Curricula comparison of electrical and electronics engineering technology and similarly named associate degree programmes

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ABSTRACT: The associate degree programmes discussed in this article are offered in the Kingdom of Saudi Arabia. In the first part of the article is presented a curriculum comparison study of the historically Accreditation Board for Engineering and Technology (ABET) accredited Electrical and Electronics Engineering Technology (EEET) associate degree programme at Applied College, Hafr Al Batin, the currently ABET-accredited Instrumentation and Control Engineering Technology (ICET) associate degree programme at Jubail Industrial College (JIC), and the currently ABET-accredited Electronics and Communication Technology (ECT) and Instrumentation and Control Technology (ICT) associate degree programmes at Yanbu Industrial College (YIC). The currently ABET-accredited ICET programme at JIC, and ECT and ICT programmes at YIC have served as a regional benchmark for the historically ABET-accredited EEET programme at Applied College. In the second part of the article, the indirect assessment process of ABET student outcomes and evaluation of ABET programme criteria of the EEET programme at Applied College is described.

INTRODUCTION

Curricula comparison among similarly named degree programmes offered at the local, regional and international institutions is an important topic. Many studies have been conducted on this topic and can be found in the literature. Programmes offering departments in Saudi universities and colleges, usually undertake such studies while proposing a new degree programme and during the programme revision process, albeit not at such minute detail as discussed in this article.

The curriculum revision of the electrical and electronic engineering programme at Eastern Mediterranean University in North Cyprus as part of the preparation towards accreditation by ABET were reported by Erdil and Bilsel [1]. The curricula of the mechanical engineering Bachelor's degree programme at Ming Chi University of Technology in Taiwan and the mechanical engineering technology Bachelor's degree programme at Purdue University in the USA was compared by Tsai and Wang [2]. The direct and indirect assessment methods were used by Nordin et al to evaluate the programme outcomes achievement in order to enhance the quality of teaching and learning process for the electrical engineering programme at Universiti Kebangsaan Malaysia [3].

A survey of credit hour requirements in civil, electrical and mechanical engineering ABET-accredited Bachelor's degree programmes at several institutions in the USA was conducted by Williamson and Fridley [4]. A comparative study of all ABET-accredited associate degree programmes in the Kingdom of Saudi Arabia was conducted by Almutairi [5].

The rubrics-based direct assessment process of ABET student outcomes of the Electrical and Electronics Engineering Technology (EEET) programme at Applied College was described in detail by Faiz and Almutairi [6]. The name of Hafr Al Batin Community College (HBCC) has been officially changed to Applied College very recently [6]. There is presently one track in the EEET programme at Applied College; namely, Instrumentation Engineering Technology (IET). Thus, for the sake of simplicity, the IET track mentioned by Faiz and Almutairi in their article [6] is referred to by its programme name; viz. EEET, throughout this article.

In this article, curricula of the historically ABET-accredited EEET associate degree programme at Applied College, Hafr Al Batin, the currently ABET-accredited ICET associate degree programme at JIC, and the currently ABET-accredited ECT and ICT associate degree programmes at YIC have been compared [7].

In this curricula comparison, the respective general and core requirements of these engineering technology programmes at Applied College, JIC, and YIC, which are among the leading technical colleges in the Kingdom of Saudi Arabia, have been examined in finer details. This activity was undertaken as part of the EEET programme revision process at

Applied College, which has provided the EEET Department with deeper insights on the EEET curriculum. Moreover, the indirect assessment process of ABET student outcomes and evaluation of ABET programme criteria of the EEET programme at Applied College has also been described in detail.

CURRICULA COMPARISON

The required number of general, core and total laboratory courses in the EEET programme at Applied College [8], ICET programme at JIC [9], and ECT and ICT programmes at YIC [10] are shown in Table 1. Depending on the free elective course offered, the general and total laboratory courses for the ICET programme at JIC in Table 1 will add up to 7 to 8 and 22 to 23, respectively.

Table 1: Required number of general, core and total laboratory courses.

Programme	General laboratory courses	Core laboratory courses	Total laboratory courses
EEET	6	12	18
ICET	7 to 8	15	22 to 23
ECT	5	15	20
ICT	5	14	19

The required number of general, core and total courses in the EEET programme at Applied College, ICET programme at JIC, and ECT and ICT programmes at YIC are shown in Table 2. As can be seen from this table, the EEET programme at Applied College has the least number of total courses as compared to the ICET programme at JIC, and ECT and ICT programmes at YIC.

Table 2: Required number of general, core and total courses.

Programme	General courses	Core courses	Total courses
EEET	11	12	23
ICET	14	15	29
ECT	13	15	28
ICT	13	14	27

The required number of free and technical elective courses in the EEET programme at Applied College, ICET programme at JIC, and ECT and ICT programmes at YIC are shown in Table 3. As can be seen from this table, the EEET programme at Applied College offers both free and technical elective courses as compared to the ICET programme at JIC, and ECT and ICT programmes at YIC.

Table 3: Required number of free and technical elective courses.

Programme	Free elective courses	Technical elective courses
EEET	1	1
ICET	1	-
ECT	-	-
ICT	-	-

Table 4 and Table 5 show the weekly required number of lecture hours, laboratory hours and total hours for general and core courses, respectively, in the EEET programme at Applied College, ICET programme at JIC, and ECT and ICT programmes at YIC. In all these programmes, the co-op or summer training students are required to spend 40 hours per week (8 hours per day for 5 working days) during their training period. Therefore, the laboratory hours for all these programmes are calculated by including these 40 hours in Table 5.

As can be seen from Table 4, the weekly required number of total hours for general courses of the EEET programme at Applied College are placed in between those of the ICET programme at JIC, and ECT and ICT programmes at YIC. As can be seen from Table 5, the EEET programme at Applied College has the least weekly required number of total hours for core courses as compared to the ICET programme at JIC, and ECT and ICT programmes at YIC.

Table 4: Weekly required number of lecture, laboratory and total hours for general courses.

Programme	Lecture hours	Laboratory hours	Total hours
EEET	25	18	43
ICET	29 to 30	19 to 21	49 to 50
ECT	25	13	38
ICT	25	13	38

Table 5: Weekly required number of lecture, laboratory and total hours for core courses.

Programme	Lecture hours	Laboratory hours	Total hours
EEET	22	76	98
ICET	24	81	105
ECT	22	85	107
ICT	23	82	105

The co-op training course in the ICET programme at JIC, and ECT and ICT programmes at YIC is of 3 credit hours. However, the summer training course in the EEET programme at Applied College is of 2 credit hours. Nevertheless, the summer training course in the EEET programme at Applied College offers the students a similar degree of experience as compared to the co-op training course experience in the ICET programme at JIC, and ECT and ICT programmes at YIC. Moreover, the academic component of the summer training course in the EEET programme at Applied College will be evaluated by the respective faculty members as mentioned in the General Criterion 5-Curriculum of the Engineering Technology Accreditation Commission (ETAC) of ABET [11].

The required number of general, core and total credit hours in the EEET programme at Applied College, ICET programme at JIC, and ECT and ICT programmes at YIC are shown in Table 6. As can be seen from this table, the EEET programme at Applied College has the least number of total credit hours as compared to the ICET programme at JIC, and ECT and ICT programmes at YIC.

The EEET programme at Applied College was historically accredited by the ETAC of ABET until 30 September 2020. The historical accreditation of the EEET programme at Applied College by the ETAC of ABET has provided assurance that the programme has met the quality standards of the electrical and electronics engineering technology profession for which the programme has prepared its graduates during the accreditation period. The University of Hafr Al Batin chose not to go ahead with the ABET reaccreditation process due to the Covid-19 pandemic.

Table 6: Required number of general, core, and total credit hours.

Programme	General credit hours	Core credit hours	Total credit hours
EEET	31	36	67
ICET	31	42	73
ECT	30	40	70
ICT	30	40	70

Among the 14 core courses for the ICT programme at YIC, it can be noted that the following eight courses are exactly the same as those for the ECT programme at YIC; namely, Electric Circuit I (ELET 101), Electrical Circuits II (ELET 102), Electrical Machines I (ELET 103), Electronics I (ELET 105), Basic Industrial Electronics (ELET 201), Digital Electronics I (ELET 202), Control System Components (ELET 203) and Microcontroller (ELET 212). Therefore, the core requirements of the ICT programme at YIC are 57.14% same as compared to those of the ECT programme at YIC.

As per the General Criterion 5-Curriculum of the ETAC of ABET, the discipline-specific content of the curriculum must represent at least one-third of the total credit hours for the curriculum, but no more than two-thirds of the total credit hours for the curriculum [11]. The discipline-specific content credit hours in the EEET programme at Applied College, ICET programme at JIC, and ECT and ICT programmes at YIC are shown in Table 7. As can be seen from this table, the currently ABET-accredited ICET programme at JIC, and ECT and ICT programmes at YIC satisfy the discipline-specific content part-A of the General Criterion 5-Curriculum of the ETAC of ABET as expected. As can be seen from Table 7, the EEET programme at Applied College, which is seeking ABET accreditation also satisfies the discipline-specific content part-A of the General Criterion 5-Curriculum of the ETAC of ABET [11].

Table 7: Discipline-specific content credit hours.

Programme	Total credit hours	1/3rd of the total credit hours	2/3rd of the total credit hours	Core credit hours
EEET	67	22.33	44.67	36
ICET	73	24.33	48.67	42
ECT	70	23.33	46.67	40
ICT	70	23.33	46.67	40

Table 8 shows the comparison of the EEET programme at Applied College, ICET programme at JIC, and ECT and ICT programmes at YIC in terms of accreditation, duration of the programme, entrance requirements, instructional methods, use of computers and tuition costs. During the Covid-19 pandemic all these programmes have adopted distance education format as per the instructions and guidelines issued by the Ministry of Education in the Kingdom of Saudi Arabia. For example, all the academic programmes at Applied College are being offered through the Blackboard learning management system during the Covid-19 pandemic.

Table 8: Comparison of the programmes.

Programme	EEET	ICET	ECT and ICT
College	Applied College	JIC	YIC
Location	Hafr Al Batin City	Jubail Industrial City	Yanbu Industrial City
Accreditation	Historically accredited by ETAC of ABET	Currently accredited by ETAC of ABET	Currently accredited by ETAC of ABET
Duration of programme	2 years	2 years	2 years
Entrance requirements	1-year preparatory programme	1-year preparatory programme	1-year preparatory programme
Instructional methods	Traditional classroom	Traditional classroom	Traditional classroom
Use of computers	Yes	Yes	Yes
Tuition costs	Free tuition	Free tuition	Free tuition

The percentage of required credit hours in the EEET, ICET, ECT and ICT programmes is shown in Figure 1. As can be seen from this figure, the percentage of required credit hours in the EEET programme at Applied College are fairly close to those of the ICET programme at JIC, and ECT and ICT programmes at YIC.

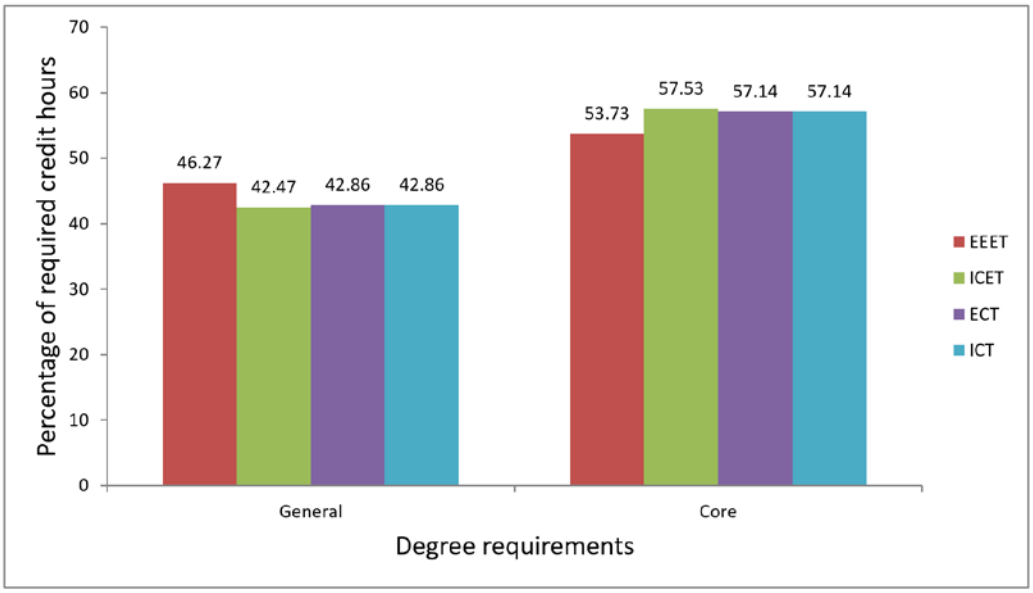

Figure 1: Percentage of required credit hours.

INDIRECT ASSESSMENT OF ABET STUDENT OUTCOMES

Indirect assessments of student learning ascertain the perceived extent or value of learning experiences from the student's perspective. They assess opinions or thoughts about student knowledge or skills. As such, they are an integral part of the ABET student outcomes assessment and evaluation process, whereby the programme can gauge information about student perception of their learning and how this learning is valued by different constituencies.

However, as evidence of student learning, indirect measures are not as strong as direct measures because assumptions must be made about what exactly the self-report means. If students report that they have attained a particular learning outcome, how can that report be validated? An indirect assessment is useful in that it can be used to measure certain implicit qualities of student learning, such as values, perceptions and attitudes, from a variety of perspectives. Various assessment tools as shown in Table 9 are used by the EEET Department for the indirect assessment of ABET student outcomes of the EEET programme.

Table 9: Classification of assessment tools for indirect assessment of ABET student outcomes of the EEET programme at Applied College.

Assessment tool	Assessment type	Assessment instrument	Schedule
Student course exit survey	Indirect	Survey questionnaire	Semester
Employer survey	Indirect	Survey questionnaire	Annual
Alumni survey	Indirect	Survey questionnaire	Annual
Graduating student exit survey	Indirect	Survey questionnaire	Annual
Summer training self-evaluation survey	Indirect	Survey questionnaire	Annual

The sample size of various assessment tools and schedule of assessment where data was collected is shown in Table 10. Most of the EEET students could not go for summer training during semester 193 because of the Covid-19 pandemic. Therefore, summer training self-evaluation surveys were not conducted during semester 193. The EEET students who could not go for summer training during semester 193 were assigned in groups to build simple applied projects at home, submit reports and make a presentation via Blackboard.

Table 10: Sample size for indirect assessment of ABET student outcomes of the EEET programme at Applied College.

Assessment tool	Sample size	Semester of data collection
Student course exit survey	11 courses	191 and 192
Employer survey	2	191
Alumni survey	3	191
Graduating student exit survey	8	191
Summer training self-evaluation survey	-	193

The indirect assessment of ABET student outcomes (SOs) of the EEET programme at Applied College for the academic year 2019-2020 is shown in Table 11. As can be seen from this table, the ABET student outcomes of the EEET programme at Applied College are found to be at the proficient level of 3 for the academic year 2019-2020.

Table 11: Indirect assessment of ABET student outcomes of the EEET programme at Applied College for the academic year 2019-2020.

Assessment tool	SO (1)	SO (2)	SO (3)	SO (4)	SO (5)
Student course exit survey	3.72	3.53	3.32	3.66	3.78
Employer survey	4	4	4	4	4
Alumni survey	4	3.67	4	3.67	3.67
Graduating student exit survey	3.75	3.75	3.75	3.88	3.75
Average	3.87	3.74	3.77	3.8	3.8

EVALUATION OF ABET PROGRAMME CRITERIA

The programme criteria (PC) as specified in the 2021-2022 ABET ETAC criteria for accrediting engineering technology associate degree programmes, require that graduates must demonstrate knowledge and hands-on competence appropriate to the objectives of the programme in two categories (a) and (b) as follows [11]:

(a):

- PC (1): Circuit analysis and design;
- PC (2): Computer programming;
- PC (3): Associated software applications;
- PC (4): Analog and digital electronics;
- PC (5): Microcomputers;
- PC (6): Engineering standards to the building, testing, operation and maintenance of electrical/electronic(s) systems.

(b):

- PC (7): The applications of physics or chemistry to electrical/electronic(s) circuits in a rigorous mathematical environment at or above the level of algebra and trigonometry [11].

The mapping of ABET programme criteria to the courses of the EEET programme at Applied College is shown in Table 12. The mapping in this table enables the evaluation of the ABET programme criteria based on the rubrics-based direct assessment of ABET student outcomes. This enables a quantifiable evaluation of the programme criteria, where corrective measures can also be proposed for improvement. As was the case for rubrics-based direct assessment of ABET student outcomes, the target metric goal for each component of the programme criteria is set to a score of 2.4.

The results of the evaluation of ABET programme criteria of the EEET programme at Applied College for the academic year 2019-2020, which are obtained by employing the results of the rubrics-based direct assessment of ABET student outcomes in all the core courses are shown in Table 13 [6]. It is evident that the EEET programme has attained the target metric goal set for each programme criterion. Although one can see the mapping of MATH 151, PHYS 151 and CSET 121 courses to the ABET programme criteria in Table 12, these courses are not assessed as they are common courses. Students from all the four departments at Applied College must take these common courses as they contribute towards fulfilling the general requirements of their respective associate degree programmes.

Table 12: Mapping of ABET programme criteria to the courses of the EEET programme at Applied College.

Code	PC (1)	PC (2)	PC (3)	PC (4)	PC (5)	PC (6)	PC (7)
EEET 214	✓					✓	✓
EEET 210	✓			✓			✓
EEET 231	✓			✓		✓	✓
EEET 211	✓			✓			
EEET 212	✓			✓			
EEET 232						✓	✓
EEET 239	✓			✓		✓	✓
EEET 241		✓	✓	✓	✓		
EEET 234	✓			✓			
EEET 237		✓	✓				
EEET 291	✓		✓			✓	
EEET 299						✓	
MATH 151			✓				
PHYS 151							✓
CSET 121		✓					

Table 13: Evaluation of ABET programme criteria of the EEET programme at Applied College for the academic year 2019-2020.

Code	PC (1)	PC (2)	PC (3)	PC (4)	PC (5)	PC (6)	PC (7)	Is any action plan required?
EEET 214	3.52					3.52	3.08	None
EEET 210	3.15			3.15			3.4	None
EEET 231	3.54			3.54		4	3.98	None
EEET 211	3.45			3.45				None
EEET 212	3.57			3.57				None
EEET 232						2.86	4	None
EEET 239	4			4		4	4	None
EEET 241		3.85	3.85	3.85	3.85			None
EEET 234	3.58			3.58				None
EEET 237		3.6	3.6					None
EEET 291	3.36		3.36			3.36		None
EEET 299						3.38		None

The percentage attainment of ABET programme criteria of the EEET programme at Applied College for the academic year 2019-2020 corresponding to Table 13 is shown in Figure 2. As can be seen from this figure, the percentage attainment of ABET programme criteria of the EEET programme at Applied College is above the target goal of 60% for the academic year 2019-2020.

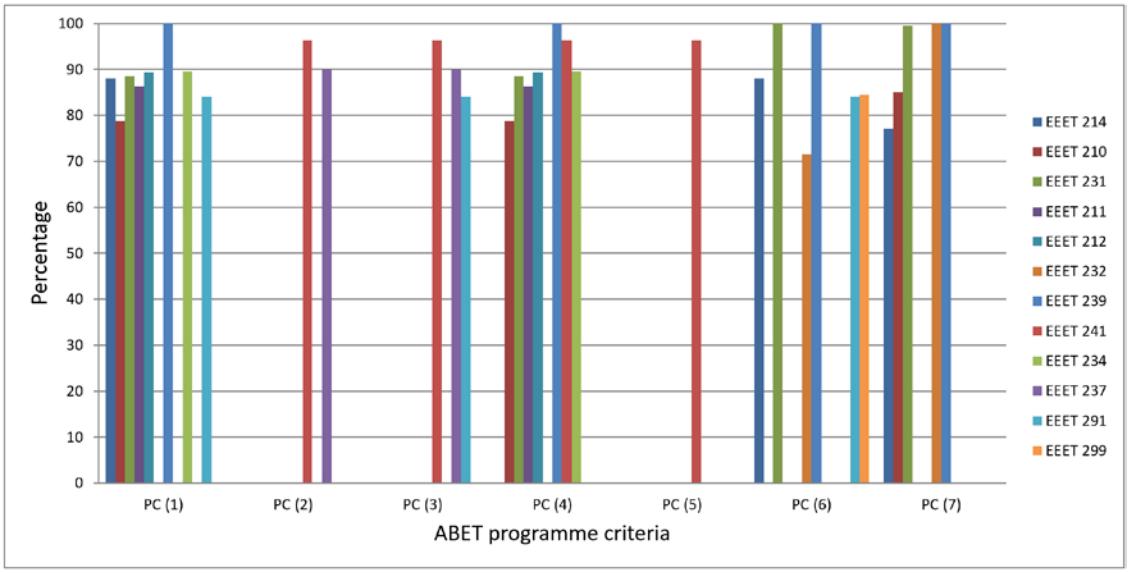

Figure 2: Percentage attainment of ABET programme criteria of the EEET programme at Applied College for the academic year 2019-2020.

PROPOSED CHANGES TO THE EEET PROGRAMME AT APPLIED COLLEGE

The proposed changes outlined below include those that are directly connected to the study presented in this article, and also those that are based on the authors' broader experience in the EEET Department at Applied College.

- Applied Calculus (MATH 151) course should be renamed as Calculus I in the 1st semester. The lecture hours, laboratory hours, and credit hours of the MATH 151 course should be changed from 3, 3 and 4 to 3, 0 and 3, respectively. This particular change to the EEET Programme at Applied College has been proposed based on the ECT and ICT programmes curricula at YIC.
- Calculus II course should be introduced in the 2nd semester with lecture hours, laboratory hours and credit hours equal to 3, 0 and 3, respectively. This course will prepare the students who would like to pursue a Bachelor's degree. This particular change to the EEET Programme at Applied College has been proposed based on the ECT and ICT programmes curricula at YIC.
- The Free Elective (XXX xxx) course should be shifted from 2nd semester to 1st semester.
- The EEET Department should offer a free elective course on Introduction to MATLAB in the 1st semester with lecture hours, laboratory hours and credit hours equal to 2, 3 and 3, respectively, which are the same as those of the Computer Applications I (OA 101) course. This elective course will allow the students to choose between OA 101 course and Introduction to MATLAB course.
- Industrial Safety (MET 101) course should be renamed as Industrial Safety and Standards in the 2nd semester. The lecture hours, laboratory hours and credit hours of the Industrial Safety and Standards course should remain the same as those of the MET 101 course.
- A course on Electrical and Electronics Codes, Standards and Specifications should be introduced in the 3rd semester with lecture hours, laboratory hours and credit hours equal to 2, 0 and 2, respectively.

The above proposed changes to the EEET curriculum at Applied College will increase the total credit hours from 67 to 71, which will be very close to those of the similarly named programmes at JIC and YIC discussed in this article.

The discipline-specific content credit hours after the above proposed changes to the EEET programme at Applied College are shown in Table 14. As can be seen from this table, the EEET programme at Applied College after the above proposed changes still complies with the discipline-specific content part-A of the General Criterion 5-Curriculum of the ETAC of ABET [11]. It is worth noting that associate degree programmes, which are seeking accreditation from the ETAC of ABET, should make this important check point as demonstrated in Table 14, while they are proposing any changes to their respective degree plans.

Table 14: Discipline-specific content credit hours after proposed changes to the EEET programme at Applied College.

Programme	Total credit hours	1/3rd of the total credit hours	2/3rd of the total credit hours	Core credit hours
EEET	71	23.67	47.33	38

CONCLUSIONS

The percentage of required credit hours in the historically ABET-accredited EEET programme at Applied College is found to be fairly close to those of the currently ABET-accredited ICET programme at JIC, and the currently ABET-accredited ECT and ICT programmes at YIC. The historically ABET-accredited EEET programme at Applied College has been shown to comply with the discipline-specific content part-A of the General Criterion 5-Curriculum of the ETAC of ABET on the same lines as the currently ABET-accredited ICET programme at JIC, and the currently ABET-accredited ECT and ICT programmes at YIC.

The indirect assessment of ABET student outcomes of the EEET programme at Applied College for the academic year 2019-2020 reported in this article has a very good level of correlation with the rubrics-based direct assessment of ABET student outcomes of the EEET programme at Applied College for the academic year 2019-2020, which was reported earlier by Faiz and Almutairi [6]. The percentage attainment of ABET programme criteria of the EEET programme at Applied College is above the target goal of 60% for the academic year 2019-2020.

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