International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Accreditation of Engineering Education: A Comprehensive Assessment Plan

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Abstract: ***Considerable expansion of technical education has taken place in India. However, the quality of technical education graduates of the country is a matter of concern. To enhance the quality and standard in technical education, NBA accreditation, a process of benchmarking of academic quality of an engineering education program or diploma engineering education program by an accreditation agency, has been introduced. India is a signatory nation of Washington Accord through National Board of Accreditation. Now, accreditation has become compulsory for quality assurance, recognition of graduates globally, recognition by the stakeholders, for branding and for expansion of the program. However, very few programs have been accredited so far in India. Outcome Based Education is the central feature of accreditation which focuses on outcomes. It is a student centered approach which measures student performance or outcomes in terms of knowledge, skills, and attributes. The institutions intending to apply for accreditation are facing difficulty in preparing Self Assessment Report (SAR), especially CO- PO attainment. The purpose of this paper is to share our experiences of NBA accreditation process, especially assessment of CO and PO attainment. CO attainment is solely measured by direct measurement methods (internal and external assessments). Program Outcome attainment is calculated by both direct attainment method and indirect attainment method (various surveys). Various boards and committees formed for the preparation for accreditation are also outlined in this paper. The accreditation of two programs of our institute by NBA is an important indication of the appropriateness of the methods applied to achieve this goal. Since NBA is a member of the Washington Accord, this study may help not only local readers but also international readers having similar accreditation systems.***

Keywords: Accreditation, CO-PO attainment, NBA, Outcome Based Education.

I. INTRODUCTION

In the era of globalization, nature of jobs and workplaces are changing at very fast pace. The globalization has provided opportunities for the transmission of technology, skills, knowledge, people, money, goods and services, values, and ideas across the borders. Engineering education has become an integral part of this globalization because engineers play very important role in the socio- economic development of any country. Considerable expansion of technical education has taken place in India and now it is emerging as globalised hub.

Revised Manuscript Received on February 28, 2020.
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The country has become the third largest higher education system in the world, after China and the US [1]. However, the quality of higher education and technical education graduates of the country is matter of concern. The new Annual" National Employability Survey 2019" report by Aspiring Minds reveals that more than 80% engineers are unemployable for any job in the knowledge economy [2]. Employability of engineering graduates is the great challenge before the nation. This calls for systemic long term changes in higher education in India. To enhance the quality and standard in technical education various quality assurance and professional accreditation processes have been introduced.

Accreditation is a process of benchmarking of academic quality of a higher education institution, engineering education program or diploma engineering education program by an accreditation agency [3]. Accreditation is "a quality assurance scheme wherein a certification of assessment given with a validity for a stated period of time and the recognition accorded to an educational institution that meets commonly accepted standards of quality or satisfies criteria laid down by a competent agency"[1]. Accreditation is compulsory for quality assurance, recognition of graduates globally, recognition by the stakeholders and for Branding [4]. India is a signatory nation of Washington Accord through National Board of Accreditation (NBA) [5]. The Washington Accord is an international agreement among bodies responsible for accrediting undergraduate engineering degree programs. It recognizes the substantial equivalency of programs accredited by bodies that are its signatory and recommends that graduates of programs accredited by any of the signatory bodies be recognized mutually as having met the academic requirements for entry to the practice of engineering in the area of their jurisdiction. The Washington Accord set the criteria, policies and procedures for accrediting engineering academic programs [5]. The NBA became a provisional member of the Washington Accord in 2007 and was given the status of permanent signatory on 13th June 2014[1, 6]. Signatory status is subject to the condition that only programs with Tier I institutions accredited by NBA are eligible for mutual recognition under the Washington Accord. The accreditation methods used by the Washington Accord signatory countries are considered to be the best developed and most well respected systems for the accreditation of engineering education in the world [7, 8]. The Indian Quality Assessment and Accreditation System for engineering education started with the setting up of National Board of Accreditation (NBA) in 1994, by the All India Council for Technical Education (AICTE)[1].

The NBA periodically conducts evaluation of technical institutions or programs on the basis of guidelines, norms and standards specified by it its committees and council. It provides the quality benchmarks targeted at global and national stockpile of human capital in all fields of technical education [4].

Outcome Based Education (OBE) is the central feature of accreditation which focuses on outcomes. It is a student centered approach which measures student performance or outcomes in terms of knowledge, skills, and attributes [9]. Outcomes should be observable and measurable [10]. Outcome based accreditation is helpful to prepare global engineers/ diploma engineers who will have to solve unknown problems and challenges and cope with the demands of the rapidly changing workplace. The OBE implementation in an institute requires the restructuring and reshaping of the educational programs, courses, curriculum, assessment techniques and reporting system according to outcomes [11, 12]. Clarity of focus, expanded opportunity, high expectations and design down are the four main principles of OBE [13].

In today's globalised world, demand for accreditation is increasing day by day and for better understanding of accreditation many research papers have been published [14-23]. In India, NBA accreditation is compulsory for expansion of any engineering program by a technical institution.

S.V. Polytechnic College Bhopal, one of the primer technical education institutes, was established by Government of Madhya Pradesh in 1953. The institute is affiliated to State Technological University RGPV Bhopal. The Diploma in Mechanical Engineering and Electrical Engineering programs has been accredited by NBA for three years in November 2019. The purpose of this paper is to share our experiences of NBA Accreditation process which may be useful for other institutions intending to apply. However, since NBA is a member of the Washington Accord, this study may help not only local readers but also international readers having similar accreditation systems.

Assessment is one or more processes that identify, collect, and prepare data to evaluate the achievement of Program Outcomes (PO) and Program Educational Objectives (PEO) [24]. The NBA program assessments are performed by independent assessors and the assessments are performed according to 9 evaluation criteria and given in Table-I [1].

Table–I: Evaluation criteria of NBA

S.No	Evaluation criteria	Marks
1.	Vision, Mission and program educational objectives	50
2.	Program curriculum and teaching-learning process	200
3.	Course outcomes and program outcomes	100
4.	Students‟ performance	200
5.	Faculty information and contribution	150
6.	Facilities and technical support	100
7.	Continuous improvement	75
8.	Student support systems	50
9.	Governance, institutional support and financial	75
	Total	1000

Each criterion is assessed separately and has its own requirements. Among these, criterion-3(course outcomes and program outcomes) is the most important one, since assessors inspect these measures more seriously according to our observations. Consequently, these two measures are focused in this work.

II. ORGANIZATION FOR THE ACCREDITATION PROCESS

As stated earlier, OBE is the soul of accreditation which requires the restructuring and reshaping of the educational programs, courses, curriculum, and assessment techniques and reporting system according to outcomes. Our institute started preparation for accreditation in 2016 and applied for accreditation in 2018. Entire institution was involved in the process and a number of committees and boards were established at institution as well as department level. The various committees formed in the Institute are shown in Fig.1.

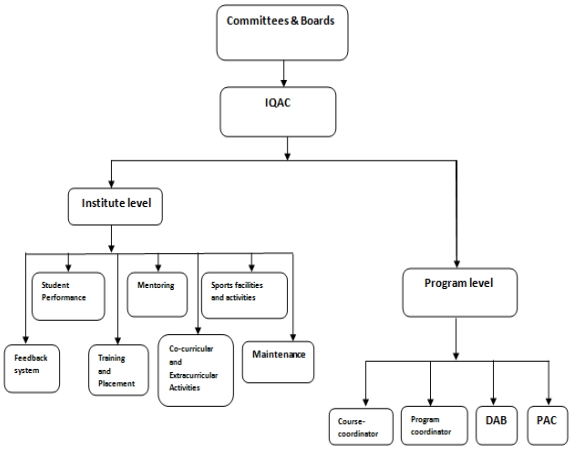

Fig.1. Flow chart of various committees formed in the Institute.

A. Committees at Institute Level

The details of Institute level committees, their missions and roles in the NBA accreditation process are given in Table-II.

Table-II: Institute level committees and their functions

Committees at Institute Level		
S.No.	Title of Committee	Brief Description of Work
	Internal Quality Assurance Cell (IQAC)	• Evaluate attainment of vision and mission of the various departments and suggest necessary changes for continuous improvement. • Monitoring and analysis of Course plan • Continuous improvement initiatives like improvement in preparation of question papers for internal and external exams • Organization of institutional level awareness workshops on Outcome Based Education • Periodical monitoring of various activities • Suggestions and measures to be taken to enhance desired outcomes
2.	Feedback System	• Design of Proforma and process for feedback mechanism for students, alumni, parents and employers • Compilation of related data
3.	Students Performance	• Ensuring availability of data related to admission intake, admission quality, success rate, academic performance. • Compilation of related data
4.	Training and Placement	• Ensuring availability of data related to placement, students admission for higher studies and self employed • Compilation of related data
5.	Mentoring System	• Appointment of mentors • Organisation of orientation classes • Organisation of counseling sessions • Special/ remedial classes and related data compilation
6.	Co-curricular and Extracurricular Activities	• Organisation of competitions/ contests and related data compilation
7.	Sport facilities and activities	• Conducting sports activities
8.	Maintenance (Civil/ electrical)	• Maintenance of institute building and compilation of related data

B. Committees at Department Level

The various committees formed at department level and their roles are given below:

i. Course Coordinator

Either one of the senior faculty member who teaches common courses (if any) otherwise individual faculty will the course coordinator. The main functions of course coordinator are to :

- Monitor and review the activities related to attainment of course outcome.
- Prepare course plan, with topic wise teaching methodologies for each course.
- Deliver course contents
- Assess the attainment of COs and develop assessment tools like question papers, Quiz and Rubrics, etc. for assigned courses.
- Maintain course file for assigned courses

ii. Program Coordinator

Usually HOD is the Program Coordinator. The main functions of Program Coordinator are to :

- Interact and maintains liaison with key stake holders, students, faculty, Department Head and employer.
- Monitor and review the activities of each year in program independently with course coordinators.
- Schedule program work plan in accordance with specifications of program objectives and outcomes.
- Oversee daily operations and coordinates activities of programs with interrelated activities of other programs, departments or staff to ensure optimum efficiency and compliance with appropriate policies and specifications given by HODs.
- Conduct and interpret various surveys required to asses POs and COs.

iii. Program Assessment Committee (PAC)

Program Assessment Committee consists of Program Coordinator, and faculty representatives. PAC is chaired by Program Coordinator and main functions of PAC are to:

- Monitor attainment of POs and PEOs.
- Evaluate program effectiveness and proposes necessary changes for continuous improvement.
- Prepare periodic reports/records on program activities, progress status or other special reports for management and key stake holders.
- Motivate the faculty and students towards attending workshops, developing projects, working models, paper publication and research.
- Interact with students, faculty, program coordinator, module coordinator and outside/ community agencies (through their representation) in facilitating program educational objectives.

iv. Departmental Advisory Board (DAB)

DAB consists of HOD, program coordinators and the representative of key stake holders. DAB is chaired by HOD and functions of DAB are to:

Receive the report of the PAC and monitor the progress of the program.

- Develop and recommend new or revised program educational objectives.

III.PROGRAM OUTCOMES (POs)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program [1]. These relate to the skills, knowledge, attitude and behavior that students acquire through the program. The NBA has defined the POs for each discipline. There are 10 POs for Engineering Programs and 7 for diploma Engineering Programs [1, 25]. The POs for Diploma Engineering program defined by NBA are as follows:

1. **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
2. **Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
3. **Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
4. **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
5. **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
7. **Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.

IV.PROGRAM SPECIFIC OUTCOMES (PSOs)

PSOs are the program specific outcomes which are articulated by the Program in addition to POs. For all Diploma programs & POs have been decided by the NBA and 3-4 outcomes are determined by Program which are program specific in nature. As an example, the program specific outcomes of Mechanical Engineering department of S.V. Polytechnic College Bhopal are given as follows:

PSO- 1 Plan and supervise maintenance activities of mechanical engineering instrument and machines.

PSO- 2 Use simple CAD/CAM software and latest techniques for mechanical engineering applications in drafting, design and manufacturing.

PSO- 3 Manage mechanical engineering processes by selecting and scheduling relevant equipment, quality control techniques, and operational parameters and by guiding subordinate workforce.

V. COURSE OUTCOMES (COs):

Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behavior that students acquire in their progress through the course. Generally 4-6 COs are defined for each course which should be focused on higher order skills. Usually, Diploma Engineering Education deals with remembering, understanding and applying. COs are started using action verbs, which should be specific, observable, measurable and can be demonstrated by students after successful completion of the course [1]. A sample of course outcomes of Chemistry (103) is given in Table III.

Table-III: Sample of course outcomes of Chemistry (103)

Course Outcomes	
CO.1	Illustrate and summarize the structure and properties of matter and phenomenon involved in Engineering.
CO.2	Classify, compare and infer some essential engineering materials.
CO.3	Describe and interpret industrial processes.
CO.4	Analyze the contents of essential raw materials utilized in industrial processes using standard procedure.
CO.5	Acquaint and adapt to essential safety measures.

VI.CO-PO MAPPING

After defining COs, they are mapped with POs. The CO-PO mapping has been done with correlation levels 1, 2, 3 and "--" for no correlation as defined below:

1. Slightly (Low)
2. Moderately (Medium)
3. Substantially (High)

--. no correlation

As an example CO-PO mapping for Chemistry (103) is given in Table IV. Hence, all CO-PO matrices from I to VI semester are developed (Table-V).

Table-IV: Sample of CO-PO mapping of Chemistry (103)

Course Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO1	PSO2	PSO3
CO103.1	**3**	**1**	**1**	**1**	**2**	**--**	**1**	1	--	1
CO103.2	**3**	**1**	**1**	**2**	**2**	**--**	**1**	1	--	1
CO103.3	**3**	**1**	**1**	**1**	**2**	**1**	**1**	1	--	1
CO103.4	**3**	**2**	**1**	**2**	**2**	**2**	**1**	1	--	1
CO103.5	**3**	**1**	**1**	**2**	**2**	**2**	**2**	1	--	1
CO103	**3**	**1**	**1**	**2**	**2**	**1**	**1**	1	--	1

Table-V: Program Level CO-PO Matrix including all Courses of Diploma in Mechanical Engineering Program

S. No	Subject Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
1	101	-	-	3	2	2	3	2	3	-	2
2	102	3	3	2	3	3	3	2	3	-	-
3	103	3	1	1	2	2	1	1	1	-	1
4	104	3	3	3	3	3	3	3	3	3	2
5	201	3	3	2	3	2	2	3	3	2	2
6	202	2	3	-	3	3	2	3	3	-	3
7	203	3	2	2	2	3	2	3	3	2	2
8	204	3	3	3	-	-	2	3	3	2	-
9	205	2	2	3	3	2	3	3	2	2	3
10	301	3	2	2	-	2	-	2	3	-	2
11	302	3	2	3	2	2	3	3	3	-	1
12	303	3	3	2	3	2	-	3	3	-	1
13	304	3	2	3	2	2	3	3	3	3	1
14	305	3	3	-	2	3	-	3	3	2	3
15	401	3	3	2	3	3	2	3	3	-	3
16	402	3	3	-	3	3	1	3	3	-	3
17	403	3	2	3	2	-	2	3	2	2	2
18	404	2	2	2	-	2	3	3	-	-	3
19	411	-	-	-	-	2	2	3	-	-	2
20	501	3	3	-	-	2	3	3	-	-	2
21	502	2	2	2	3	-	-	2	3	-	2
22	503	3	3	3	3	3	2	3	3	2	3
23	504	2	2	2	3	2	2	2	2	3	3
24	505	3	3	2	2	2	2	2	2	-	3
25	601	3	3	3	-	2	2	2	3	3	-
26	611	2	3	2	3	3	2	3	3	-	3
27	621	2	2	2	2	2	-	3	2	-	2
28	604	3	3	3	3	3	3	3	3	2	3

VII. CO ATTAINMENT

CO attainment is solely measured by direct measurement methods[1,24,25,26]. It may be in terms of student's performance in external assessments ie. University examination and student's performance in internal assessments such as term work (tutorials, assignments, quizes etc), lab work (laboratory tests, oral examinations, quizzes etc.), progressive tests, project evaluation, project presentations etc. The flow chart of Course Outcome Assessment is given in Fig.2.

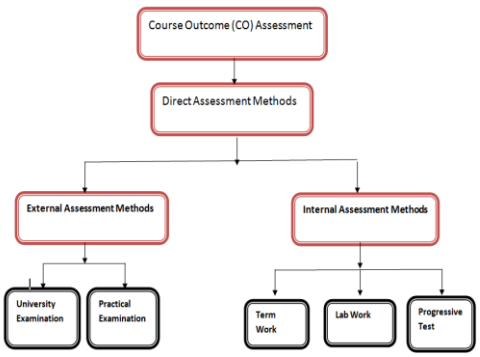

Fig.2. Flow chart of course outcome assessment

University or Board provides teaching scheme for each semester, which includes the components of assessment tools viz. theory exam, practical exam, progressive tests, lab work and term work along with the maximum marks allotted for each component. As an example distribution of marks by RGPV, Bhopal has been shown in Table-V.

Table-V: Overall % Distribution of marks as per scheme

Direct assessment	University examination		Internal assessment			
	Theory Exam	Practical Exam	Term work	Lab Work	Progressive Test	
Total Marks	70	30	10	20	20	150
Overall Marks	100		50			
Overall %	*66.6≈70		*33.3 ≈30			100
Multyplying factor	.7		.3			1

*For convenience percentage of marks have been rounded

With the help of Table-V, percentage distribution of marks for external assessment and internal assessment can be calculated, which are shown in Table VI and Table VII.

Table-VI:% Distribution of marks in External assessment

Direct assessment	University Examination		
	Theory Exam	Practical Exam	Total
Total Marks	70	30	100
Overall%	70	30	100
Multiplying factor	.7	.3	1

Table VII -% Distribution of marks in Internal assessment

Direct assessment	Progressive Test	Lab Work	Term work	Total
Marks	20	20	10	50
%	40	40	20	100
Multiplying factor	.4	.4	.2	1

The percentage of CO from assessment tools is designed accordingly by course coordinator considering the weightage distribution of marks allotted in teaching scheme for the course. For example percentage of CO for different assessment tools is assigned for each specified CO for Chemistry is shown in Table VIII.

Table-VIII: Percentage of CO for different assessment tools for Chemistry

CO	CO1%	CO2%	CO3%	CO4%	CO5%	Total
Theory Examination (TE)	26	29	22	16	7	100
Practical Examination (PE)	0	0	26	64	10	100
Term Work (TW)	30	30	10	20	10	100
Progressive test (PT)	15	30	20	20	15	100
Lab work (LW)	20	20	20	30	10	100

The overall percentage distribution of marks for direct assessment methods as per examination scheme is shown in Table V, assuming 70% weightage to University examination (TE and PE) and 30% weightage to Internal Assessment (TW, LW and PT). This measurement method is further used to calculate final CO attainment. Based on the % CO distribution of marks, as per teaching and examination scheme of University, CO attainment can be obtained. For example the final CO attainment using Table-V, Table-VI, Table-VII and Table-VIII is calculated as following:

(I) External Attainment :
CO(N*)= 0.7* (Theory Marks)*CO(N)% + 0.3*(Practical Marks)*CO(N)%

(II) Internal Attainment:
CO(N*)=0.2*(TWMarks)CO(N)%+0.4(ProgressiveTestmarks)CO(N)%+0.4(LW Marks)CO(N)%
(*Where "N" is the no. of course outcome for which attainment level has to be calculated)

(III) Total Attainment :
After calculating the 'CO' attainment percentage for individual element, average of 'External' and 'Internal ' attainment calculated by taking average of all CO elements attainment percentage. The 'Total Attainment' of the subject calculated by :
Total Attainment = 0.7(Average External Attainment) +0.3(Average Internal Attainment)

As per Table-VI and Table-VIII, External CO attainment of different COs for Chemistry will be as follows:

CO1= (0.7* Th)*0.26+ (0.3*Pr)*0.00
CO2= (0.7* Th)*0.29+ (0.3*Pr)*0.00
CO3= (0.7* Th)*0.22+ (0.3*Pr)*0.26
CO4= (0.7* Th)*0.16+ (0.3*Pr)*0.64
CO5= (0.7* Th)*0.07+ (0.3*Pr)*0.10

As per Table-VII and Table-VIII, Internal CO attainment of different COs for Chemistry will be as follows **:**

CO1= (0.4* PT)*0.15+ (0.4*LW)*0.20+ (0.2* TW)*0.30
CO2= (0.4* PT)*0.30+ (0.4*LW)*0.20+ (0.2* TW)*0.30
CO3= (0.4* PT)*0.20+ (0.4*LW)*0.20+ (0.2* TW)*0.20
CO4= (0.4* PT)*0.20+ (0.4*LW)*0.30+ (0.2* TW)*0.10
CO5= (0.4* PT)*0.15+ (0.4*LW)*0.10+ (0.2* TW)*0.10

Retrieval Number: D9070019420/2020©BEIESP
DOI: 10.35940/ijitee.D9070.029420
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Table-IX: Calculation of External CO attainment

External CO Attainment

Student's Name	TR	Theory	TW	M/N	PT	M/N	Act. Theory	M/N	LW	M/N	Practical	M/N	CO1	M/N	CO2	M/N	CO3	M/N	CO4	M/N	CO5	M/N
1	7	70	7	1	14	1	56	1	16	1	23	1	10.192	1	11.368	1	10.418	1	10.688	1	3.434	1
2	8	80	8	1	15	1	65	1	17	1	24	1	11.83	1	13.195	1	11.882	1	11.888	1	3.905	1
3	7	70	7	1	13	1	57	1	16	1	25	1	10.374	1	11.571	1	10.728	1	11.184	1	3.543	1
4	7	70	7	1	16	1	54	1	15	1	27	1	9.828	1	10.962	1	10.422	1	11.232	1	3.456	1
5	6	60	7	1	15	1	45	1	14	1	23	1	8.19	1	9.135	1	8.724	1	9.456	1	2.895	1
6	8	80	8	1	17	1	63	1	16	1	27	1	11.466	1	12.789	1	11.808	1	12.24	1	3.897	1
7	8	80	8	1	17	1	63	1	17	1	25	1	11.466	1	12.789	1	11.652	1	11.856	1	3.837	1
8	0	0	8	1	16	1	0	0	17	1	27	1	0	0	0	0	2.106	0	5.184	0	0.81	0
9	5	50	6	1	12	1	38	1	15	1	25	1	6.916	1	7.714	1	7.802	1	9.056	1	2.612	1
10	5	50	4	0	2	0	48	1	12	1	12	1	8.736	1	9.744	1	8.328	1	7.68	0	2.712	1
11	7	70	8	1	16	1	54	1	17	1	26	1	9.828	1	10.962	1	10.344	1	11.04	1	3.426	1
12	7	70	8	1	17	1	53	1	17	1	27	1	9.646	1	10.759	1	10.268	1	11.12	1	3.407	1
13	7	70	8	1	17	1	53	1	18	1	27	1	9.646	1	10.759	1	10.268	1	11.12	1	3.407	1
14	7	70	9	1	18	1	52	1	18	1	28	1	9.464	1	10.556	1	10.192	1	11.2	1	3.388	1
15	6	60	6	1	15	1	45	1	14	1	26	1	8.19	1	9.135	1	8.958	1	10.032	1	2.985	1
16	8	80	9	1	18	1	62	1	18	1	28	1	11.284	1	12.586	1	11.732	1	12.32	1	3.878	1
17	4	40	4	0	1	0	39	1	4	0	12	1	7.098	1	7.917	1	6.942	1	6.672	0	2.271	1
18	7	70	8	1	17	1	53	1	18	1	27	1	9.646	1	10.759	1	10.268	1	11.12	1	3.407	1
19	6	60	8	1	16	1	44	1	16	1	21	1	8.008	1	8.932	1	8.414	1	8.96	1	2.786	1
20	7	70	9	1	16	1	54	1	18	1	27	1	9.828	1	10.962	1	10.422	1	11.232	1	3.456	1
21	7	70	8	1	15	1	55	1	16	1	25	1	10.01	1	11.165	1	10.42	1	10.96	1	3.445	1
22	5	50	4	0	1	0	49	1	6	0	18	1	8.918	1	9.947	1	8.95	1	8.944	1	2.941	1
23	6	60	8	1	17	1	43	1	17	1	26	1	7.826	1	8.729	1	8.65	1	9.808	1	2.887	1
24	4	40	4	0	2	0	38	1	6	0	10	0	6.916	1	7.714	1	6.632	1	6.176	0	2.162	1
25	4	40	6	1	2	0	38	1	6	0	12	1	6.916	1	7.714	1	6.788	1	6.56	0	2.222	1
26	0	0	6	1	13	1	0	0	13	1	24	1	0	0	0	0	1.872	0	4.608	0	0.72	0
27	7	70	8	1	18	1	52	1	18	1	28	1	9.464	1	10.556	1	10.192	1	11.2	1	3.388	1
28	6	60	6	1	13	1	47	1	14	1	25	1	8.554	1	9.541	1	9.188	1	10.064	1	3.053	1
29	6	60	8	1	18	1	42	1	17	1	26	1	7.644	1	8.526	1	8.496	1	9.696	1	2.838	1
30	6	60	7	1	16	1	44	1	17	1	26	1	8.008	1	8.932	1	8.804	1	9.92	1	2.936	1
31	8	80	8	1	18	1	62	1	18	1	28	1	11.284	1	12.586	1	11.732	1	12.32	1	3.878	1
32	6	60	5	1	8	0	52	1	9	0	26	1	9.464	1	10.556	1	10.036	1	10.816	1	3.328	1
33	6	60	8	1	17	1	43	1	18	1	26	1	7.826	1	8.729	1	8.65	1	9.808	1	2.887	1
34	7	70	6	1	14	1	56	1	16	1	25	1	10.192	1	11.368	1	10.574	1	11.072	1	3.494	1
35	8	80	8	1	17	1	63	1	18	1	25	1	11.466	1	12.789	1	11.652	1	11.856	1	3.837	1
36	7	70	8	1	17	1	53	1	16	1	25	1	9.646	1	10.759	1	10.112	1	10.736	1	3.347	1
37	6	60	7	1	14	1	46	1	15	1	25	1	8.372	1	9.338	1	9.034	1	9.952	1	3.004	1
38	9	90	8	1	17	1	73	1	16	1	28	1	13.286	1	14.819	1	13.426	1	13.552	1	4.417	1
39	8	80	8	1	17	1	63	1	17	1	22	1	11.466	1	12.789	1	11.418	1	11.28	1	3.747	1
40	7	70	8	1	16	1	54	1	16	1	25	1	9.828	1	10.962	1	10.266	1	10.848	1	3.396	1
41	8	80	8	1	17	1	63	1	17	1	26	1	11.466	1	12.789	1	11.73	1	12.048	1	3.867	1
42	6	60	7	1	10	1	50	1	14	1	15	1	9.1	1	10.15	1	8.87	1	8.48	1	2.9	1
43	6	60	7	1	15	1	45	1	14	1	24	1	8.19	1	9.135	1	8.802	1	9.648	1	2.925	1
44	6	60	7	1	14	1	46	1	15	1	25	1	8.372	1	9.338	1	9.034	1	9.952	1	3.004	1
45	8	80	8	1	17	1	63	1	17	1	25	1	11.466	1	12.789	1	11.652	1	11.856	1	3.837	1
46	5	50	4	0	2	0	48	1	5	0	12	1	8.736	1	9.744	1	8.328	1	7.68	0	2.712	1
47	5	50	8	1	17	1	33	1	16	1	24	1	6.006	1	6.699	1	6.954	1	8.304	0	2.337	1
48	8	80	8	1	16	1	64	1	18	1	27	1	11.648	1	12.992	1	11.962	1	12.352	1	3.946	1
49	6	60	4	0	9	0	51	1	7	0	12	1	9.282	1	10.353	1	8.79	1	8.016	0	2.859	1
50	8	80	8	1	17	1	63	1	17	1	27	1	11.466	1	12.789	1	11.808	1	12.24	1	3.897	1
51	7	70	7	1	14	1	56	1	16	1	25	1	10.192	1	11.368	1	10.574	1	11.072	1	3.494	1
52	7	70	8	1	14	1	56	1	16	1	25	1	10.192	1	11.368	1	10.574	1	11.072	1	3.494	1
53	6	60	6	1	12	1	48	1	14	1	21	1	8.736	1	9.744	1	9.03	1	9.408	1	2.982	1
54	8	80	8	1	17	1	63	1	17	1	28	1	11.466	1	12.789	1	11.886	1	12.432	1	3.927	1
55	7	70	8	1	13	1	57	1	14	1	22	1	10.374	1	11.571	1	10.494	1	10.608	1	3.453	1
56	8	80	8	1	15	1	65	1	16	1	26	1	11.83	1	13.195	1	12.038	1	12.272	1	3.965	1
57	0	0	7	1	16	1	0	0	17	1	24	1	0	0	0	0	1.872	0	4.608	0	0.72	0
58	6	60	8	1	16	1	44	1	16	1	26	1	8.008	1	8.932	1	8.804	1	9.92	1	2.936	1
59	7	70	8	1	16	1	54	1	15	1	25	1	9.828	1	10.962	1	10.266	1	10.848	1	3.396	1
													9.0692	56	10.116	56	9.5261	56	10.14	49	3.1541	56
													5.096	94%	4.116	94%	5.248	94.00%	8.416	83.00%	1.73	94%
													70% CO	65.80%		65.80%		65.80%		58.10%		65.80%

Here, M means met - when student scores 40% marks or more =1
N means not met - when student scores less than 40% marks =0

Table-X: Calculation for Internal CO attainment

Internal CO attainment																						
Student's Name	TR	Theory	TW	M/N	PT	M/N	t. Theo	M/N	LW	M/N	Pract	M/N	CO1	M/N	CO2	M/N	CO3	M/N	CO4	M/N	CO5	M/N
1	7	70	7	1	14	1	56	1	16	1	23	1	2.54	1	3.38	1	2.54	1	3.32	1	1.62	1
2	8	80	8	1	15	1	65	1	17	1	24	1	2.74	1	3.64	1	2.72	1	3.56	1	1.74	1
3	7	70	7	1	13	1	57	1	16	1	25	1	2.48	1	3.26	1	2.46	1	3.24	1	1.56	1
4	7	70	7	1	16	1	54	1	15	1	27	1	2.58	1	3.54	1	2.62	1	3.36	1	1.7	1
5	6	60	7	1	15	1	45	1	14	1	23	1	2.44	1	3.34	1	2.46	1	3.16	1	1.6	1
6	8	80	8	1	17	1	63	1	16	1	27	1	2.78	1	3.8	1	2.8	1	3.6	1	1.82	1
7	8	80	8	1	17	1	63	1	17	1	25	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
8	0	0	8	1	16	1	0	0	17	1	27	1	2.8	1	3.76	1	2.8	1	3.64	1	1.8	1
9	5	50	6	1	12	1	38	1	15	1	25	1	2.28	1	3	1	2.28	1	3	1	1.44	1
10	5	50	4	0	2	0	48	1	12	1	12	1	1.32	0	1.44	0	1.2	0	1.76	0	0.68	0
11	7	70	8	1	16	1	54	1	17	1	26	1	2.8	1	3.76	1	2.8	1	3.64	1	1.8	1
12	7	70	8	1	17	1	53	1	17	1	27	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
13	7	70	8	1	17	1	53	1	18	1	27	1	2.94	1	3.96	1	2.96	1	3.84	1	1.9	1
14	7	70	9	1	18	1	52	1	18	1	28	1	3.06	1	4.14	1	3.06	1	3.96	1	1.98	1
15	6	60	6	1	15	1	45	1	14	1	26	1	2.38	1	3.28	1	2.44	1	3.12	1	1.58	1
16	8	80	9	1	18	1	62	1	18	1	28	1	3.06	1	4.14	1	3.06	1	3.96	1	1.98	1
17	4	40	4	0	1	0	39	1	4	0	12	1	0.62	0	0.68	0	0.48	0	0.72	0	0.3	0
18	7	70	8	1	17	1	53	1	18	1	27	1	2.94	1	3.96	1	2.96	1	3.84	1	1.9	1
19	6	60	8	1	16	1	44	1	16	1	21	1	2.72	1	3.68	1	2.72	1	3.52	1	1.76	1
20	7	70	9	1	16	1	54	1	18	1	27	1	2.94	1	3.9	1	2.9	1	3.8	1	1.86	1
21	7	70	8	1	15	1	55	1	16	1	25	1	2.66	1	3.56	1	2.64	1	3.44	1	1.7	1
22	5	50	4	0	1	0	49	1	6	0	18	1	0.78	0	0.84	0	0.64	0	0.96	0	0.38	0
23	6	60	8	1	17	1	43	1	17	1	26	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
24	4	40	4	0	2	0	38	1	6	0	10	0	0.84	0	0.96	0	0.72	0	1.04	0	0.44	0
25	4	40	6	1	2	0	38	1	6	0	12	1	0.96	0	1.08	0	0.76	0	1.12	0	0.48	0
26	0	0	6	1	13	1	0	0	13	1	24	1	2.18	1	2.96	1	2.2	1	2.84	1	1.42	1
27	7	70	8	1	18	1	52	1	18	1	28	1	3	1	4.08	1	3.04	1	3.92	1	1.96	1
28	6	60	6	1	13	1	47	1	14	1	25	1	2.26	1	3.04	1	2.28	1	2.96	1	1.46	1
29	6	60	8	1	18	1	42	1	17	1	26	1	2.92	1	4	1	2.96	1	3.8	1	1.92	1
30	6	60	7	1	16	1	44	1	17	1	26	1	2.74	1	3.7	1	2.78	1	3.6	1	1.78	1
31	8	80	8	1	18	1	62	1	18	1	28	1	3	1	4.08	1	3.04	1	3.92	1	1.96	1
32	6	60	5	1	8	0	52	1	9	0	26	1	1.5	0	1.98	0	1.46	0	1.92	0	0.94	0
33	6	60	8	1	17	1	43	1	18	1	26	1	2.94	1	3.96	1	2.96	1	3.84	1	1.9	1
34	7	70	6	1	14	1	56	1	16	1	25	1	2.48	1	3.32	1	2.52	1	3.28	1	1.6	1
35	8	80	8	1	17	1	63	1	18	1	25	1	2.94	1	3.96	1	2.96	1	3.84	1	1.9	1
36	7	70	8	1	17	1	53	1	16	1	25	1	2.78	1	3.8	1	2.8	1	3.6	1	1.82	1
37	6	60	7	1	14	1	46	1	15	1	25	1	2.46	1	3.3	1	2.46	1	3.2	1	1.58	1
38	9	90	8	1	17	1	73	1	16	1	28	1	2.78	1	3.8	1	2.8	1	3.6	1	1.82	1
39	8	80	8	1	17	1	63	1	17	1	22	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
40	7	70	8	1	16	1	54	1	16	1	25	1	2.72	1	3.68	1	2.72	1	3.52	1	1.76	1
41	8	80	8	1	17	1	63	1	17	1	26	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
42	6	60	7	1	10	1	50	1	14	1	15	1	2.14	1	2.74	1	2.06	1	2.76	1	1.3	1
43	6	60	7	1	15	1	45	1	14	1	24	1	2.44	1	3.34	1	2.46	1	3.16	1	1.6	1
44	6	60	7	1	14	1	46	1	15	1	25	1	2.46	1	3.3	1	2.46	1	3.2	1	1.58	1
45	8	80	8	1	17	1	63	1	17	1	25	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
46	5	50	4	0	2	0	48	1	5	0	12	1	0.76	0	0.88	0	0.64	0	0.92	0	0.4	0
47	5	50	8	1	17	1	33	1	16	1	24	1	2.78	1	3.8	1	2.8	1	3.6	1	1.82	1
48	8	80	8	1	16	1	64	1	18	1	27	1	2.88	1	3.84	1	2.88	1	3.76	1	1.84	1
49	6	60	4	0	9	0	51	1	7	0	12	1	1.34	0	1.88	0	1.36	0	1.72	0	0.9	0
50	8	80	8	1	17	1	63	1	17	1	27	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
51	7	70	7	1	14	1	56	1	16	1	25	1	2.54	1	3.38	1	2.54	1	3.32	1	1.62	1
52	7	70	8	1	14	1	56	1	16	1	25	1	2.6	1	3.44	1	2.56	1	3.36	1	1.64	1
53	6	60	6	1	12	1	48	1	14	1	21	1	2.2	1	2.92	1	2.2	1	2.88	1	1.4	1
54	8	80	8	1	17	1	63	1	17	1	28	1	2.86	1	3.88	1	2.88	1	3.72	1	1.86	1
55	7	70	8	1	13	1	57	1	14	1	22	1	2.38	1	3.16	1	2.32	1	3.04	1	1.5	1
56	8	80	8	1	15	1	65	1	16	1	26	1	2.66	1	3.56	1	2.64	1	3.44	1	1.7	1
57	0	0	7	1	16	1	0	0	17	1	24	1	2.74	1	3.7	1	2.78	1	3.6	1	1.78	1
58	6	60	8	1	16	1	44	1	16	1	26	1	2.72	1	3.68	1	2.72	1	3.52	1	1.76	1
59	7	70	8	1	16	1	54	1	15	1	25	1	2.64	1	3.6	1	2.64	1	3.4	1	1.72	1
													2.47	51	3.31	51	2.459	51	3.2	51	1.581	51
													1.7	86.40%	2.3	86.40%	1.7	86.40%	2.2	86.40%	1.1	86.40%

Here, M means met - when student scores 50% marks or more =1
N means not met - when student scores less than 50% marks =0

Table XI: Total CO attainment for Chemistry

Attainment tool	CO-1	CO-2	CO-3	CO-4	CO-5
University Examination	94	94	94	83	94
Internal assessment	86.40	86.40	86.40	86.40	86.40
70% of University Examination	65.80	65.80	65.80	58.10	65.80
30% of Internal assessment	25.92	25.92	25.92	25.92	25.92
Overall %CO attainment	91.72	91.72	91.72	84.02	91.72
Attainment Level	3	3	3	3	3
Mapped PO	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7

The % CO attainment for Chemistry course is calculated from the above normalized formula by using marks scored by the entire class in Theory exam, Practical exam, Term work, Lab work and Progressive test as shown in Table-IX, Table-X and Table-XI.

To measure the external attainment level of each CO, it is compared with 40% as the minimum marks for completion of course is 40, while for internal assessment attainment level of each course outcome,
it is compared with 50%.

The different attainment levels considered are as below:

Target level for External Assessment:

Attainment Level 1: If 50% students get 40 % or more marks

Attainment Level 2: If 51-60% students get 40 % or more marks

Attainment Level 3: If more than 60% students get 40 % or more marks

Target level for Internal Assessment:

Attainment Level 1: If 50% students get 50 % or more marks

Attainment Level 2: If 51-60% students get 50 % or more marks

Attainment Level 3: If more than 60% students get 50 % or more mark

VIII. PROGRAM OUTCOME ATTAINMENT

Program Outcome attainment is calculated by both direct attainment method and indirect attainment method. For the overall PO attainment, 80% weightage is given to direct assessment and 20% weightage is given to indirect assessment by NBA [1].

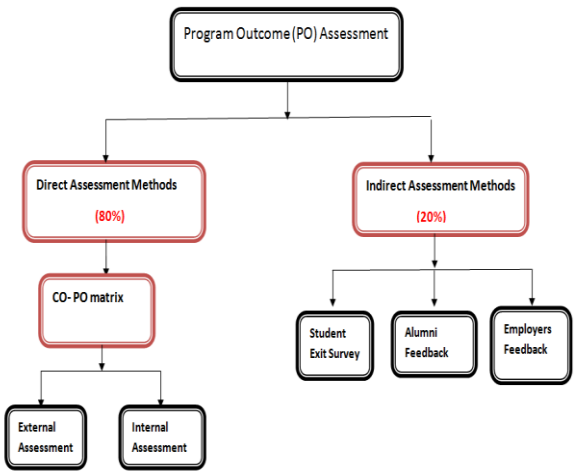

Fig. 3.Flow Chart of Program Outcome Assessment

A. Direct Attainment of PO

PO attainment through direct assessment is done by developing CO-PO matrix of different courses. CO-PO matrix of Chemistry is developed with the help of Table-XI. From the Table-XI the average attainment of all the POs for the selected course are calculated [26]. The average attainment of all the POs for Chemistry is shown in Table-XII.

TableXII: Average attainment level for CO-PO Matrix for Chemistry

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO103.1	3	3	3	3	3	--	3
CO103.2	3	3	3	3	3	--	3
CO103.3	3	3	3	3	3	3	3
CO103.4	3	3	3	3	3	3	3
CO103.5	3	3	3	3	3	3	3
CO 103	**3**	**3**	**3**	**3**	**3**	**3**	**3**

PO attainment through direct assessment is depicted in Table-XII; Similarly the average attainment levels for all the courses from I to VI semester are calculated and then average of attainment level of all courses is taken to calculate average attainment of PO of Program .

B. Indirect Attainment of PO:

PO attainment through indirect assessment is done by different assessment tools. Some possible assessment tools are:

1. **Student Exit Surveys***:* These surveys are taken in the final semester i.e. VI semester, by the student of Final year.
2. **Alumni Feedback***:* Alumni, particularly the student who has completed diploma within the 2-3 years of current academic year, feedback is taken with reference to the achievement of POs.
3. **Employers Feedback***:* A written feedback is taken from the industries for the performance of students, those who has undergone vocational/summer training and internship in the industries as well as who got the jobs in the industries.

Table-XIII: Indirect Assessment Tools

Indirect Assessment Tools	
Alumni Feedback	To Collect variety of information about program satisfaction and success from Alumni.
Employer/ Industry Feedback	To Provide information about our diploma students, skills and capability.
Student Exit Survey	To assess the success of program through feedback and discussions done to achieve the POs.

In the feedback/survey form, responses are noted as strongly agree, agree, average and convert it into score based on 1-3 scale. As an example Alumni feedback form is given here:

Alumni Feedback Form

Dear Alumni,

It is our pleasure to note that you have successfully completed your diploma from this institute .We hope that you have assimilated all that is required for your successful career. Kindly give your response on the following outcomes you have gained through your three year diploma program. During your job, have you been able to:

Fig.4. Sample of Alumni's Feedback Form

S. No	Outcome	Strongly agree	Agree	Average
1.	Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.			
2.	Identify and analyse well-defined engineering problems using codified standard methods.			
3.	Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.			
4.	Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.			
5.	Apply appropriate technology in context of society, sustainability, environment and ethical practices.			
6.	Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.			
7.	Ability to analyse individual needs and engage in updating in the context of technological changes.			
8.	Plan and supervise maintenance activities of mechanical engineering instrument and machines.			
9.	Use simple CAD/CAM software for mechanical engineering applications in drafting, design and manufacturing.			
10.	Manage mechanical engineering processes by selecting and scheduling relevant equipment, quality control techniques, and operational parameters and by guiding subordinate workforce.			

Note: To give your response, please tick (✔) appropriate box in front of each outcome.
Name:

Year of completing Diploma:

Name of the organization (Currently working with):

Surveys from the stakeholders reflect on student's overall learning during the program. They assess opinions about the diploma holder's knowledge or skills. PAC collects the feedback on POs from the Alumni, Employer and Industry, then analyses the collected data. If the assessment meets the performance targets the outcome is attained. Otherwise, corrective actions are initiated. The outline of indirect attainment processes of assessment, evaluation and documentation is done by PA in regular interval.

Table-XIV: indirect PO attainment processes

Assessment Tool	Assessment frequency	Assessed by	Reviewed by
POs Assessment Report	Yearly	PAC	PAC & DAB Members
Alumni Feedback	Every Years	PAC	PAC & DAB Members
Employer Feedback	Every Years	TPO	PAC & DAB Members
Student Exit Survey	Every Year	TPO	PAC & DAB Members

*PAC – Program Assessment Committee, DAB – Departmental Advisory Board

Data collected for an academic year is given and analysed below:

Table-XV: % PO attainment by Alumni's Response Sheet

S.No.	Outcome	Strongly Agree	Agree	Average	PO%
1.	PO1	10	10	0	83%
2.	PO2	8	8	4	73%
3.	PO3	6	10	4	70%
4.	PO4	7	7	6	68%
5.	PO5	10	8	2	77%
6.	PO6	9	8	3	75%
7.	PO7	10	7	3	78%
8.	PSO1	7	8	5	70%
9.	PSO2	6	8	6	67%
10.	PSO3	8	7	5	72%

(Sample Size-20)

Table -XVI, enumerates the average of indirect attainment of POs for Mechanical Engineering Program, here the Students/Alumni/Employers have filled the form as per their responses.

Table-XVI: Average Indirect Attainment of Pos

S. No.	Out come	Alumni Response	Student's Response	Employer Response	Averag	Attainment
1.	PO1	83%	81%	67%	77%	2.31
2.	PO2	73%	64%	75%	71%	2.13
3.	PO3	70%	64%	58%	64%	1.92
4.	PO4	68%	69%	75%	71%	2.13
5.	PO5	77%	72%	83%	77%	2.31
6.	PO6	75%	78%	75%	76%	2.28
7.	PO7	78%	72%	75%	75%	2.25
8.	PSO1	70%	61%	83%	71%	2.13
9.	PSO2	67%	64%	50%	60%	1.8
10.	PSO3	72%	70%	83%	75%	2.25

IX. RESULT AND DISCUSSION

OBE is central to NBA accreditation. PO attainment is an important tool in OBE which provides a yardstick to determine how far a program has been successful. The PO attainment is thoroughly checked by NBA expert team during visit.

As stated earlier, PO attainment is calculated by both direct attainment method and indirect attainment method. For calculating total PO attainment, 80% weightage is given to direct assessment and 20% weightage is given to indirect assessment by NBA [1].

i.e., Total PO Attainment = (80% of DA) + (20% of IA)

Table-XVII is used to tabulate the results of direct and indirect attainments and hence to assess the overall attainment of POs. The attainment level is calculated by converting percentage PO attainment to 1-3 scale.

For any particular program, PAC and program coordinator have to set the targets for POs and PSOs. If the targets are not achieved then gap analysis is to be performed. They suggest faculty to bridge gaps, shortfalls or need for improvements if any required. Continuous improvement in PO attainment is desired. Hence, IQAC has to closely monitor PO attainment. If PO attainment is not achieved, course coordinator has to specify which cos were not achieved successfully and action plan to achieve them next year. If the targets are achieved then higher targets are fixed for next year so that quality and standards of education can be enhanced. That's why accreditation is a continuous process.

Process followed for overall PO attainment is shown in Fig.5.

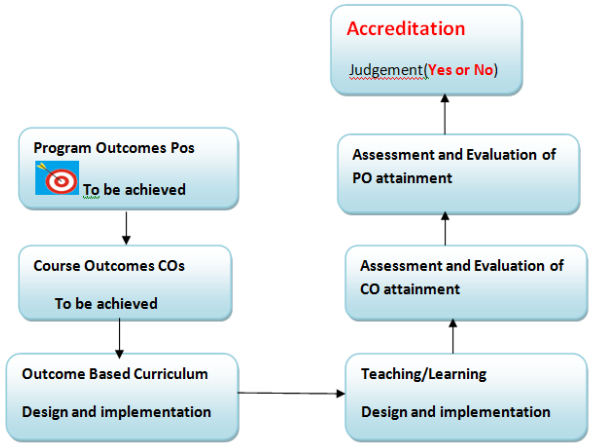

Fig.5. Assessment and evaluation of PO attainment.

Table-XVII: Overall PO Attainment

Attainment/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
Direct Attainment(%)	65.48	68.54	69.76	68.79	65.53	68.43	67.14	51.88	45.00	43.33
Indirect Attainment(%)	77	71	74	71	77	76	75	71	60	75
Total PO Attainment (%)	67.78	69.03	70.60	69.232	67.82	69.94	68.71	55.70	48.00	49.67
Attainment level	2.03	2.07	2.12	2.08	2.03	2.10	2.06	1.67	1.44	1.49
Satisfactory attainment level*	2	2	2	2	2	2	2	1	1	1
PO attained	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* Fixed by PAC

PAC of mechanical engineering program has set satisfactory PO attainment level '2' for POs and '1' for PSOs. Since this satisfactory level has been attained for all POs and PSOs, PO attained is marked as YES for all POs and PSOs in Table-XVII. In the table, for PO-1, direct attainment is 64.48% (Calculated from CO attainment) and indirect attainment is 77% (Calculated from surveys). As stated earlier total PO attainment is calculated by adding 80% of DA and 20% of IA. As a result, total attainment for PO-1 is 67.78% which is 2.03 on a scale of 3. Since it is higher than 2, it is achieved. Similarly all other POs have been analysed. As stated earlier, If PO attainment is not achieved, course coordinator has to specify which COs were not achieved successfully and action plan to achieve them next year.

X. CONCLUSION

OBE has become a central feature in accreditation of the technical education programs. Implementation of OBE in any educational institute require to first determine the desired outcome, then plan content delivery, assessment procedure and facilities required. This paper provides an appropriate method for calculating the attainment of Course outcome and program outcomes in line with the guideline outlined by NBA. Sample calculation for CO-PO attainment is given in the paper. The direct assessment method (internal and external exam result) is used for the CO attainment. PO attainment is calculated by both direct assessment method and indirect assessment method (various surveys). The Program outcome assessment matrix indicates which course may be modified, and course assessment matrix for each course indicates areas that need to strengthen. Hence, OBE is an important instrument to assess student's performance through their regular assessment by using different assessment tools/methods.

The accreditation of two programs of our institute by NBA is an important indication of the appropriateness of the methods applied to achieve this goal. We hope that our experiences will help the new programs for accreditation and provide a clear idea for calculating their CO attainment and PO attainments as well as monitoring the students' performance. In view of the authors, it takes around 3 years to prepare to apply for NBA accreditation. Involvement of entire institution and true team work are vital to attain success in NBA accreditation.

Literature survey suggests that there is a limited research on NBA accreditation in India.

Further scope for research includes strategies for continuous improvement, role of faculty in NBA accreditation, role of stake holders, feedback system, industry institute interaction, mentoring system, strategies to enhance student performance, implementation of OBE and reorientation of curriculum from OBE point of view etc.

ACKNOLEDGMENT

We would like to thank the editor and anonymous reviewers for their support. The authors gratefully acknowledge the support provided by their affiliated institution, Principal, Department of Mechanical Engineering and Department of Electrical Engineering during the study.

REFERENCES:

1. https://www.nbaind.org/files/general-manual-of-accreditation.pdf
2. https://www.aspiringminds.com/research-reports/national-employability-report-for-engineers-2019/
3. Venkatesh P. Accreditation as a Benchmark of Quality Sustenance in Higher Education: A Review of Quality Assurance in Indian University System. Nitte Management Review. 2013 Jul 7;7(1):59-67.
4. https://www.nbaind.org/files/obe-and-nba-accreditation.pdf
5. http://accreditation.org/accords/washington-accord-1989
6. International Engineering Alliance (Washing Accord) [retrieved from http://www.washingtonaccord.org/Washington-Accord/signatories.cfm).
7. Stefan Becker F. Globalization, curricula reform and the consequences for engineers working in an international company. European Journal of Engineering Education. 2006 Jun 1;31(3):261-72.
8. Chowdhury H, Alam F, Biswas SK, Islam MT, Islam AS. Quality assurance and accreditation of engineering education in Bangladesh. Procedia Engineering. 2013 Jan 1;56:864-9.
9. Jaafar MS, Nordin NK, Wagiran R, Aziz A, Noor MJ, Osman MR, Noorzaei J, Abdulaziz FN. Assessment strategy for an outcome based education. InInternational Conference on Engineering Education 2008 Jul.
10. Spady WG. Outcome-Based Education: Critical Issues and Answers. American Association of School Administrators, 1801 North Moore Street, Arlington, VA 22209 (Stock No. 21-00488; $18.95 plus postage).; 1994.
11. Killen R. Outcomes-based education: Principles and possibilities. Unpublished manuscript, University of Newcastle, faculty of education. 2000 Aug.
12. Malan SP. The 'new paradigm' of outcomes-based education in perspective. Journal of Consumer Sciences. 2000;28(1).
13. Brandt R. On outcome-based education: A conversation with Bill Spady. Educational Leadership. 1992 Dec;50:66.
14. Ezeldin AS. International accreditation for engineering programs: Mission, learning objectives and outcomes. Procedia-Social and Behavioral Sciences. 2013 Nov 22;102:267-75.
15. Al-Twaijry HA, Mekhallalati MC, Abachi HR, Muhammad G. A rubrics based quality improvement methodology for ABET accreditation. International Journal of Engineering Education. 2012 Jan 1;28(6):1266.
16. Tanke ML. Accreditation: What It Is… and Is Not. Hospitality Review. 1985;3(1):5.
17. Al-Yahya SA, Abdel-Halim MA. A successful experience of ABET accreditation of an electrical engineering program. IEEE Transactions on Education. 2012 Jul 18;56(2):165-73.
18. Shearman R, Seddon D. Challenges for academic accreditation: the UK experience. European Journal of Engineering Education. 2010 Aug 1;35(4):469-77.
19. Min KJ, Jackman JK, Gemmill DD. Assessment and Evaluation of Objectives and Outcomes for Continuous Improvement of an Industrial Engineering Program. International Journal of Engineering Education. 2013;29(2):520.
20. Heitmann G. Quality assurance in German engineering education against the background of European developments. International Journal of Engineering Education. 2000 Jan 1;16(2):117-26.
21. Turhan C, Sengul G, Koyuncu M. A Comprehensive Assessment Plan for Accreditation in Engineering Education: A Case Study in Turkey. International Journal of Engineering Education. 2015 Jan 1;31(2015):1270-81.
22. Augusti G. Quality and accreditation in engineering education in Europe. InProceedings. International Symposium on Innovation and Quality in Engineering Education. Valladolid (Spain) 2012 Apr (pp. 26-28).
23. Rajak A, Shrivastava AK, Bhardwaj S, Tripathi AK. Assessment and Attainment of Program Educational Objectives for Post Graduate Courses [J]. International Journal of Modern Education & Computer Science. 2019 Feb 1;2:26-32..
24. https://www.nbaind.org/files/co-po-mapping-and-attainment-of-cos-and-pos.pdf
25. https://www.bits-pilani.ac.in/tlc/Pilani/Resources/Talks/Talk_Dr_A_Roy.pdf
26. Rawat S, Karkare S. An empirical study on assessment of PO attainment for a diploma program. methodology. 2015;1(2):3.

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