



48/C

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly DELHI COLLEGE OF ENGINEERING)
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Internal Quality Assurance Cell (IQAC)

University Guidelines and Procedure for Outcome Based Education (OBE)

Preamble

Outcome-Based Education (OBE), as envisaged in the New Education Policy (NEP), is a learner-centric method of teaching in which all essential learning methods, assessments, and evaluation processes are planned and continuously improved to achieve pre-specified outcomes. This document provides University Guidelines and Procedure for defining and calculating the various objectives and outcomes for the attainment of OBE. The methodology provided in this document is to measure the student performance against a specified set of outcomes at different levels. The outcome-based education measures educational effectiveness from the learner's prospective based on academic performance and several other rubrics.

The University has formulated the guidelines and procedure for the following aspects of OBE:

1. Defining Program Educational Objectives (PEOs), Program Outcomes (POs) and Program Specific Outcomes (PSOs) and setting targets for POs and PSOs [By the Department and recommended by Board of Studies (BoS) of the Department].
 2. Defining Course Outcomes (CO) [By the course coordinator/ Subject Faculties of the Department].
 3. Preparing CO-PO and CO-PSO Articulation Matrices [By the course coordinator/ Subject Faculties of the Department].
 4. Calculating the attainment of COs [By the course coordinator and faculty members teaching the course].
 5. Calculating the direct attainment of POs/PSOs from the course [By the course coordinator and faculty members teaching the course].
 6. Calculating the overall attainment of PO/PSO of the program [By the Departmental IQAC Coordinator(s)].
 7. Comparing the attainment of POs and PSOs against the targets. [By the Departmental IQAC Coordinator(s)].
- 1. Defining Program Educational Objectives (PEOs), Program Outcomes (POs), and Program Specific Outcomes (PSOs) and setting targets for POs and PSOs.**
- a. PEOs to be defined by a department committee consisting of faculty members, alumni, and industry experts. It should be in line with department vision and mission statement.
 - b. The program outcomes (POs) be defined by a department committee consisting of faculty members, alumni, and industry experts. It should be in line with NBA guidelines, where ever it has been defined by NBA.
 - c. The program specific outcomes (PSOs) be defined by a department committee consisting of faculty members, alumni, and industry experts.
 - d. The target POs/PSOs should be inspiring, realistic and attainable. Efforts should be made to achieve the target and enhance the same every year. (5% to 10% approx.)

The above to be considered by BoS and recommended to Academic council.

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2. Defining Course Outcome COs

Course Outcome (CO) 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 can be precisely defined as statements of what a learner is expected to know, understand, apply, analyse, evaluate, and create after the completion of a process of learning.

While defining the COs of a course, the following aspects should be kept in mind:

- Each CO should represent the syllabus of a course rather than a unit.
- Together, all COs should be measurable and aligned with all the cognitive levels of learning as per Bloom Taxonomy: remember, understand, apply, analyse, evaluate and create.
- A CO should not be futuristic.
- The number COs should be 4 to 6, (preferably six).

Note – All faculty members shall disseminate the COs in the introductory class of their respective course in each semester.

3. Preparing Articulation Matrix of CO-PO and CO-PSO

After defining the COs for the course, the articulation matrices for CO-PO and CO-PSO must be ascertained. As in Table I, the appropriate strength of correlation between the COs of the course and the POs and PSOs of the program should be filled. The numbers (1, 2, and 3) in Table-I represent the level of correlation between the COs of a course and POs/PSOs.

3 - High Correlation, 2 - Moderate Correlation, 1 - Low Correlation
'-' in case of No Correlation

Table-I: Articulation Matrix: CO- PO/PSO

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)				
	PO1	PO2	PO3	...	...	...	POn	PSO1	PSO2	...	PSOm	
CO1	3	2	3	...	...	...	...	-	1	3	...	2
CO2	3	3	3	...	...	...	...	-	-	2	...	2
CO3	2	2	3	...	...	...	...	1	3	-	...	1
CO4	2	3	-	...	...	...	...	2	1	1	...	3
CO5	-	3	2	...	...	...	...	-	-	2	...	-

4. Calculating the attainment of COs

The attainment of COs characterizes the learning of students in the course. The attainment of COs for a given course comprises of Direct Method of Assessment and an Indirect Method of Assessment (Course Feedback).

4.1 Direct Method of Assessment

Direct method of assessment is based on student performance in various components, defined by the University in teaching and evaluation scheme. The various course evaluation components for direct method of CO's Attainment broadly comprise of the following:

- CWS: Class Work Sessional (Assignments, Quizzes, Class Projects, etc.)
- MTE: Mid Term Examination (As per University Policy)
- ETE: End Term Examination (As per University Policy)
- PRS: Practical Sessional (Laboratory Performance)
- PRE: Practical End Term, wherever applicable

Weightage of each of these components shall be as per the scheme of the courses defined by the University for each program.

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Steps for the Calculation of CO's Attainment through Direct Method of Assessment

Step-I. List all the components direct measurement along with maximum marks allocated to each, and fill the marks of all students in each component (as shown in Table-II).

Table-II: Calculation component wise Level of Performance (P)

Semester	Components of Evaluation→		CWS					MTE	PRS	ETE	
			Assignments			Quizzes					Attendance
V	Symbols→		A1	A2	A3	Q1	Q2	AT	M	L	E
	Maximum Marks→		10	10	10	10	10	5	20	25	40
CO327	S. No.	Roll. No.									
	1	2k15/CS/..	5	0.5	1.5	3	2	3	14	23	30
Course	2	2k15/CS/..	7.5	2	1	2.5	3	2	8	12	20
	3	2k15/CS/..	10	1	0.5	1	4	1	15	22	17
Machine Learning	.	.	.	.	.	.	.	.	.	.	.

	60% of Maximum marks		6	6	6	6	6	3	18	9	24
	Percentage of students having marks more than 60 % of maximum marks		85%	72%	65%	87%	77%	92%	72%	73%	83%
	Level of performance attainment (P)		3	2	1	3	2	3	2	2	3

Step-II. Calculate level of performance attainment using criterion described below:

- Level 3:** 80% or more students attain more than 60% marks in a direct assessment method
- Level 2:** 70% or more students attain more than 60% marks in a direct assessment method
- Level 1:** 60% or more students attain more than 60% marks in a direct assessment method
- Level 0:** Less than 60% of students attain more than 60% marks in a direct assessment method

Note: On achieving the CO attainment, the aforementioned threshold values (which is either percentage of students or percentage of maximum marks) may be increased to improve the learning targets. In some cases, where the difficulty level the course is higher, the course coordinator in consultation with HOD, may decide relaxation in these percentages. The same may be reported to the BoS of the department.

Step-III. Identify marks allocated to each CO for all components of the direct assessment methods, and fill (for all components) total marks (including choices in questions), maximum marks, weightage out of 100 marks, level of performance attainment, and marks allocated to each CO as shown in Table-III.

Step-IV. Calculate correlation coefficient W_{ij} between i^{th} COs and j^{th} components of the direct assessment methods using following formula (as shown in Table-IV)

$$W_{ij} = M_{ij} \times \left(\frac{\rho_j}{T_j}\right) \tag{1}$$

Where M_{ij} is marks allocated to i^{th} COs in j^{th} components of direct assessment

ρ_j is weightage of j^{th} components of direct assessment out of 100 marks

T_j is total marks j^{th} components of direct assessment (including choices)

Step-V. Level of attainment of each CO is calculated using following formula (as shown in Table-V).

$$\text{Level of attainment of } i^{th} \text{ CO} = \frac{\sum_j (W_{ij} \times P_j)}{\sum_j (W_{ij})} \tag{2}$$

Where P_j is level of performance in j^{th} component of evaluation

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Table-III: Distribution of Total Marks among COs as per Question Paper/ Assignment

Semester	Components of Evaluation→	CWS						MTE	PRS	ETE
		Assignments			Quizzes		Attendance			
V	Symbols→	A1 (j=1)	A2 (j=2)	A3 (j=3)	Q1 (j=4)	Q2 (j=5)	AT (j=6)	M (j=7)	L (j=8)	E (j=9)
	Total Marks→	10	10	10	10	10	#	20	25	54
	Maximum Marks→	10	10	10	10	10	5	20	25	40
Course: CO327 Machine Learning	Weightage out of 100 Marks→	2	1	2	2	3	5	20	25	40
	Level of performance (P)	3	2	1	3	2	3	2	2	3
	Course Outcomes									
	CO1 (i=1)	6		1	3	2	1	7		15
	CO2 (i=2)	4	3	2	1	1	1	4	3	14
	CO3 (i=3)		2	1	2	4	1	5	5	8
	CO4 (i=4)		5		4	3	1	4	2	17
CO5 (i=5)			6			1		15		

is number of COs

Table-IV: Weights adjusted in proportion to weightage of evaluation components

Semester	Components of Evaluation→	CWS						MTE	PRS	ETE
		Assignments			Quizzes		Attendance			
V	Symbols→	A1 (j=1)	A2 (j=2)	A3 (j=3)	Q1 (j=4)	Q2 (j=5)	AT (j=6)	M (j=7)	L (j=8)	E (j=9)
	Total Marks→	10	10	10	10	10	#	20	25	54
	Maximum Marks→	10	10	10	10	10	5	20	25	40
Course: CO327 Machine Learning	Weightage out of 100 Marks→	2	1	2	2	3	5	20	25	40
	Level of performance (P)	3	2	1	3	2	3	2	2	3
	Course Outcomes									
	CO1 (i=1)	1.2	0.0	0.2	0.6	0.6	1.0	7.00	0.00	11.11
	CO2 (i=2)	0.8	0.3	0.4	0.2	0.3	1.0	4.00	3.00	10.37
	CO3 (i=3)	0.0	0.2	0.2	0.4	1.2	1.0	5.00	5.00	5.93
	CO4 (i=4)	0.0	0.5	0.0	0.8	0.9	1.0	4.00	2.00	12.59
CO5 (i=5)	0.0	0.0	1.2	0.0	0.0	1.0	0.0	15.0	0.0	

is number of COs

Table-V: CO Attainment levels (Direct Assessment)

Course:	Course Outcomes	Attainment
CO327 Machine Learning	CO1	2.63
	CO2	2.59
	CO3	2.38
	CO4	2.66
	CO5	1.99

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4.2 Indirect Assessment of COs:

Indirect assessment of COs is performed using the course feedback provided by the students towards the end of semester. Students are asked to rate the learning in the course on a scale [1, 5], 5 having the highest degree of satisfaction.

A table can be created as shown in Table-VI, wherein the percentage of students giving 4 or more rating in the Course Exit Feedback for a CO is provided. From this rating the components of indirect COs attainment are set as shown in the bottom row of Table-VI.

- Level 3:** 80% or more respondents give a rating of 4 or more
- Level 2:** 65% or more respondents give a rating of 4 or more
- Level 1:** 50% or more respondents give a rating of 4 or more
- Level 0:** less than 50% respondents give a rating of 4 or more

Table-VI: Course Feedback

S. No.	Roll. No.	Name	CO1	CO2	CO3	CO4	CO5
1	2k15/CS/..	Arun Kumar	2	5	2	3	2
2	2k15/CS/..	Deepika	4	3	2	1	5
3	2k15/CS/..	Chandan	5	4	2	4	3
.
.
.
Percentage of students giving 4 or more points			78%	71%	86%	74%	90%
Level of attainment (P)			2	2	3	2	3

NOTE: The summary of the google form through which the CO-wise feedback for the course is collected must be attached.

4.3 Overall (Direct + Indirect) Attainment of COs:

Create a table and copy the CO attainment values by Direct Assessment and Indirect Assessment as shown in Table VII. By taking a weightage of 90% for direct and 10% for indirect, calculate the overall attainment of COs.

Overall attainment of COs =

$$0.9 \text{ Attainment Level (Direct Assessment)} + 0.1 \times \text{Attainment Level (Indirect Assessment)}$$

Table-VII: Overall CO Attainment of a Course

Course outcomes	CO Attainment (Direct Assessment)	CO Attainment (Indirect Assessment)	Overall CO Attainment
CO1	2.63	2	2.57
CO2	2.59	2	2.53
CO3	2.38	3	2.44
CO4	2.66	2	2.59
CO5	1.99	3	2.09

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5. Steps for the Calculation of PO/PSO [Direct Attainment] from a Course

POs/PSOs attainment of a course using the Direct method of assessment is performed using the CO-PO and CO-PSO Articulation Matrix of a course and its overall CO attainment values. The calculations for direct attainment of POs/PSOs at the course level must be carried out by individual teachers for the courses taught by them.

The table is developed by the faculty teaching the subject with the help of Tables I and VI as shown in Table VII. Table I provides the articulation matrix where the CO are mapped with POs/PSOs for the strength of correlation whereas Table VII provides the overall attainment of COs.

Table-VII: Calculation of PO/PSO Attainment from the Course Outcomes

Course Outcomes (COs)	CO Attainment	Program Outcomes (POs)								Program Specific Outcomes (PSOs)			
		PO1	PO2	PO3	...	...	...	...	POn	PSO1	PSO2	...	PSOm
CO1	2.57	3	2	3	...	...	...	...	0	1	3	...	2
CO2	2.53	3	3	3	...	...	...	...	0	0	2	...	2
CO3	2.44	2	2	3	...	...	...	...	1	3	0	...	1
CO4	2.59	2	3	0	...	...	...	...	2	1	1	...	3
CO5	2.09	0	3	2	...	...	...	...	0	0	2	...	0
Course-wise PO attainment		2.54	2.43	2.44	...	...	...	...	2.54	2.50	2.44	...	2.55

Now, consider, the column containing overall attainment levels of COs (Col 2, Table-VII) as a column vector **CO**, and a column vector PO_j containing the correlation of COs to j^{th} PO, for instance a $PO3 = [3, 3, 3, 0, 2]^T$ a column vector in Col 5, Table-VII, then Level of attainment for j^{th} PO/PSO is calculated using the formula:

$$\text{Level of attainment for } j^{th} \text{ PO} = \frac{\sum_i CO_i \times PO_{ij}}{\sum_i PO_{ij}} \tag{3}$$

In other words, level of attainment for j^{th} PO is weighted average of COs, where elements of PO_j are considered as weights. For example, the bottom row of Table-VII shows the PO/PSO Attainment levels for the given course in a program.

Note:

1. In case of a PO has no correlation with any of the COs of a course then level of attainment for that PO through the course is 0 and it is not calculated using above formula.
2. The numbers in a PO vector represent the correlations of COs of the course to that PO and should not be mistaken for the level of attainment, as both are scored as 0, 1, 2, and 3. This can be clarified with the following example.

Example: Consider a course where all five COs have a level of attainment set at 3, denoted as vector $CO = [3, 3, 3, 3, 3]^T$, let's consider $PO1 = [3, 3, 3, 3, 3]^T$ and $PO2 = [1, 1, 1, 1, 1]^T$. The attainment for both PO1 and PO2 would be 3. This is because all COs of the mentioned course have achieved a level of 3. Despite PO1 being strongly correlated with the course while PO2 is loosely correlated, both have been fully attained in this scenario.

6. Calculating the overall attainment of PO/PSO of a program

The attainment of POs/PSOs characterizes the level of student's learning from the given Program. The attainment of POs/PSOs for a given Program comprises of *Direct Method of Assessment* and *Indirect Method of Assessment* (Program Exit Survey and feedback from Alumni and Employer).

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6.1 Attainment of POs/PSOs at the Program-Level by Direct Assessment

The POs/PSOs Attainments of all the courses (all semesters) for a given program shall be listed as shown in Table VIII. The values for POs/PSOs attainment in each row of Table VIII are provided by the course coordinator of the respective course, as calculated in Table VII.

Finally, the PO/PSO Attainment (direct assessment) shall be calculated for a particular PO/PSO by taking the average of Attainments of that PO/PSO over the contributing courses of that program in Row 17 of Table VIII.

Table-VIII: Calculation of PO/PSO Attainment (Direct Assessment) for the program

Department:													
Program:													
Batch:													
Direct Assessment of POs/PSOs													
S. No.	Course Code & Name	Program Outcomes (POs)							Program Specific Outcomes (PSOs)				
		PO1	PO2	PO3	...	...	...	POn	PSO1	PSO2	...	PSOm	
1.	AP101 Physics-I												
2.	MA 101 Mathematics -I												
.	...												
.	...												
.	...												
PO/PSO Attainment (Direct Assessment)													

6.2 Attainment of POs/PSOs by Indirect Assessment

Indirect assessment of POs/PSOs is performed using the program’s exit survey, employer’s, and alumni’s feedback. Total number of students, employers and alumni participated are inputted in corresponding rows of Table IX.

a. **Programme Exit survey:** Program exit survey is conducted after the completion of program. Students are asked to rate the program (POs/PSOs) on a scale [1, 5], 5 having the highest degree of satisfaction. The value of a number of respondents giving 4 or more rating in the Program Exit Feedback for a PO/PSO is inputted in Column 3 of Table IX. The corresponding PO’s attainment level is calculated using the following rules:

- Level 3: 80% or more respondents give a rating of 4 or more.
- Level 2: 65% or more respondents give a rating of 4 or more.
- Level 1: 50% or more respondents give a rating of 4 or more.
- Level 0: less than 50% of respondents give a rating of 4 or more.

b. **Employer’s feedback:** A feedback is taken during campus visits of companies for placement. Companies are asked to give feedback about the talent of current students (participating) and previous students (employed) on a scale [1, 5], 5 having the highest degree of satisfaction. The value of the number of respondents giving 4 or more ratings in the Employer’s Feedback for a PO/PSO is inputted in Column 5 of Table IX. The corresponding PO’s attainment level is calculated using the following rules:

- Level 3: 80% or more respondents give a rating of 4 or more.
- Level 2: 65% or more respondents give a rating of 4 or more.
- Level 1: 50% or more respondents give a rating of 4 or more.
- Level 0 (No Attainment): less than 50% respondents give a rating of 4 or more.

c. **Alumni feedback:** Using a criterion similar to Employer’s feedback, level of attainment for POs/PSOs is calculated from Alumni’s feedback in Column 7 of Table IX.

Finally, the Indirect Assessment of PO/PSO attainment is calculated in column 8 of Table IX using the formula.

$$\text{POs/PSOs attainment (Indirect assessment)} = 0.6 \times \text{Programme exit survey} + 0.2 \times \text{Employer’s feedback} + 0.2 \times \text{Alumni feedback}$$

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Table-IX: Calculation of PO/PSO Attainment (Indirect Assessment) for the program

Department:								
Program:								
Batch:								
Total Number of Alumni participated in Alumni Feedback Survey:		150						
Total Number of Employers participated in Employer's Feedback Survey:		33						
Total Number of Students participated in Program Exit Survey:		120						
Col. No.	1	2	3	4	5	6	7	8
S. No.	PO/PSO	Percentage of Students respondents giving a rating of 4 or more	PO/PSO Attainment in Program Exit Survey	Percentage of Employers respondents giving a rating of 4 or more	POs/PSO Attainment in Employer's Feedback	Percentage of Alumni respondents giving a rating of 4 or more	PO/PSO Attainment in Alumni Feedback	PO/PSO Attainment (Indirect Assessment)
1.	PO1							
2.	PO2							
3.	PO3							
4.	PO4							
5.	PO5							
6.	PO6							
7.	PO7							
8.	PO8							
9.	PO9							
10.	PO10							
11.	PO11							
12.	PO12							
13.	PSO1							
14.	PSO2							
15.	PSO3							

Overall POs/PSOs Attainment

The Overall PO/PSO attainment is calculated automatically in bottom row of Table X using the formula:

$$\text{Overall POs/PSOs Attainment} = 0.8 \times \text{PO/PSO Attainment Level (Direct Assessment)} + 0.2 \times \text{PO/PSO Attainment Level (Indirect Assessment)}$$

Table-X: Calculation of overall PO/PSO Attainment for the program

Department:													
Program:													
Batch:													
POs/PSOs	Program Outcomes (POs)								Program Specific Outcomes (PSOs)				
	PO1	PO2	PO3	...	...	...	...	POn	PSO1	PSO2	...	PSOm	
Direct PO/PSO Attainment													
Indirect PO/PSO Attainment													
Overall PO/PSO Attainment													
Target													
TA/AR	TA	AR	TA	AR	TA	TA	AR	AR	AR	TA	TA	AR	AR

TA: Target Achieved, AR: Action Required as Target not achieved

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