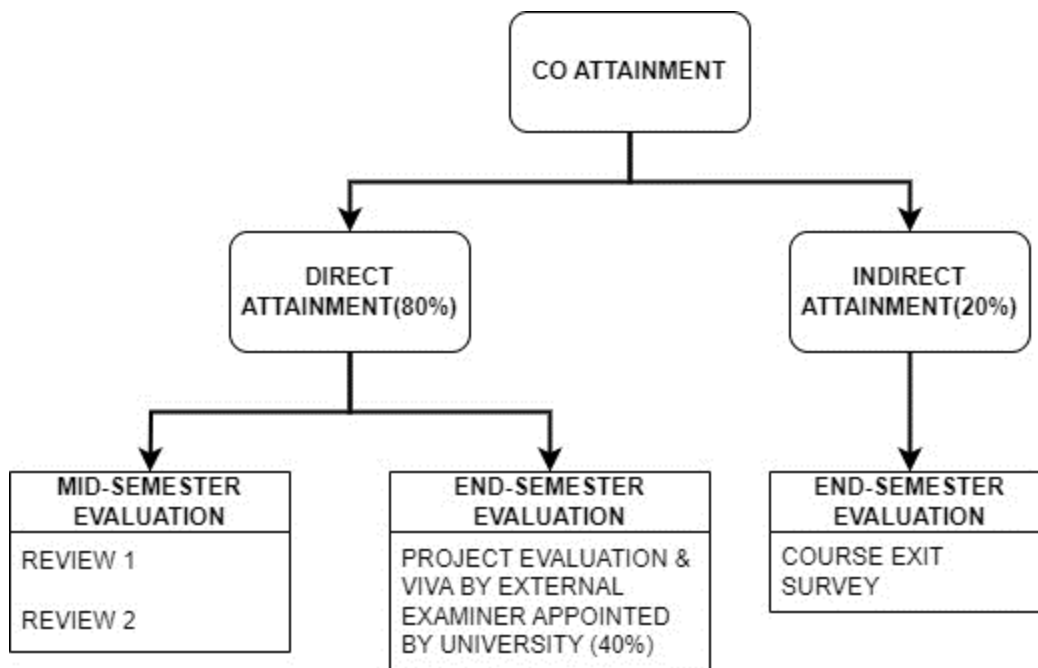Fig. 4. Assessment of course outcomes for lab/practical courses

Fig. 5. Assessment of course outcomes for project

Methodology for calculating the attainment of Program Outcomes and Program Specific Outcomes

Aggregate CO attainment along with other data gathered at the program level is used to determine whether the program is effective in accomplishing the goals it has set forth for its graduates. The attainment of COs is linked to POs and PSOs. So, CO attainment serves as a direct tool for measuring PO attainment. The other data collected for the calculation of the attainment level of POs and PSOs are based on tools like the student exit surveys, external viva voce examination, program exit surveys, and parent surveys.

PO-PSO attainment calculation through direct evaluation tools:

The CO attainment calculated from the previous section is used to calculate the attainment level of POs and PSOs associated with that course. A sample mapping of CO-PO-PSO for one particular course populated with some arbitrary values is given in Table XX. Direct attainment level of a PO and PSO is determined by taking average across all courses addressing that PO and/or PSO.

Table 3. Sample CO-PO-PSO mapping matrix

CO	CO attainment Level	CO-PO mapping Matrix						
		PO1	PO2	....	PO12	PSO1	PSO2	PSO3
CO.1	3	2	2					
CO.2	3	3	3			1	1	
....	....	....		....	....	....	....	....
CO.N	2	1	3				1	
PO attainment Level		1.89	2.33	…	…	3.00	0.83	…

PO (or PSO) attainment for each course is evaluated using the formula:

Attainment of $PO_k = \dfrac{\sum CO_k PO_{1k} / 3}{m}, k = 1,2.....N$ and m is the total no. of COs mapped to PO_k

For e.g.

For a particular course in Table 3,

PO Attainment for PO2 $= \left(3 \times \frac{2}{3} + 3 \times \frac{3}{3} + 2 \times \frac{1}{3}\right) \times \frac{1}{3}$

The calculated PO Attainment is just the partial contribution of one course towards the Program Outcomes. All the courses need to be evaluated in the same manner for the 4-year program. After getting the PO Attainment for all of the courses average value may be used to get the aggregate of PO Attainment.

PO-PSO attainment calculation through direct evaluation tools:

The indirect attainment level of PO & PSO is determined based on the course exit surveys. The indirect CO attainments are calculated and from these indirect attainment values indirect PO attainment for each course is obtained. The calculation of Indirect PO attainment is same as that of direct PO attainment from direct CO attainment. While evaluating the overall attainment level, weightages given to direct and indirect assessment were 80% and 20% respectively.

Overall PO attainment:

Overall PO(or PSO) attainment is calculated by giving specific weightage to the direct and indirect PO(or PSO) attainment values. It is calculated as:

PO(or PSO) attainment= $0.8X + 0.2Y$,

where X is the direct PO(or PSO) attainment, and

      Y is the indirect PO(or PSO) attainment.

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