Rubrics to Validate COs, POs and PSOs

Rubrics Developed to Validate COs

Assessment tools are categorized into two methods to assess the course outcomes as:

Direct methods and indirect methods.

> ➤ Direct method display the student's knowledge and skills from their performance in the continuous internal assessment tests, semester examinations, seminars, and class room and laboratory assignments etc. These methods provide a sampling of what students know and/or can do and provide strong evidence of student learning.

> ➤ Indirect method include student feedback on facilities, learning artifacts and course end survey that reflects the student's learning as shown in table 4.
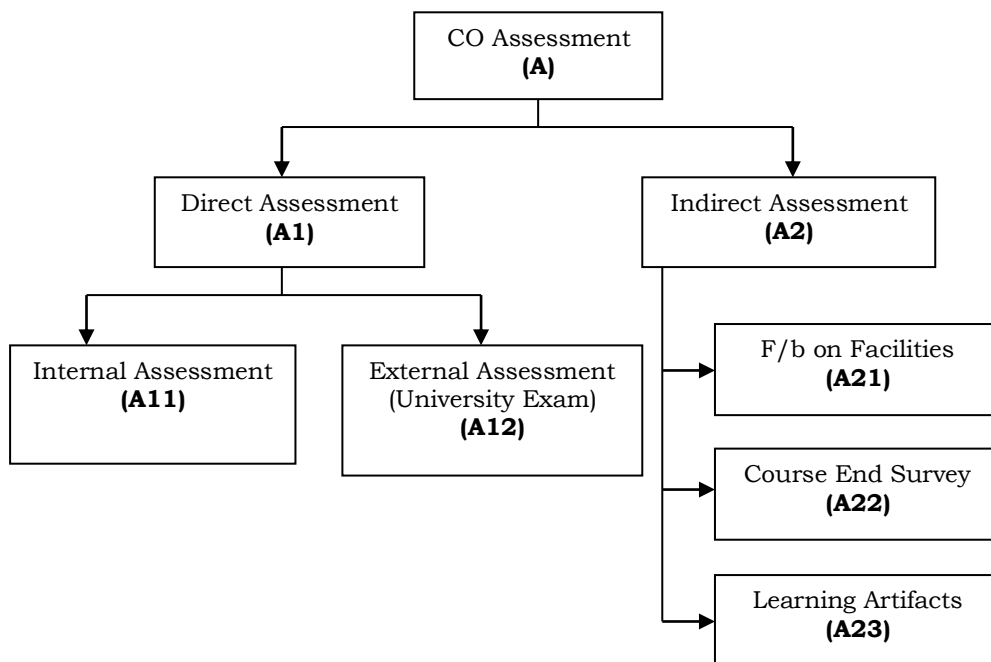
Figure 1: CO Assessment Process

Relevance of Assessment Processes and Tools

Course Outcome is assessed in view of the performance of students in internal assessment, university examination of a course and Course end survey. Direct assessment contributes 80% and indirect assessment contributes 20%. From direct assessment internal assessment

contributes 25% and university assessment contributes 75% to the aggregate attainment of a CO.

Direct Assessment Method (A1)

S. N	Direct Assessment	Method Description
1	**Internal Assessment Test**	The Internal Assessment marks in a theory paper shall be based on three tests generally conducted at the end of 6, 11 and 14 weeks of each semester. At the end of 14th week pre final examination is conducted. An improvement test may be conducted for the desirous students before the end of the semester to give an opportunity to such students to improve their Internal Assessment Marks. It is a metric to continuously assess the attainment of course outcomes w.r.t course objectives. Average of the better marks obtained from any two tests shall be the Internal Assessment Marks for the relevant subject.
2	**Lab Assignments**	Lab Assignment can be one of the measuring criteria to mainly assess student's practical knowledge with their designing capabilities. In case of Practical, the internal assessment marks shall be based on the laboratory records and one practical test.
3	**Mid Examination**	The examination pattern prescribed by the university is strictly followed. Two internal (mid) exams- mid exam 1 & mid exam 2- are conducted and two assignments (1 & 2) are given in each semester. In each of the two exams, each student is evaluated for 25 marks with the following split-up: - Descriptive test with the question paper set by concerned faculty: 10 marks - Objective type test with the question paper set by university: 10 marks - Assignment set by course teacher: 5 marks

4	**Theory Semester Examination**	Semester examination (theory or practical) are the metric to assess whether all the course outcomes are attained or not framed by the course owner. Semester Examination is more focused on attainment of course outcomes and uses a descriptive exam.
5	**Practical Semester Examination**	
6	**Seminar**	Internal assessment marks in the case of projects and seminars in the final year shall be based on the evaluation at the end of 8th semester by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the project / seminar guide.
7	**Project**	

Table 1: Direct Assessment tool

As per the JNTU regulations, the marks allotted to theory are 25% and practical 25% for internal assessment. The remaining 75% is done at university end assessment. The university end examinations are conducted at a center other than this college. Though the percentage of internal assessment is low, it is to be covering a large number of course objectives. The internal examination and the prescribed marks are to be complied with the regulation. Therefore, the scope for comprehensive assessment is less. In this frame work, the college conducts the components depicted in table 1.

The internal assessment evaluation is separately compiled and graded to understand the process. The attainment of course outcomes of all courses are given in the following section. The above description allows us to evaluate the course outcomes achieved. In the present analysis, the attainment levels are expressed in terms of the grades (3, 2 and 1) in accordance with the following rules

1. First class with distinction > 70 marks, attainment level is 3 (substantial)
2. First class 60 to 70 marks, attainment level is 2 (moderate)
3. Pass class 50 to 59 marks, attainment level is 1 (low)

The same yardsticks are applied to external evaluation. It is based on the results of the Examinations conducted by university at the end of each semester. However, the institute

doesn't have access to the answer scripts and evaluation of individual course outcomes is not possible. University authorities provide us with the information on the marks scored by each student in each course.

Table 2, illustrates a sample data collection for a group of students combining the results of the internal as well as external evaluation, student wise. Table 3 and table 5 illustrate the final calculation of CO attainment for a subject Digital Signal Processing.

Subject: Digital Signal Processing							Course Code: C316		Year of Study: 2023-24	
Roll No	Marks obtained in Internal Examination CO wise						External Exams Marks	Total Marks out of 100M	Attainment Level	CO Met (Y/N)
	CO 1 (10)	CO 2 (10)	CO 3 (10)	CO4 (10)	CO 5 (10)	Total out of 50M	Total Normalized to 25M			
20UP1A0422	10	10	3.33	3.33	3.33	29.99	15	42	57	2	Y
21UP1A0401	9.43	9.43	9.62	8.33	7.5	44.31	22	67	89	3	Y
21UP1A0402	10	10	2.69	7.81	4.06	34.56	21	43	64	3	Y
21UP1A0403	9.71	10	3.33	8.13	3.33	34.5	19	29	48	1	Y
21UP1A0404	9.43	7.14	2.69	7.5	4.17	30.93	18	42	60	2	Y
21UP1A0405	10	10	3.85	10	5	38.85	21	40	61	3	Y
21UP1A0406	9.43	9.14	3.85	5	3.13	30.55	19	45	64	3	Y
21UP1A0407	9.43	9.43	8.33	7.5	6.88	41.57	19	41	60	2	Y
21UP1A0408	10	9.71	7.31	7.5	2.5	37.02	21	48	69	3	Y
21UP1A0409	9.71	10	7.69	6.88	3.75	38.03	22	31	53	2	Y
21UP1A0410	9.43	10	10	8.75	5	43.18	22	36	58	2	Y
21UP1A0411	8.86	8.29	6.15	8.75	5	37.05	19	26	45	1	Y
21UP1A0412	10	8.86	8.85	8.13	2.19	38.03	20	15	35	0	N
21UP1A0413	9.71	10	6.15	8.75	5	39.61	20	51	71	3	Y
21UP1A0414	9.14	9.43	5	8.13	2.5	34.2	18	7	25	0	N
21UP1A0415	9.71	9.43	3.85	7.5	3.33	33.82	18	42	60	2	Y
21UP1A0416	9.14	9.43	6.67	8.75	3.13	37.12	19	Ab	19	0	N
21UP1A0417	9.71	8.86	10	7.5	3.75	39.82	22	61	83	3	Y
21UP1A0418	9.14	9.43	3.33	7.5	1.67	31.07	17	29	46	1	Y
21UP1A0419	9.43	8.86	3.08	7.5	3.13	32	19	47	66	3	Y
21UP1A0420	9.43	8.86	10	8.33	3.75	40.37	21	61	82	3	Y

21UP1A0421	9.71	9.14	8.08	3.13	4.17	34.23	19	7	26	0	N
21UP1A0422	9.14	9.43	9.23	5.83	3.13	36.76	19	46	65	3	Y
21UP1A0423	9.71	10	9.62	9.06	6.67	45.06	22	32	54	2	Y
21UP1A0424	9.71	9.43	8.33	8.44	3.44	39.35	20	33	53	2	Y
21UP1A0425	8.86	6	5.77	8.33	2.81	31.77	17	5	22	0	N
21UP1A0426	9.71	9.71	6.15	9.06	6.67	41.3	22	62	84	3	Y
21UP1A0428	9.14	9.14	8.46	7.5	3.13	37.37	20	53	73	3	Y
21UP1A0429	9.71	9.43	9.23	8.13	6.67	43.17	21	54	75	3	Y
21UP1A0430	9.14	8.57	8.33	8.75	1.56	36.35	19	31	50	1	Y
21UP1A0431	9.71	9.14	3.33	3.33	3.33	28.84	15	Ab	15	0	N
21UP1A0433	9.14	9.43	3.85	8.33	2.5	33.25	18	31	49	1	Y
21UP1A0434	9.71	10	3.46	3.44	3.44	30.05	20	6	26	0	N
21UP1A0435	6.29	8.29	5.77	9.06	6.67	36.08	19	30	49	1	Y
21UP1A0436	9.43	9.43	10	8.33	7.81	45	22	51	73	3	Y
21UP1A0437	9.71	10	8.85	9.17	5.83	43.56	21	42	63	3	Y
21UP1A0438	9.71	9.43	6.54	9.17	5	39.85	19	37	56	2	Y
21UP1A0439	8.86	9.14	10	8.44	5	41.44	20	30	50	1	Y
21UP1A0440	9.71	9.71	8.33	7.19	5.83	40.77	20	15	35	0	N
21UP1A0441	9.71	10	4.62	8.33	2.5	35.16	19	13	32	0	N
21UP1A0442	9.71	10	10	9.38	6.67	45.76	22	35	57	2	Y
22UP5A0401	9.71	10	6.92	6.67	2.81	36.11	20	26	46	1	Y
22UP5A0402	9.43	10	10	10	5.63	45.06	21	29	50	1	Y
22UP5A0403	9.14	8.86	10	8.44	5.63	42.07	22	52	74	3	Y
22UP5A0404	9.71	9.43	9.62	9.17	5	42.93	22	54	76	3	Y
22UP5A0405	9.43	10	5.77	10	3.44	38.64	21	52	73	3	Y
22UP5A0406	9.14	8.86	5.38	8.33	3.44	35.15	18	39	57	2	Y
22UP5A0407	9.43	9.14	9.62	10	3.75	41.94	22	48	70	3	Y
22UP5A0408	9.43	10	3.85	5.94	3.13	32.35	21	31	52	2	Y
22UP5A0409	3.33	3.33	9.62	9.17	5.83	31.28	11	29	40	1	Y
22UP5A0410	9.71	8	3.85	8.33	3.44	33.33	19	26	45	1	Y
22UP5A0411	10	9.71	10	9.38	5.31	44.4	23	37	60	2	Y
22UP5A0412	9.43	9.43	10	7.5	3.13	39.49	20	10	30	0	N

22UP5A0413	9.43	8.57	3.46	8.33	4.06	33.85	19	48	67	3	Y
22UP5A0414	9.71	10	3.46	3.44	2.5	29.11	20	5	25	0	N
22UP5A0415	2	2	9.23	8.33	3.13	24.69	10	12	22	0	N
Average	**9.2**	**9.1**	**6.9**	**7.5**	**5.1**	**37.9**	**19.9**	**32.5**	**51.8**	**1.6**	**82.0**

Table 2: Sample data collection for a group of students

The computation of course outcome grades combining the results of internal & external evaluation is as shown in Table 3

	Subject: Digital Signal Processing				Course Code: C316				Year of Study: 2023-24
CO NO	**CO wise Internal assessment results & attainment grades**				**Course wise External assessment results & attainment grades**				**Overall Grade of attainment #(as per formula Below) (A1)**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
	Class Avg (out of 10)	**Average targeted attainment (out of 10)**	**% Attainment level (% students securing more than the value in column 2)**	**Attainment grade (A11)**	**Class Average (out of 75)**	**Average Targeted attainment (out of 75)**	**% Attainment level**	**Attainment grade (A12)**	
1	9.16	5.25	98.21	3	51.84	40	73.21	3	2.90
2	9.13	5.30	98.21	3					
3	6.93	5.45	63.39	3					
4	7.52	5.50	86.61	3					
5	5.12	5.25	44.64	1					
Avg	7.57	5.35	78.21	2.60					

Table 3: Computation of Course Outcome (Direct Assessment)

Overall grade of attainment (A1) = { (A11) x 0.25}+{ (A12) x 0.75}

Indirect Assessment Method (A2)

Sl. No	Indirect Assessment Method	Method Description
1	**Feedback on facilities**	Collect variety of information about facilities from the students at the end of each semester.
2	**Course End Survey**	Collect variety of information about course studied at the end of the semester
3	**Learning Artifact**	Students are allowed to display their knowledge in a public

	forum (usually the classroom). Artifacts are in the form of paintings, drawings, sculptures, project models, paper presentation etc.

Table .4: Indirect Assessment Tool

Final CO Attainment (A) = (0.8*A1)+(0.2*A2)

CO	Internal % Attainment level	External % Attainment level	Direct Attainment	Indirect Attainment	Final Attainment %	Attainment Level
CO-I	98.21	73.21	79.46	93.00	82.17	2.47
CO-II	98.21	73.21	79.46	93.00	82.17	2.47
CO-III	63.39	73.21	70.76	93.00	75.21	2.26
CO-IV	86.61	73.21	76.56	93.00	79.85	2.40
CO-V	44.64	73.21	66.07	93.00	71.46	2.14
					Average	**2.35**

Table 5: Computation of CO Attainment

Rubrics developed to validate POs and PSOs

The Course/ Program outcomes are difficult to measure such as assessing critical thinking, creativity, analytical skills, and problem solving etc. Hence the department has adopted Criterion Referenced Rubrics to assess the POs, PSOs and COs wherever appropriate. The Rubric criteria are either developed by department faculty or sometimes even with consultation with students and distributed before an assignment or test. Rubrics are used for both formative and summative assessment of students. Same rubric is used for assessing an outcome so that the faculty is able to assess student progress and maintain the record of the same for each student.

The program outcomes are assessed with the help of course outcomes of the relevant Courses through direct and indirect methods.
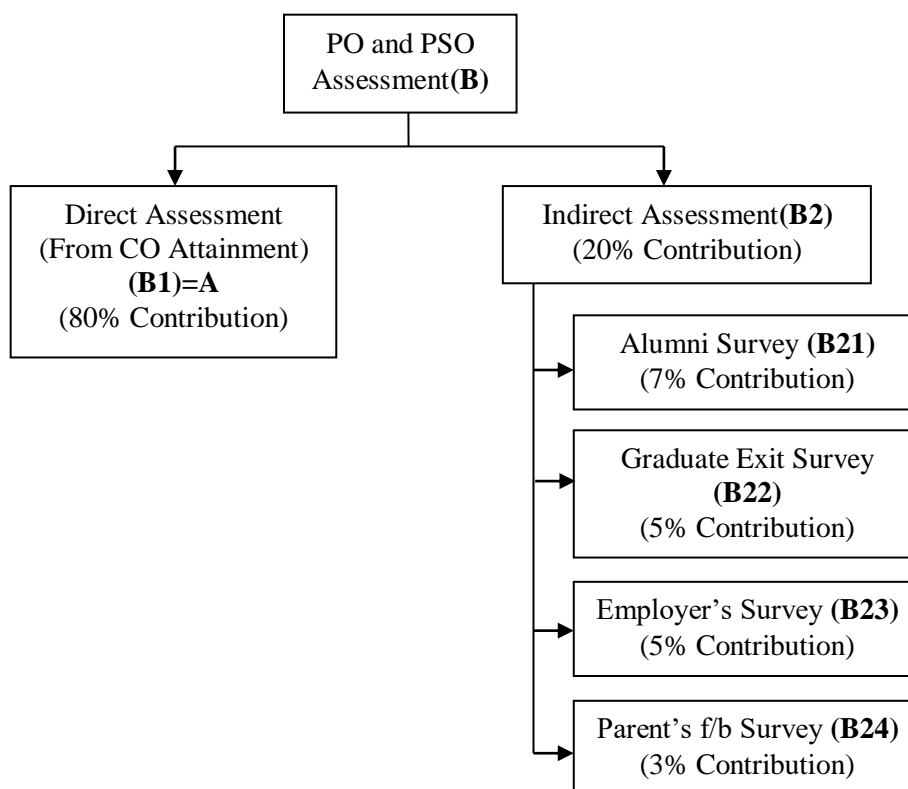

Figure 2.: PO and PSO Assessment Process

Direct Assessment Method (B1=A):

Direct Assessment methods are formative as well as summative. It measures are provided through direct examinations or observations of student knowledge or skills against measureable course outcomes. The knowledge and skills described by the course outcomes are mapped to specific problems on internal exams/home assignment/group task. Throughout

the semester the faculty records the performance of each student on each course outcome. At the end of the semester students receive grades from external exams. Calculations are same as that done for CO attainment and carry forwarded here

Indirect Assessment Method (B2)

Indirect assessment strategies are implemented by embedding them in

a)   Alumni Survey

b)   Graduate Exit Survey

c)   Employer survey and

d)   Parents Survey

$$B2= 0.35*a + 0.25*(b+c)+ 0.15*d$$

Sl. No	Assessment Method	Method Description	Frequency of data collection
1	**Graduate Exit survey**	To evaluate the success of programme in providing students with opportunities to achieve the programme outcome.	Every year
2	**Parents Survey**	Collect variety of information about program satisfaction, from parent's end.	Once in a year
3	**Alumni survey**	Collect variety of information about program satisfaction, from graduate's end	Every year
4	**Employer Survey**	Provide information about our graduate's skills and capability.	Every year

Table 1: Indirect Assessment methods

Finally, program outcomes are assessed with above mentioned data and Program Assessment Committee concludes the Po attainment level.

Final assessment value of each PO and PSO = (0.8*B1)+(0.2*B2)

The step by step process for assessing program outcomes is tabulated below

Step 1: The Program coordinator analyses each outcome into elements (different abilities specified in the outcome) and a set of attributes are defined for each element (actions that explicitly demonstrate mastery of the abilities specified). In addition, generate well designed surveys to assess the outcome.

Step2: For each outcome define performance indicators (Assessment criteria) and their targets.

Step3: Identify/select courses that address the outcome (each course contributes to at least one of the outcomes). Hence, each outcome is assessed in several courses to ensure that students acquire an appropriate level in terms of knowledge/skills of an outcome.

Step4: The module coordinators collect the qualitative and quantitative data and are used for outcome assessment in a continual process.

Step5: The Program Assessment Committee analyzes the collected data. If the assessed data meets the performance targets which are specified, the outcome is attained. Otherwise, consider **step6**.

Step6: The Department Advisory Board recommends content delivery methods/course outcomes

Table 6(a), 6(b), 7(a) and Table 7(b) illustrates the final calculation of CO attainment for a subject Digital Signal Processing.

COURSE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C316.1	3	2	3	3	2	1	-	-	-	2	2	3
C316.2	3	2	3	3	2	1	-	-	-	2	2	3
C316.3	1	3	3	2	2	1	1	-	-	3	2	3
C316.4	3	2	3	3	2	1	-	-	1	2	2	3
C316.5	3	2	3	3	2	1	-	1	-	2	2	3
Average	**3**	**2.2**	**3**	**2.8**	**2**	**1**	**1**	**1**	**1**	**2.2**	**2**	**3**

Table 6(a): CO-PO Mapping for Digital Signal Processing Course

COURSE	PSO1	PSO2	PSO3	ATTAINMENT LEVELS	ATTAINMENT (%)
C316.1	3	3	1	2.47	82.17
C316.2	2	3	1	2.47	82.17
C316.3	3	1	1	2.26	75.21
C316.4	3	3	1	2.40	79.85
C316.5	3	3	1	2.14	71.46
Average	**2.8**	**2.6**	**1**	**2.35**	**78.17**

Table 6(b): CO-PSO Mapping and Attainment for Digital Signal Processing

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Weighted Sum	1022.16	856.93	1172.58	1097.37	781.72	390.86	75.21	71.46	79.85	856.93	781.72	1172.58
Attainment (%)	68.14	57.13	78.17	73.16	52.11	26.06	25.07	23.82	26.62	57.13	52.11	78.17
Attainment Level (Direct) (80%)	2.04	1.71	2.35	2.19	1.56	0.78	0.75	0.71	0.8	1.71	1.56	2.35
Alumni Survey (7%)	2.3	2.2	2.1	2.35	2.45	2.36	2.41	2.51	2.21	2.32	2.78	2.54
Graduate Exit Survey (5%)	2.32	2.35	2.54	2.56	2.31	2.22	2.29	2.64	2.46	2.58	2.61	2.31
Employer's Survey (5%)	2.29	2.35	2.39	2.58	2.49	2.43	2.59	2.51	2.86	2.15	2.49	2.89
Parent's f/b Survey (3%)	2.68	2.59	2.47	2.84	2.64	2.67	2.13	2.57	2.84	2.46	2.06	2.37
Over All Attainment	**2.10**	**1.83**	**2.35**	**2.26**	**1.74**	**1.10**	**1.08**	**1.08**	**1.15**	**1.84**	**1.76**	**2.39**

Table 7(a): PO Attainment for Digital Signal Processing

PSO	PSO1	PSO2	PSO3
Weighted Sum	1090.41	1022.16	390.86
Attainment (%)	72.69	68.14	26.06
Attainment Level (Direct) (80%)	2.18	2.04	0.78
Alumni Survey (7%)	2.85	2.12	2.14
Graduate Exit Survey (5%)	2.36	2.19	2.58
Employer's Survey (5%)	2.54	2.89	2.71
Parent's f/b Survey (3%)	2.09	2.14	2.46
Over All Attainment	**2.25**	**2.10**	**1.11**

Table 7(b): PSO Attainment for Digital Signal Processing

ATTAINMENT LEVEL

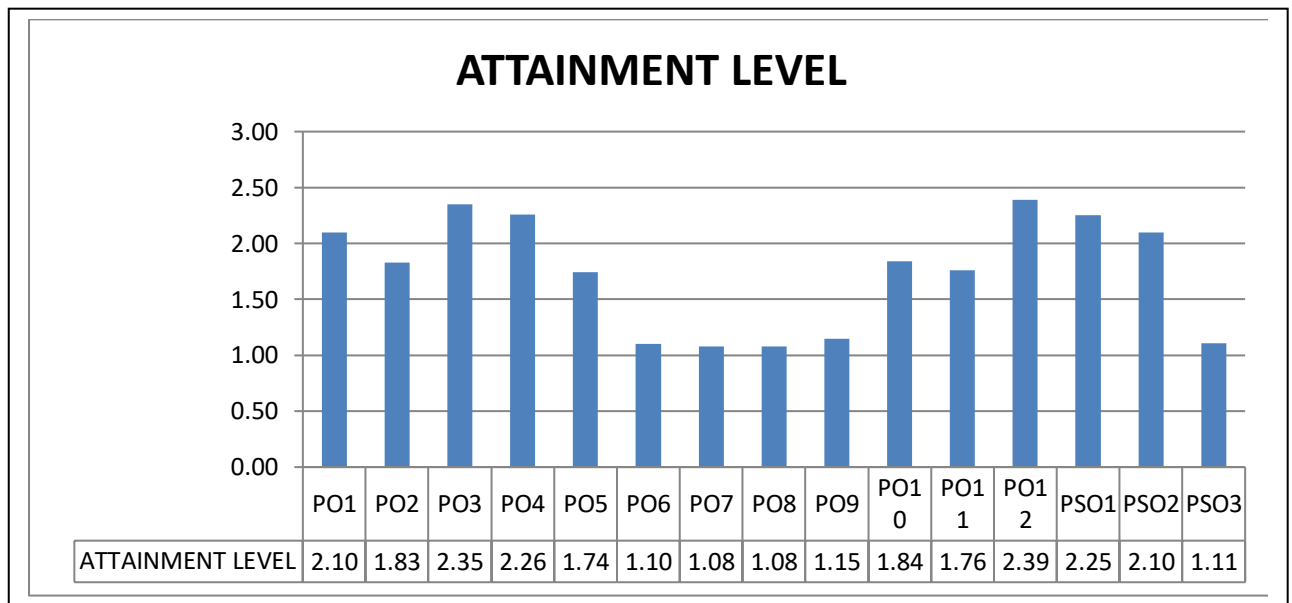|	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ATTAINMENT LEVEL	2.10	1.83	2.35	2.26	1.74	1.10	1.08	1.08	1.15	1.84	1.76	2.39	2.25	2.10	1.11

Figure 3: Graphical representation of PO and PSO Attainment for Digital Signal Processing