International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:14, No:12, 2020

Assessing and Evaluating the Course Outcomes of Electrical Circuit Course for Bachelor of Science in Electrical and Electronic Engineering Program

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***Abstract*—**At present, it is an imperative and stimulating task to grow the concepts and skills of undergraduate students in any course. Educators must build up students' higher-order complex and critical thinking abilities. But many of them find it difficult to assess and evaluate these abilities of students who undertake their courses during undergraduate studies. In this research work, a simple assessment and evaluation process for the electrical circuit course of the undergraduate Electrical and Electronic Engineering (EEE) program is reported using the Outcome-Based Education (OBE) approach. The methodology of the work, course contents design, course outcomes (COs) preparation and mapping it with program outcomes (POs), question setting following Bloom's taxonomy, assessment strategy of the students, CO and PO evaluation records, statistics, and charts have been reported for a student-cohort of electrical circuit course taken in Spring 2019 Semester at EEE Department of Southeast University (SEU). It is found that the benchmark fixed by the course instructor has been achieved by the students of that course through CO assessment and evaluation. Recommendations of the course teacher for further quality enhancement based on CO achievement are also presented.

***Keywords*—**OBE, COs, POs, assessment and evaluation, electrical circuit course.

I. Introduction

THE University Grants Commission (UGC), Bangladesh permitted SEU to start a Bachelor of Science in Electrical and Electronic Engineering (BSc in EEE) program on 15 November 2009 but it was the middle of the Fall 2009 Semester. Therefore, the Department of EEE started BSc in EEE program from the spring 2010 Semester. After that, this department is getting fresh students in every tri-semester (spring, summer, and fall) of each academic calendar. By this time, 19 batches of students have graduated with over 500 in number [1].

In Bangladesh, any engineering program is accredited by the Board of Accreditation for Engineering and Technical Education (BAETE). Without accreditation, the graduates cannot get the membership of the Institution of Engineers, Bangladesh (IEB)- a non-profit professional body for the BSc engineers of Bangladesh. An engineer needs an IEB membership when he/she wants to approve any engineering design. Therefore, our graduates are facing some problems in their jobs and hence, it is felt that the BSc in EEE program needs to be accredited by BAETE. But to obtain the accreditation, the main criterion is that the curriculum of the program must be based on OBE [2]. Therefore, we have started to practice it in our department by designing a few courses as per the guidelines of an OBE curriculum from the spring 2019 Semester that spans from January to April. BAETE has two versions of its OBE Manual- one has been made effective since 1st July 2017 [2], and the other has been made effective since 1st January 2020 [3]. The department of EEE has applied based on the first version of the manual in March 2019 [4].

Currently, Bangladesh has over 150 public, private, and international universities [5], and hence getting students is tremendously competitive. One main focus of the university is to highlight the standard and quality of education they are providing. At present, it is well known that through the OBE process, quality education to the students can be provided. Therefore, BAETE in Bangladesh also adopted the OBE-based engineering education model as a standard to evaluate the quality of a program for accreditation. After the adoption of the Outcome-Based Accreditation (OBA) of the engineering program, it has been observed that the universities offering engineering programs in Bangladesh are gradually becoming interested to switch to the OBE-based curriculum model, many programs of different universities have applied to BAETE for OBA [4]. Therefore, the EEE Department of SEU has also started to implement the OBE-based curriculum by a few of its full-time faculty members. In the first stage, the electrical circuit course has been chosen to be implemented through OBE based model and its COs will be evaluated through a direct assessment.

This paper explains how the assessment and evaluation process of the electrical circuit course based on its defined COs are found through a definite assessment plan, which was informed to the students earlier. After that, each CO is mapped to the corresponding PO and hence attainment levels for each student are calculated. It is to be mentioned that the BSc in EEE program has embraced the 12 POs provided by BAETE for its curriculum [2].

The evaluations obtained from this assessment are used to implement OBE processes for the other higher-level courses of the BSc in EEE program of SEU. On the whole, these data and evaluations can effectively be utilized by the university

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management and the concerned academic program for the improvement of the program in terms of quality [6] and future student intake quantity by developing strategic frameworks for the sustainable development of the department and hence the university. Not only that, it will provide the EEE graduates of SEU better pathways for their future career build-up and thus to contribute to the national development.

II. Literature Review

Assessment of COs is necessary to assess POs in OBE based engineering education [7], [8]. COs are assessed from a course taught to the students in a particular cohort in a particular semester. This is an essential tool to have a clear picture of the student learning outcomes of a course and hence the PO of the students [9], [10]. In the works of literature, various types of methodologies are found for the calculation of COs by computing the accomplishments of every single student for a set of predefined goals [11].

Assessment is a continuing systematic procedure that is intended at identifying, collecting, analyzing, and interpreting student achievements' data to quantify the accomplishment of each CO and to ascertain how well attainment matches between the expectations and standards, and also to take appropriate measures for improving the student learning as well as for ensuring and propelling the quality engineering education at tertiary level. Hence, for each program, a sustainable assessment methodology needs to be developed [12]. Effective assessment uses quantitative, qualitative, direct, and/or indirect methods as appropriate to the outcome being measured [13].

The most important requirement of all accreditation agencies for any engineering program is to specify a set of knowledge and skills that they anticipate the students to accomplish upon completion of their graduation and to prepare an evaluation procedure to establish the degree to which the POs are attained productively given that the indispensable ancillary atmospheres have been provided to the learners to achieve the specified level of the course and POs together [1], [14].

COs mainly focus on the rational, interactive, and collaborative development of students as it helps to become successful in the learning activities. Students are to prove their outcomes in terms of knowledge, skills, and attitudes after the successful ending of a specific course in the curriculum through the teaching-learning experiences are defined by the course learning outcomes [15], [16]. COs entail a direct impact on the curriculum design of the engineering program in addition to the quality assurance (QA) method [17].

Different types of assessment schemes are being used to quantify the attainment of POs. Of them, direct and indirect assessment schemes are the major types of assessment schemes [18]. But for CO measurement, direct assessment schemes [19] are mainly used. The CO assessment processes enable a program to demonstrate how a particular PO has been addressed in the curriculum. Hence CO assessment has become a very time-consuming task.

Direct assessment is performed using direct shreds of evidence of course learning outcomes. These shreds of evidence provide the degree of relationship among the mastery of a student's grasp on a specific subject area, developed skill sets, and other characteristics. This type of assessment technique is mainly used to determine the course or program level outcome, but it can also be used to measure the institution level outcome as well. Many tools can be used for direct assessment. Of them, the examination is the most common tool. Other important tools are writing samples, oral presentation, etc. [20]. It should be noted that the direct assessments are an important and essential component of an assessment scheme but it is not able to provide the assessment analysis completely. It can provide learning achievement but fails to provide in which way or for which purpose the learning procedures took place. However, indirect assessment is an essential tool that can provide a perception about the learning atmosphere so that the learning process may be enhanced [18].

Indirect assessment mainly emphasizes the predicting parameters that are related to learning but does not measure the learning itself. The most common tools for it are called survey which receives data from the students, alumni of the program, employers of the graduates, faculty members of the program, industry advisory panel members, curriculum committee members, and so on. The surveys provide the specific intuition into the learning pledge and efficacy of the specific activities for the definite courses of the program [18].

An approach was suggested for direct assessment of how well the individual students can achieve the COs and as such the POs that define a set of measurable performance indicators in strong co-relationship with the courses being taught [14]. These performance indicators should be measurable attributes distinguishing the performance level mandatory to satisfy the program level outcomes or POs [21].

An electrical circuit is an important and basic course in any engineering curriculum. For many years, attempts have been taken to make the concepts clear to the students about DC and AC circuits [22]. However, for the BSc in EEE program, this course is like an inter-disciplinary engineering program stemming from Physics and Mathematics. This makes it more challenging for the course teachers to make the students of BSc in EEE program to attain the outcomes of this course [23], and hence motivation is required to be given by the teachers to the students [24].

Basic criteria intended to measure students' progress towards the outcomes of the electrical circuit course for the EEE program have been developed with assessment tools and performance indicators. The depth and breadth of the course material must be described elaborately than its' set of outcome indicative standards; because this set of standards provides a few rudimentary data about what the students could have grasped as well as achieved. However, this set of standards may be the same each semester when the electrical circuit course would be offered to the students. Then the comprehensive set of standards, as well as the evaluations of the major qualifying requirements for the undergraduate students and also the other assessment data, provides us an

actual portrait of what the BSc in EEE program is accomplishing. Faculty members of the electrical circuits course of the program should try to establish a correlation among the quiz, class tests, assignments, midterm, and final examination questions as well as the other evaluations related to the students' performances to the set of standards and program objectives. While grading the students' answers and evaluating their achievement, a course-based assessment is to be used and their obtained scores are to be tabulated independently [25].

III. Objectives of the Work

The main objective of this work is to find a definite method for assessing and evaluating the COs and hence see its contribution to the POs of the BSc in EEE program at SEU. However, the other purposes of this work are to-

i. Study several works on the OBE-based assessment and evaluation process and frame an assessment plan for calculating the attainment of the COs of the electrical circuit course to impart some knowledge of circuit design and problem-solving that are very much relevant to the undergraduate EEE program.
ii. Evaluate the attainment level of each student.
iii. Evaluate the attainment level of PO mapped to the outcome of the electrical circuit course.
iv. Determine the strong and weak areas of the course and recommend appropriate remedial actions to be taken by the EEE Department for the Continuous Quality Improvement (CQI).

IV. Methodology

At SEU, three engineering programs can get the formal recognition of the Bangladeshi program accreditation agency, BAETE. It is well known that through accreditation, quality of education can be ensured [1], [26]. Therefore, SEU management had decided in 2017 to apply to BAETE for its three engineering programs simultaneously, viz. Computer Science and Engineering (CSE), EEE, and Textile Engineering (TE) programs for accreditation [1]. The main objective of this bold step was to deliver these engineering departments with the required financial and physical resources to grow as the quality-ensuring tertiary-level engineering education hubs in Bangladesh. In this regard, these three departments had to find the crucial performance indicators to measure the COs and hence the POs [1]. As a result, they had to take several initiatives to ensure quality engineering education through developing an OBE-based curriculum, launching the obligatory laboratory set-up, purchasing the most essential machines, equipment, test, and measurement instrument, designing, testing, and demonstrating new laboratory experiments to the students as per the newly designed undergraduate curriculum, preparing the necessary laboratory experiment manuals, employing competent as well as experienced faculty members to teach the OBE-based curriculum, formulating the OBE-based teaching guidelines, facilitating the necessary training to the faculty members, familiarizing the students on OBE-based practices, etc. [1].

The OBE-based curriculum has been made effective for the BSc in EEE program in January 2019 through a curriculum revision committee meeting [1]. In that meeting, a model has been adopted to quantify the accomplishment of the POs through numerous direct as well as indirect measurements. Each CO of all core courses of the BSc in EEE program was linked to any one or more POs of the program. This is done by the individual course teacher and then it was placed to the Academic Committee of the EEE Department for approval. After it is passed in the Academic Committee, each course teacher devised the various methods of assessing the COs attainment by the students of his/her course. Then, each course teacher has to prepare an assessment plan and according to that plan he/she has to set questions based on COs and level of learning outcomes based on Bloom's taxonomy of learning. After his/her assessment and evaluation, he/she needs to submit the data to the department's OBE committee headed by the Chairman of the EEE Department. Based on the submitted COs and POs data by each faculty member, the OBE committee then analyzes the POs attained by each student of the program. This committee also checks whether any PO is left untouched for any student. If any such thing happens then re-mapping of the CO-PO matrix for that cohort of the student is made. Besides, PO evaluation is done for each student based on the data collected from the results of the course examinations, faculty members of various courses, existing students, alumni, research and internship students and their supervisors, and employers of the graduates to measure its level of achievement [27]. Then the accuracy of the results was investigated and it was found erroneous due to the equal weightage given to the different types of measurement steps, which ultimately contribute towards the same PO [1].

A. Course Outcomes

A CO is a list of skills, competencies, and/or attitudes a successful student will develop at the endpoint of a particular course. There may be further higher-level COs during the entire program, but the electrical circuit course is very basic and fundamental in the undergraduate EEE program. The understanding of many courses where knowledge of electrical circuits is required depends on the clear understanding of this particular course as well. Therefore, the COs of the electrical circuit course should be designed in such a way that the students can develop their deep understanding of designing various types of electrical circuits. In this course, various theorems and laws of electrical circuits are taught to the students in both theory and laboratory classes. To prepare the COs, we used appropriate action verbs for each CO. Then we wrote four- Os for the electrical circuit course with a starting phrase as follows-

After the successful completion of this course, the students will be able to-

[CO1] State and explain various laws and theories of DC electrical circuits
[CO2] Compute electrical signals and parameters of various types of DC electrical circuits using various rules and

formulas
[CO3] Apply rules and network theories to DC electrical circuits to solve circuit problems
[CO4] Solve various transient problems of DC electrical circuits
[CO5] Find the magnetic circuit parameters employing ampere's circuital law and B-H curves.

B. Program Outcomes

The BSc in EEE program offered at SEU requires that students earn the degree with minimum degree requirements of 153 credits following the guidelines set by the UGC, Bangladesh [28] and BAETE, Bangladesh. The courses in the curricula of the BSc in EEE program have been designed by the faculty members, and then placed in the academic and curriculum committee of the department. But before that, the opinions of the Industry Advisory Panel (IAP) were also taken. Once the curriculum committee approves it then it goes to the academic council and finally to the syndicate meeting to pass and as per their recommendation, the revised curriculum has been made effective from the Spring 2019 Semester in the EEE Department of SEU [1]. There are 12 POs in the BAETE Manual [2], and all of these POs are adopted in the curriculum of the BSc in EEE program of SEU [29]. Graduates of this program are anticipated that they will also be able to attain the 12 POs upon their graduation as set by BAETE's manual [29].

At the EEE Department of SEU, the faculty members conduct their assigned courses face to face inside the on-site classes along with the Google Classroom and Google Meet for conducting online classes and student meetings as an alternative way of the education management process. They also give each course syllabus of their courses to the students on the class start date of the concerned semester. The course syllabus includes detailed course contents, course objectives, course learning outcomes, major focus areas of the course, course requirements, classroom policies, sequential list of lecturer contents, quiz, class tests, midterm, and final examination timetables, text and reference books, teaching domains and levels, teaching-learning-assessment strategies for each lecture class, assessment and grading policies, CO-PO mappings, etc. [1], [29].

C. CO-PO Mapping and Performance Assessment

Performance Indicators (PI) are quantifiable parameters that each learner necessity full-fill to validate the attainment of the various COs of his/her program [1], [13]. In the electrical circuit course, direct measurement techniques are used to obtain students' knowledge or skills against quantifiable COs. This should give us a portrait of how well an individual student is attaining each CO. The faculty member of the 'electrical circuits' course must preserve the performance record of each student during the whole semester. At the point of the completion of the course when the semester ends officially, the students will get the letter grades as usual. Nonetheless, each student will also get a "score" on the scale of 1-to-5 (highest) or in percentage signifying the degree of achievement level for each CO [1], [29], [30]. These parameters indicate the students' ability to perform at the point of their completion of the EEE program.

The anticipated knowledge, skills, and attitude essential to accomplish any of the 12 program outcomes mentioned in the BAETE manual [2], and adopted by the BSc in EEE curriculum of SEU [29] to define the various performance indicating parameters with relevant teaching domains and levels of Bloom's taxonomy, teaching-learning approaches, and assessment apparatuses of electrical circuit course are shown in Table I with the CO-PO mapping. To provide students with the necessary knowledge of electrical circuits, various levels of the cognitive domain in the teaching-learning strategies (from 'remember' to 'create' level) have been charted for the electrical circuit course. The reason is that it has already been observed that this method is more effective than that observed in the traditional method of teaching-learning strategies in several studies [1], [31], [33].

Table I shows how each CO is mapped to different PO and teaching-learning domains of Bloom's taxonomy; how the teaching-learning process will be implemented using different methods, and how different direct assessment tools will be utilized for CO-PO measurement. On the other hand, Table II shows the breakdown of each direct assessment component [1], [34], [35] through which CO measurement of electrical circuit course will be made. These include a few selected questions of class tests, assignments, midterm, and final examinations, etc. Besides, marks allocated to each question are also shown. Here, we assume a linear relationship among the COs and POs for the electrical circuit course [1].

TABLE I
CO-PO MAPPING, TEACHING DOMAIN, TEACHING-LEARNING STRATEGY, AND ASSESSMENT TOOLS OF THE ELECTRICAL CIRCUIT COURSE

Course Outcome	Program Outcome	Teaching Domain and Level	Teaching-Learning Strategy	Assessment Tools
[CO1] State and explain various laws and theories of DC electrical circuits	PO1 (Engineering Knowledge)	Cognitive Domain/ Understand	Lecture Discussion Demonstration Question and Answer	Direct Assessment Tools like Class Test, Midterm and Final Exams
[CO2] Compute electrical signals and parameters of various types of DC electrical circuits using rules and formulas	PO2 (Problem Analysis)	Cognitive Domain/ Apply	Lecture Discussion Problem Solving Question and Answer	
[CO3] Apply rules and network theories to DC electrical circuits to solve circuit problems	PO2 (Problem Analysis)	Cognitive Domain/ Apply	Lecture Discussion Problem Solving Question and Answer	
[CO4] Solve various transient problems of DC electrical circuits	PO4 (Investigation)	Cognitive Domain/ Synthesis	Lecture Discussion Problem Solving Question and Answer	
[CO5] Design the magnetic circuits employing ampere's circuital law and B-H curves	PO3 (Design/ Development of Solutions)	Cognitive Domain/ Apply	Lecture Discussion Problem Solving Question and Answer	

TABLE II
ASSESSMENT PLAN OF ELECTRICAL CIRCUIT COURSE

Assessment Tools				Course Outcomes				
Item	Q#	CL	Marks	CO1	CO2	CO3	CO4	CO5
Class Test1	Q2	C2	3.0	√				
Class Test2	Q3	C3	5.0		√			
Midterm Exam	Q1(a)	C2	3.0	√				
	Q1(b)	C3	3.0		√			
	Q1(c)	C3	4.0		√			
	Q2(b)	C3	4.0			√		
	Q3(a)	C5	6.0			√		
Final Exam	Q1(a)	C2	3.0	√				
	Q1(b)	C3	6.0			√		
	Q2(a)	C5	5.0					√
	Q2(b)	C3	3.0					√
	Q2(c)	C3	2.0				√	
	Q3(a)	C3	5.0				√	
	Q3(b)	C4	5.0				√	
	Q4(a)	C2	3.0	√				
	Q4(b)	C6	6.0					√
Total	**16**	**-**	**66.0**					

The percentage of question distribution in the assessment plan as per various levels of Bloom's taxonomy in terms of the number of questions and amount of allotted marks is shown in Table III. From this table, it is seen that no questions are set from level one of the cognitive domain. Most of the questions (50%) are set from level three and the marks allotted to this type of question are 48.5%. Since this is the electrical circuit course, it is expected that the students should be able to solve mostly the application-level problems. Besides, a few questions have been set from levels 4, 5, and 6 with 6.25%, 12.5%, and 6.25% questions with 7.5%, 16.7%, and 9.1% of allotted marks respectively.

TABLE III
PERCENTAGE DISTRIBUTION OF QUESTIONS AS PER LEVELS OF BLOOM'S TAXONOMY IN THE COGNITIVE DOMAIN

Cognitive Levels		Questions			
Level #	Level Name	Number of Questions		Marks of Questions	
		In Count	In %	In Number	In %
C2	Understand	4	25%	12	18.2%
C3	Apply	8	50%	32	48.5%
C4	Analyze	1	6.25%	5	7.5%
C5	Evaluate	2	12.5%	11	16.7%
C6	Create	1	6.25%	6	9.1%
Total		**16**	**100.00%**	**66.0**	**100.00%**

TABLE IV
PERFORMANCE SCALE BASED ON THE PERCENTAGE OF MARKS OBTAINED

Performance Level	Numerical Scale
Excellent	80% and Above
Very Good	70-79%
Good	60-69%
Satisfactory	50-59%
Developing	40-49%
Unsatisfactory	Below 40%

A performance scale is also developed (as shown in Table IV) based on the percentage of marks obtained in each CO contributed from different direct assessment tools discussed in Table II. Initially, the CO achievement target has been set to 50%; that means, 50% of students of the cohort of this course should be at the satisfactory or above level, because, in a satisfactory level, the numerical scale is also 50%.

D.PO Assessment

To measure the attainment echelons of POs for each student of the electrical circuit course, each CO of this course is assigned to at least one PO out of the 12 POs of the BSc in EEE program at SEU. The attainment status of each PO is calculated as per the following steps [1]:

i. Contributions of each CO to the corresponding PO is the same for the electrical circuit course.
ii. From Table I, we observe that CO1 helps to achieve PO1, CO2 and CO3 jointly help to achieve PO2, CO4 helps to achieve PO4 and CO5 helps to achieve PO3.
iii. The percentage of scores is calculated and is assigned to the PO contribution for each student.
iv. The percentages of students in each CO and PO are computed as well.
v. A PO is said to be attained if the combined percentage of students in the "Excellent", "Very Good", "Good" and "Satisfactory" groups is equal to or greater than 50%. This is corresponding to 50% of the students scoring grade C+ (50%) and above. Because SEU follows the UGC grading scale [1], [24].
vi. The PO status is calculated as per the following criteria of the percentage score contributed to each PO [1]-

a. Score ≥ 50% → achieved
b. Score < 50% → not achieved
c. Score ≥ 50% but < 59% → marginally achieved
d. Score ≥ 60% but < 69% → achieved but need improvements in knowledge and skills.
e. Score ≥ 70% but < 79% → achieved with very good status but still need improvements in a few areas of knowledge and skills.
f. Score ≥ 80% → achieved with an excellent status
g. Score ≥ 40% but < 49% → unachieved and in the developing stage and require additional care for the attainment of COs and POs.
h. Score < 40% → unachieved and in the unsatisfactory stage and require retaking the course for the attainment of COs and POs.

E. Data Collection

The sample of 18 students used in the study was chosen from the pool of undergraduate students enrolled in the electrical circuits course offered in the spring 2019 Semester of the academic year 2019 at the EEE Department of SEU. Data were collected from direct assessment tools of the 'Electrical Circuits' course offered during the first semester of the EEE Department for one cohort of students. It is to be mentioned that the EEE Department of SEU started OBE curriculum implementation from the spring 2019 Semester with the fresh students admitted in that particular semester. To evaluate the students' CO and POs attainment based on direct

assessment tools, we have used data only from the course offered in the Spring 2019 Semester as we started to implement OBE at the EEE Department of SEU from the Spring 2019 Semester and the OBE curriculum is effective from this semester. There was no indirect assessment tool for the students this semester.

V. Results and Discussions

A. CO-PO Evaluation

Tables V and VI give a summary of the attainment level of the CO and POs respectively in terms of the number of students for CO and PO. Tables V and VI show that the required engineering knowledge through the learning of various laws, rules, and theorems has been achieved above satisfaction level by 15 students out of total 18 students in the cohort and this is more than 50% of the students in the class and hence the course and POs through this course have been achieved by this cohort of students as per the first-CO of the electrical circuit course and thus the first PO for these students have also been achieved partially. The remaining three students in the cohort need proper care. These two tables also show that the computation of electrical signals and parameters of various types of DC electrical circuits using various rules and formulas as well as the solution of DC electrical circuits problems by applying rules, laws, and network theorems have been achieved by them, 14 and 17 in number for CO2 and CO3 respectively. Thus, the contribution to PO2 has been achieved by all the students in the cohort. On the other hand, it is observed that the skills required to solve various transient problems of DC electrical circuits are also above expectations (16 out of 18 students could achieve CO4 and hence PO4 through this course). Since only CO4 of this course is directly mapped to PO4 so the same results are obtained for both CO and its corresponding PO. Similar is true for CO5 and its corresponding PO numbered PO3, 17 out of 18 students of the cohort of electrical circuit courses could achieve CO5, that is they could find the magnetic circuit parameters easily by employing ampere's circuital law and *B-H* curves and hence the program outcome, PO3.

TABLE V
Number of Students Achieving the Performance Levels for All COs of the Electrical Circuit Course of EEE Department at SEU

	Excellent	Very Good	Good	Satisfactory	Developing	Un-satisfactory
CO1	5	2	5	3	1	2
CO2	4	5	3	2	3	1
CO3	3	4	7	3	0	1
CO4	4	5	4	3	2	0
CO5	3	5	4	5	1	0

TABLE VI
Number of Students Achieving the Performance Levels for Various POs through the Electrical Circuit Course of EEE Department

	Excellent	Very Good	Good	Satisfactory	Developing	Un-satisfactory
PO1	5	2	5	3	1	2
PO2	0	9	6	3	0	0
PO3	3	5	4	5	1	0
PO4	4	5	4	3	2	0

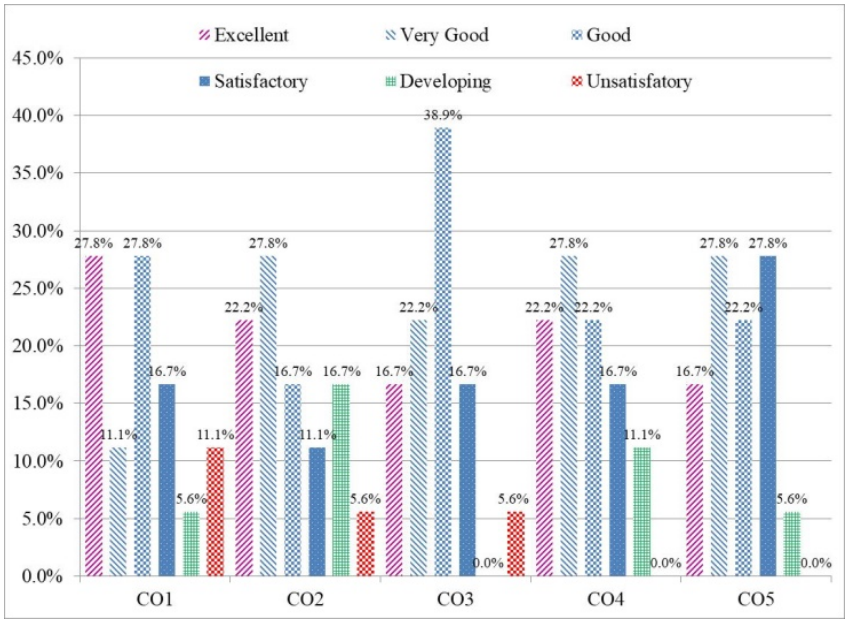

Fig. 1 CO evaluation attainment report summary

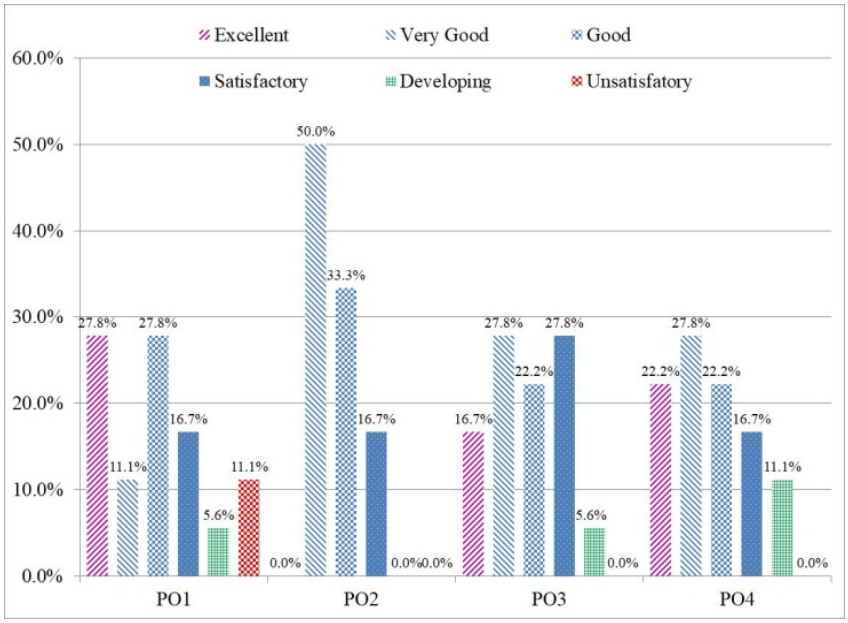

Fig. 2 PO evaluation attainment report summary

Based on the obtained results, graphical representations have been produced as shown in Figs. 1 and 2 for demonstrating the attainment levels of each CO and corresponding PO. Since the benchmark of achievement has been set as 50% for this course, it is seen that most of the students could achieve all COs and hence could contribute towards their respective POs from this course; because the sum of percentage data from satisfactory level to excellent level is well above 50% for all COs and POs. However, it needs much care for the remaining students who could not achieve their COs and POs.

B. Suggestions for Improvement

To improve the level of attainment of COs and hence POs, the EEE department has also prepared a list of potentially effective measures to solve this problem. However, the number of suggested measures to be accepted is decided by the respective course teacher of a particular semester. These are suggested measures for further improvement of the individual student. But a course teacher may not limit himself/ herself to these suggested measures, that is, he/she can also improvise one or more remedial techniques so that the students can improve their attainment level. Some of the typical suggested remedial measures that may be applied to the electrical circuit course are as follows:

a. Engaging students with more home works and assignments on various electrical circuits related problems and derivations;
b. Assigning students with field survey on collecting electrical energy data, electrical circuit troubleshooting;
c. Engaging students with more individual work that are more relevant to achieving a particular CO of electrical circuit course.
d. Devoting more time for tutorial classes for the weak students in the areas where improvements are needed.
e. Suggesting more than one standard text or reference books that are being used in the top class universities to teach the electrical circuit course.
f. Using a different teaching-learning method/strategy, especially to address non-attainment of COs by a particular student.
g. Preparing lecture notes by the course teacher for each lecture touching all the key points related to the electrical circuits and network theories so that the students feel easy to learn the circuit theorems.
h. Using real-life electrical circuits related to numerical problems and using real-time data to solve those problems based on circuit laws and theories. This will help to grow students' interests in the course.
i. Giving practical examples where electrical circuits are being used and the relevant laws and theories are found suitable and useful.

The EEE Department has required concerned faculty members to document all actions to be taken to improve the attainment level of COs/POs and to submit a report at the end of the course offering semester indicating whether there have been any significant improvements on the achievement levels of the COs/POs as a consequence of their remedial measures suggested by the course teacher of the previous semester when the electrical circuits course was offered to the students.

VI. Conclusion

This paper describes a simple model that the EEE Department of SEU is using to implement the outcome-based assessment and evaluation process for the accreditation of the BSc in EEE program through an OBE-based curriculum and teaching-learning process. This model depends on several direct assessment tools to assess COs of electrical circuit

course and hence its contribution towards a few POs. Several PIs are developed to assess and evaluate the knowledge of the students that are required to acquire by the students at the point of their successful completion of this course.

Implementing a model to measure the achievement of POs for any academic program helps the institution to identify the challenging areas and take suitable corrective actions. The model described here is very generic; it may be applied to any course of any academic program to measure COs. In this study, data collection and analysis were carried out manually. These tasks require a considerable amount of time from the faculty members. As future work, we are developing a software tool, which could facilitate the whole process of assessing and evaluating the COs and hence the POs of any academic program in the engineering discipline.

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