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COURSE OUTCOME AND PROGRAM OUTCOME IN REFERENCE TO NBA ACCREDITATION PROCEDURES FOR DIPLOMA ENGINEERING PROGRAMS

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Abstract:

It is critically important to enhance the quality of technical education in India. The National Board of Accreditation, New Delhi (NBA) is putting the efforts since 1994. The Self Assessment Report (SAR) for Diploma Engineering Institutes includes the calculation of Attainments of Course Outcomes (COs) and Program Outcomes (POs). CO & PO relates to the "KSA" that is Knowledge, Skills and Attitude that students acquire during the study. The program outcomes can be attained through the attainment of Course Outcomes of individual courses included in particular program. This paper demonstrates the contribution of Course Outcomes to program outcomes for a sample course "Metrology & Quality Control". Also it highlights the process involved in the attainment of Course Outcomes.

Keywords: National Board of Accreditation, Self Assessment Report, Outcome based education, Course Outcomes, Program Outcomes

I. Introduction

Indian higher education system is the third largest system in the world. In an increasingly technologically dependent world, expansion of higher education sector is imperative in an emerging economy such as India as evidenced by the phenomenal growth and development in technical education during the past two decades. The number of institutions has multiplied exponentially, from a modest number around 30 colleges in 1950-51, to more than 20,000 colleges and from 20 universities to more than 500 universities awarding degrees, which include all types of institutions, namely, central, state, private, govt. aided, deemed to be universities and other institutes of national importance. The challenge is to ensure its quality to the stakeholders along with the expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. [2]

There are debates across continents as to who sets the standards for quality. The accreditation system prevailing in various countries provides a measure of educational quality. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards and also seeks ways to enhance the quality of education. [2]

The spirit of continuous improvement is a prerequisite for any quality initiative. Educational institutions are no exception to this. ISO 9000 and such initiatives focus on meeting customer expectations and

making a whole-hearted effort to exceed the same. The process of accreditation is an effort in this direction, to meet the quality goals in education. [2]

NBA will facilitate to enhance the quality of technical education and help in establishing relevancy of technical education as per the needs of the industry and society at large. National Board of Accreditation (NBA) is one of the platforms that provides a framework to bridge the 'academic- industry gap' and enables better employment prospects for diploma engineer. The process guidelines help in building curriculum to improve not only the technical skills but also the soft-skills of the diploma engineer, which in-turn increases the employability of diploma engineer.

The NBA, which insists on 'Outcome Based Education', has published guidelines and templates for Diploma Engineering Programs to conduct 'Self-Assessment' of their quality of education. The guidelines help the institutions, who conduct Diploma Engineering Programs, improve their teaching-learning processes to meet the global standards of technical education. The guidelines are presented in the SAR in the form of nine criteria meeting which will enable polytechnic engineering institution to get accredited. One of the important criteria is about measuring the attainment of course outcomes (COs), program outcomes (POs). Whereas POs are defined by the NBA, COs need to be defined or formulated by the respective programs. However, in the earlier versions of SAR, POs should have been defined by the programs based on the graduate attributes. [1]

II. Concepts

The schematic presentation of Development and Attainment of NBA Elements is as shown in fig.1 & 2.

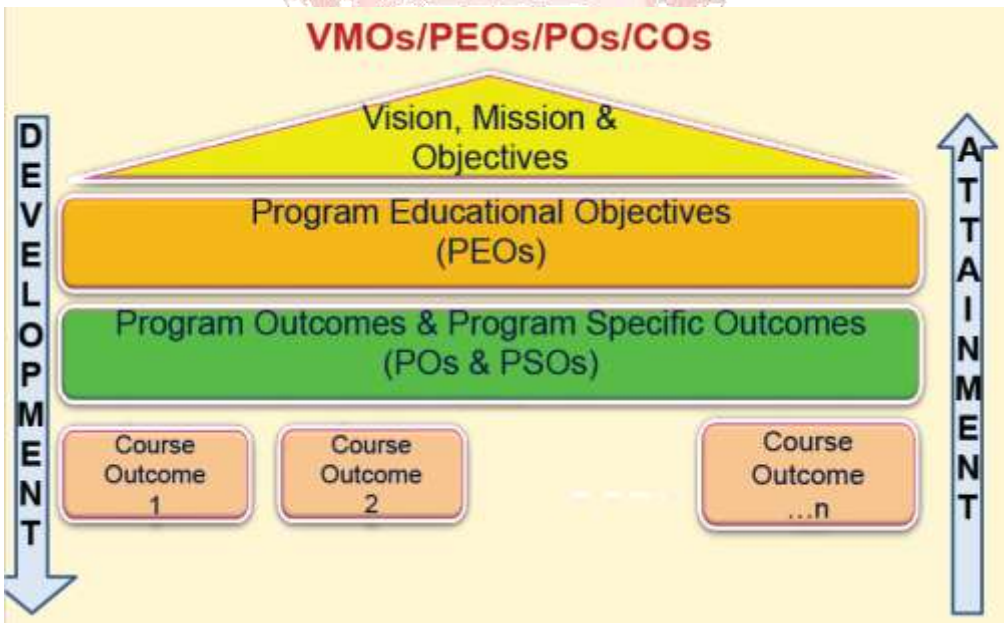

Fig. 1: Schematic presentation of Development and Attainment of NBA Elements

- **COs- Course Outcomes should be action oriented**
  - ❖ COs are clear statements of what a student should be able to demonstrate upon completion of a course.
  - ❖ They should be assessable and measurable knowledge, skills, abilities or attitudes that students attain by the end of the course.

- Usually 3-5 Statements

- **POs- Programme Outcomes are to be SMART**
  - The Program outcomes (POs) are narrower statements that describe what students are expected to do after completion of diploma due to this curriculum.
  - Describe student performance, not teacher/professor performance
  - Describe learning product, not process
  - Are specific without simply stating the subject matter to be learned
  - Stick to one type of result for each outcome (e.g., do not say "Knows the scientific method and applies it effectively")
  - Start with an action verb that indicates observable and measurable behaviour
  - 7 Statements given by NBA

Fig. 2: Schematic presentation of Attainment of COs & POs

III. Mapping of CO to PO

The process of attainment of COs and POs start from writing appropriate COs for each course of the program from first year to third year in a three-year diploma engineering program. The course outcomes are written by the respective faculty member using action verbs of learning levels suggested by Bloom Taxonomy. Then, a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (Low), 2 being moderate (Medium) and 3 being substantial (High). A mapping matrix is prepared in this regard for every course in the program including project. The course outcomes written and their mapping with POs are reviewed frequently by BOS (Board of Study) members i.e. a committee of senior faculty members before they finalized. The following tables 1 show the COs and the CO-PO mapping matrix for a sample course and table 2 shows CO-PO mapping matrix for all courses.

C1-17001 is indicative courses number in the first semester. Similarly, C6-17612 is sixth semester course number. Alphabet "C" indicates course and followed by semester number and then Course code given by MSBTE in the respective semester of study

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Table 1: Semester V - Subject Name and Code: C5-17530: Metrology & Quality Control

Course Name - Course Outcomes / Program Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
Student will be able to							
CO1-17530.1-Apply Metrology Basics and measurement standards, comparators.	3	3	-	2	1	-	-
CO2-17530.2-Calculate Limits, Fits, Tolerances and gauges.	-	3	3	2	1	-	-
CO3-17530.3-Evaluate Angular Measurements and metrology of thread & gear	-	3	3	3	-	-	-
CO4-17530.4-Measure the Surface Finish	-	3	2	1	-	-	-
CO5-17530.5-Apply basics of Quality Control.	1	3	1	2	-	-	-
CO6-17530.6-Draw Statistical Quality Control Charts		3	2	2	1	-	-
Total	4	18	11	12	3	-	-
Correlation	2	3	2.2	2	1	-	-

***Values are not actual. These are indicative for the sake of understanding.*

Table 2: Combined table of all courses

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Semester -I							
ENG 17101	3	2	-	-	2	-	3
EPH 17102	3	-	2	-	-	1	-
ECH 17103	3	-	2	-	2	2	1
BMS 17104	3	2	1	-	-	-	-
EGG 17001	3	3	2	-	-	-	-
CMF 17002	3	3	2.85	2.71	3	2.14	2.14
WPM 17006	2	3	3	3	3	-	1.5

***Values are not actual. These are indicative for the sake of understanding.*

Similar Table is prepared for Semester 2 to 6…

IV. Assessment Tools for COs:

V.

1) Assessment process is divided into two parts

   a. Internal Assessment b. Board Exam Assessment

2) 30% Weightage is given for internal assessment and 70% Weightage is given for external assessment. This is given in accordance with the total weightage given in MSBTE curriculum (MSBTE Teaching and Examination Scheme). The internal assessment includes Class Test I, Class Test II, Term work and external assessment includes MSBTE theory and PR/OR exam in each semester of the curriculum.

Following processes have been undertaken to find the attainment of course outcomes. For direct attainment, the MSBTE Class tests result and theory exam result are taken into consideration. Refer Fig. 3.

- **MSBTE Class Tests**
  - Two MSBTE Class tests are conducted in each semester – one in the mid-semester and the other at the end of semester.
  - MSBTE provides Teacher's guide for all subjects. It includes lecture wise topics to be covered and the syllabus to be completed before each class test.
  - Teacher's guide also includes sample question papers as guidelines for setting question paper for class tests.
  - Course outcomes are taken into consideration while setting up the question paper.
  - After assessment of answer sheets, attainments of course outcome are found by determining the number of students having met the set standard in the said course.
  - Based on the above calculation the attainment level is found.
  -

- **MSBTE Exam**

  - MSBTE provides teaching scheme for every semester, which includes the components viz., Theory Exam, Practical/Oral exam and Term work along with the maximum marks allotted for each component.
  - The marks of the applicable components are added and attainments of course outcome is found by determining the number of students who have met the set standard in the said course.
  - The direct attainment is calculated by taking into consideration 30% weightage for class test, Term work and 70% weightage for MSBTE exam.

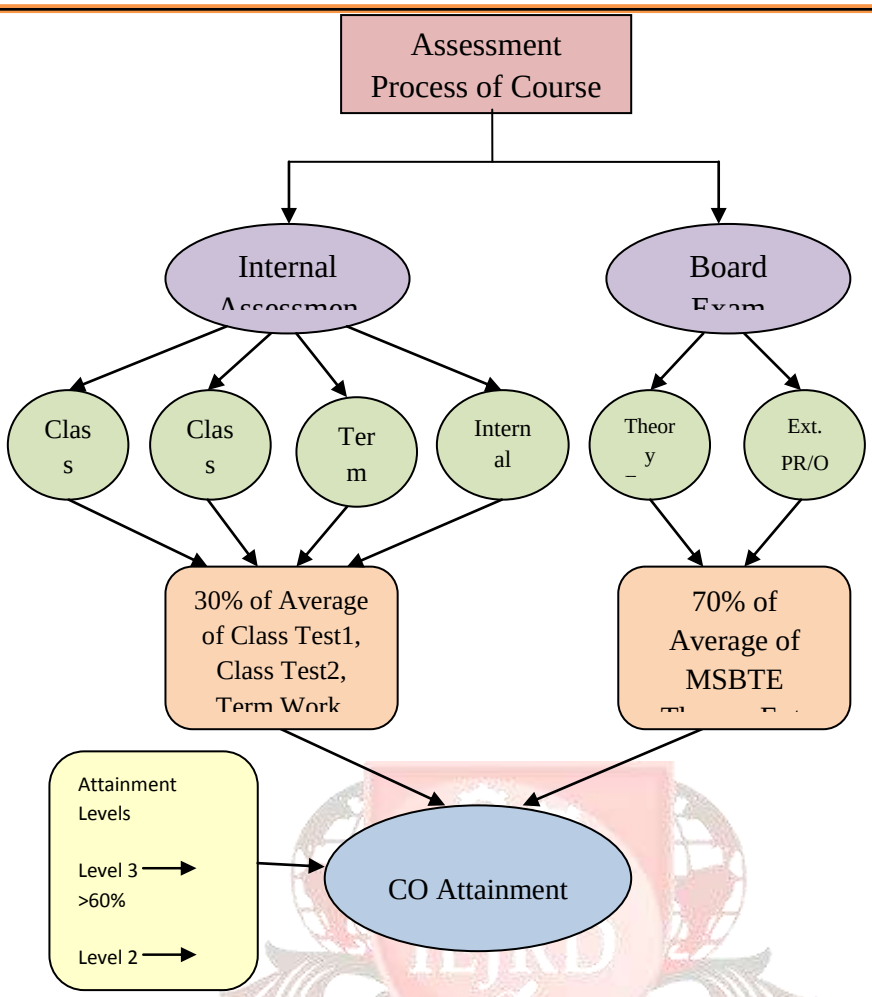

Figure 3: Procedure for Course Outcomes Attainment

VI. The attainment of Course Outcomes of MQC Course with respect to set attainment levels

- **Attainment Target Levels selected by the program for the curriculum 2014-17.:**

Program has set course outcome attainment levels as 40%, 50% & 60% for all courses. (Refer Table 3). To measure course outcome attained through board examination (TEE) & Continuous internal assessment (CIA), the above said target levels are used. The reason behind selecting such values for attainment levels is the eligibility to Diploma Engineering is 35% by Govt. of Maharashtra; hence 40% target is minimum level of attainment. Program has continued to consider this level for the curriculum 2014-17

Table 3: Program defined attainment levels vs. target for Internal and Board Exams

Attainment Level	Target Level
Attainment Level 1	40% to 50% students scoring more than average percentage marks
Attainment Level 2	51% to 60% students scoring more than average percentage marks
Attainment Level 3	Above 60% students scoring more than average percentage marks

***Values are not actual. These are indicative for the sake of understanding.*

- Direct attainment level of a PO is determined by taking average across all courses addressing that PO.
- Indirect attainment level of a PO is determined based on the student exit surveys, employer/faculty surveys and Alumni survey.

  Program has decided three attainment levels:

  - Level 3 –High - Score from 2.50 to 3
  - Level 2 – Medium - Score from 2.0 to 2.49
  - Level 1 – Low- Score from 1.0 to 1.99

Table 4 displays the CO attainment for MQC course using various assessment tools.

Table 4: CO Attainment for MQC

SR No.	Course Outcomes (COs)	CT1 Attainment Level-A&B	CT2 Attainment Level-A&B	TW Attainment Level-A&B	Attainment Level for All IA occasion	Board Attainment Level	30% of CIA Attainment Level	70% of Board Attainment Level	CO Attainment Level
1	CO1	3	--	3	3	3	0.9	2.1	3
2	CO2	3	--	3	3	3	0.9	2.1	3
3	CO3	3	--	3	3	3	0.9	2.1	3
4	CO4	--	3	3	3	3	0.9	2.1	3
5	CO5	--	3	3	3	3	0.9	2.1	3
6	CO6	--	3	3	3	3	0.9	2.1	3

***Values are not actual. These are indicative for the sake of understanding.*

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VII. Assessment Tools for PO attainment

- The input to polytechnic education system is the students who passed S.S.C. (Std. 10+) qualifications.
- The MSBTE curriculum is revised approximately every five years and is prepared by considering the industry needs.
- An Industry survey is conducted on state level and feedback received is taken into consideration along with suggestions received from subject experts.
- Subject experts from various institutes are invited to prepare the content detailing of Theory and Laboratory work.
- Bloom's Revised Taxonomy is used while implementing the curriculum.
- MSBTE provides training to the faculty across the state of Maharashtra through orientation programs.
- Course outcomes are prepared by course owner from course objectives given by MSBTE as given in Table 3.1.1 in the SAR. [1]
- Course Outcomes are then mapped with the Program Outcomes & Program Specific Outcomes by course owner. Correlation levels are entered and the overall Course Outcome is calculated.
- All the Outcomes of various Courses are mapped with the POs & correlation levels are entered in CO-PO Matrix.

- The Course Outcomes are measured for MSBTE class tests as well as MSBTE Board Examinations by setting standards and calculating the number of students scoring above the set standard. The Class Test term work marks and MSBTE Exam gives Direct Attainment Level.
- 80% of the Direct Attainment levels are calculated.
- For Indirect Attainment, the average scores of the feedback taken from various stakeholders are considered.
- 20% of the Indirect Attainment score is considered for calculation of Attainment Levels.
- The Direct & Indirect attainment levels of POs are added and final attainment levels are calculated.

Refer fig. 4

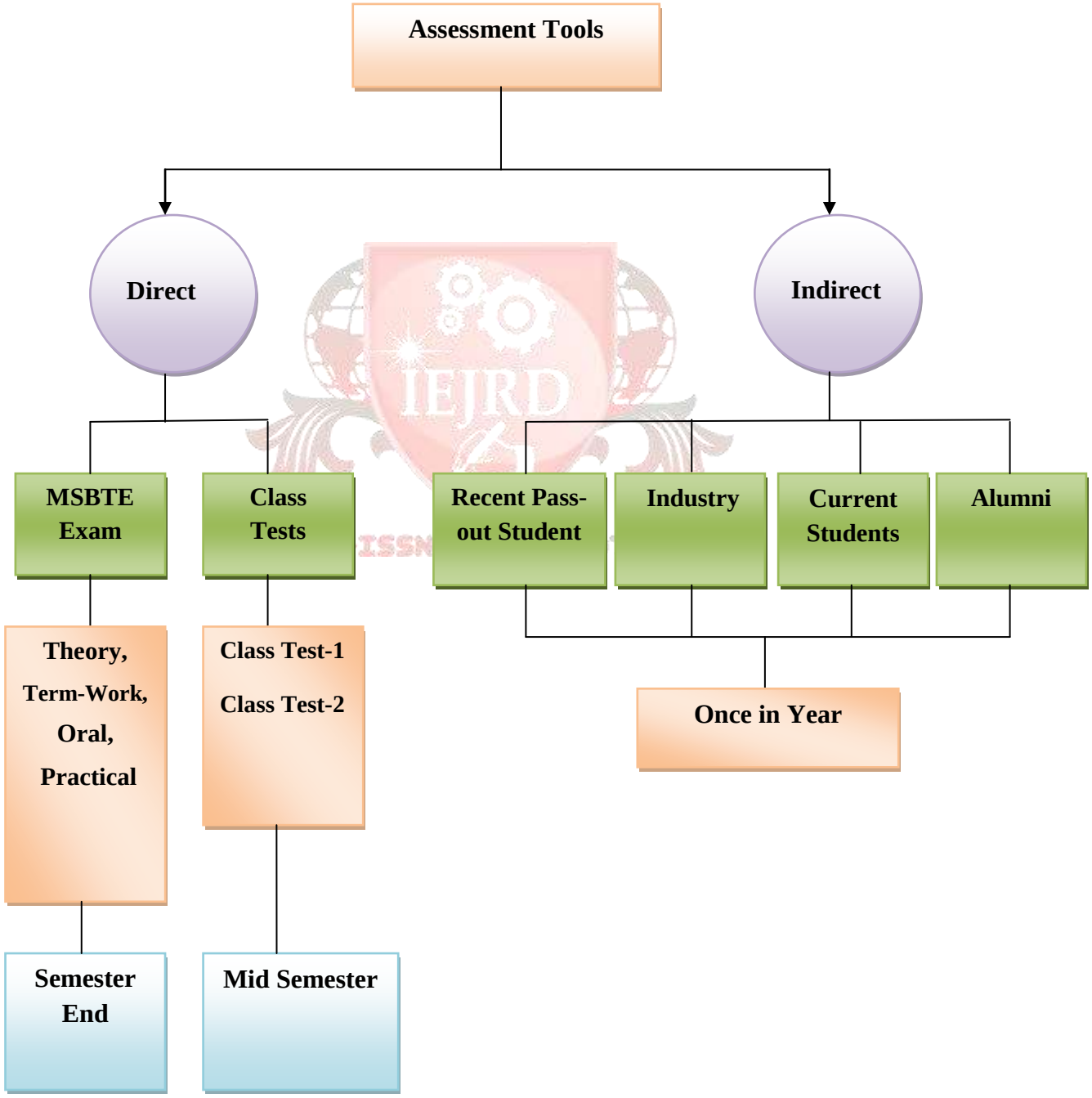

Figure 4: Procedure for POs attainment

VIII. Attainment of PO attainment

Table 5 displays the attainment of PO by the use of CO attainment for MQC course.

Table 5: PO attainment from CO attainment

PO Attainments- 2016-17							
	Course and Code: ME5G					Subject Code: 17530	
	Subject Name : Metrology & Quality Control (MQC)						
Course Outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	--	2	1	--	--
CO2	--	3	3	2	1	--	--
CO3	--	3	3	3	--	--	--
CO4	--	3	2	1	--	--	--
CO5	1	3	1	2	--	--	--
CO6	--	3	2	2	1	--	--
TOTAL	4	18	11	12	3	--	--
Correlation Level	2	3	2.2	2	1	--	--
CO1	3	3	--	3	3	--	--
CO2	--	3	3	3	3	--	--
CO3	--	3	3	3	--	--	--
CO4	--	3	3	3	--	--	--
CO5	3	3	3	3	--	--	--
CO6	--	3	3	3	3	--	--
Sum	6.00	18.00	15.00	18.00	9.00	--	--
PO and PSO attainment	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	--	--

***Values are not actual. These are indicative for the sake of understanding.*

Table 6 conveys the summary of PO Direct- attainment by all courses in a program for a batch for which students got admitted in academic year 2014-15 and passed out in academic year 2016-17.

Table 6: PO-Direct Attainment for BATCH 2014-17

Course Name	Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7
ENG	17101	2.08	2	-	-	2.15		2.3
EPH	17102	1.6	1.6	1.6	-	-	1.6	-
ECH	17103	2.3	-	2.3	-	2.3	2.3	2.3
BMS	17104	2.3	2.3	2.3	-	-	-	-
EGG	17001	3	3	3	-	-	-	-
CMF	17002	2.3	2.3	2.3	2.3	2.3	2.3	2.3
WPM	17006	3	3	3	3	3	-	3
CMS	17201	2.92	-	-	-	2.77	-	2.58
ACH	17203	2.3	-	2.3	-	2.3	2.3	2.3
APH	17202	2.3	2.3	2.3	2.3	2.3	-	-
EGM	17204	1.6	1.6	1.6	-	-	-	1.6
EDG	17205	-	1.53	1.53	-	1.6	-	-
EMS	17216	3	3	3	-	-	-	-
DLS	17010	-	-	-	-	3	3	3
WPC	17011	3	3	3	3	-	-	3

AMS	17301	1.53	1.53	1.5	-	1.5	-	-
BEM	17302		2.29	2.29	2.29	2.29		2.29
MEM	17303	1.48	1.51	1.5	-	-	-	-
SOM	17304	2.3	2.3	2.3	2.3	-	-	-
MED	17305	-	2.97	2.97	2.97	-	-	-
CAD	17016	3	3	3	3	3	-	-
PPO	17017	3	3	3	3	3	3	3
EST	17401	3	-	-	-	3	3	3
MPR	17402	-	2.98	2.98	3	2.95	2.98	3
EEN	17404	3	3	3	3	3	-	-
TEN	17410	2.94	2.94	2.95	-	2.94	2.92	2.95
FMM	17411	3	3	3	3	3	3	-
TOM	17412	-	2.98	2.98	-	-	-	-
PPT	17035	3	3	3	3	3	3	3
AEN	17526	-	1.6	1.6	-	1.6	-	-
AMP	17527		3	3	3	3	3	3
MAC	17528	3	3	3	3	3	3	-
PEN	17529	3	3	3	3	-	3	-
MQC	**17530**	**3**	**3**	**3**	**3**	**3**	**-**	**-**
BSC	17075	3	-	-	3	3	3	3
CNC	17064	-	3	3	3	-	-	-
PP-III	17065	-	3	-	-	-	-	3
MAN	17601	-	-	-	-	3	3	3
IFP	17608	2.3	2.3	2.3	-	-	-	2.3
PER	17609	-	2.19	2.3	2.27	2.05	-	2
DME	17610	-	2.24	2.25	-	2.3	-	-
RAC	17612	-	1.6	1.6	-	-	1.6	-
SMO	17063	-	3	3	3	3	-	-
PRO	17090	3	3	3	3	3	3	3
EDE	17099	3	--	3	3	3	3	3
TOTAL		78.25	92.46	96.75	65.43	79.35	52	61.92
Number of Courses Attained PO		30	36	38	23	30	19	23
Direct Attainment		2.61	2.57	2.55	2.84	2.65	2.74	2.69
80% Direct Attainment		**2.09**	**2.05**	**2.04**	**2.28**	**2.12**	**2.19**	**2.15**

***Values are not actual. These are indicative for the sake of understanding.*

Similarly Table 7 conveys the summary of PO Indirect- attainment and Table 8 communicates the Overall PO Attainment for batch 2014-17.

Table 7: PO-Indirect Attainment for BATCH 2014-17

Students Survey	2.5	2.43	2.49	2.52	2.39	2.43	2.39
Alumni Survey	2.48	2.48	2.76	2.38	2.29	2.38	2.43
Employer Survey	2.48	2.4	2.48	2.21	2.31	2.06	2.29
Total	7.46	7.31	7.73	7.11	6.99	6.86	7.11
Indirect Attainment Level	2.49	2.44	2.58	2.37	2.33	2.29	2.37
20% of Indirect Attainment Level	0.5	0.49	0.52	0.47	0.47	0.46	0.47

***Values are not actual. These are indicative for the sake of understanding.*

Table 8: Overall PO Attainment for BATCH 2014-17

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
80% Direct Attainment	2.09	2.05	2.04	2.28	2.12	2.19	2.15
20% of Indirect Attainment Level	0.5	0.49	0.52	0.47	0.47	0.46	0.47
Total Attainment Level	**2.59**	**2.55**	**2.56**	**2.75**	**2.59**	**2.65**	**2.62**

***Values are not actual. These are indicative for the sake of understanding.*

IX. Conclusion:

The analysis of CO-PO attainment helps to get an idea about the understanding level of students getting passed out. It also helps the faculty to rectify the teaching methodology, if required. Attainments are indices for domain knowledge along with overall professional development.

References:

[1] Self Assessment Report (October, 2015) for Diploma programs from NBA Website

[2] Guideline Manual of I-Scheme by Maharashtra State Board of Technical Education, Mumbai

[3] Balasubramani R, Niranjan N Chiplunkar, "Attainment of Programme Outcomes Through Course Outcomes In Outcome Based Education: A Case Study", Journal of Engineering Education Transformations, Volume 31, No. 2, October 2017, ISSN 2349-2473, eISSN 2394-1707, pp. 26-30