MASTER OF SCIENCE IN TECHNICAL EDUCATION

ELECTRICAL ENGINEERING

A STUDY ON KNOWLEDGE GAP BETWEEN UNIVERSITY GRADUATES AND THE REQUIREMENTS OF THE POWER COMPANIES IN MAROODI-JEEX REGION, SOMALILAND.

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DECLARATION

This is to certify that the work presented in this thesis is the outcome of the investigation carried out by Mahamud Musa Abdi, under the supervision of Professor Dr.Faruque A.Haolader in the Department of Technical and Vocational Education (TVE), Board Bazar, Gazipur, Bangladesh.

It is hereby declared that this thesis which is submitted to the university for the degree of Master of Science in Technical Education (Electrical and Electronic Engineering) has not or never been submitted elsewhere for the award of any Degree or Diploma at any other university or educational establishment.

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DEDICATION

This research work is dedicated to my dear late mother Deka Muhumed and My dear late father Musa Abdi

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LIST OF ACRONYMS

EEAP :	Electrical Engineering Associate Profesionals
EEP :	Electrical Engineering Professional
HV:	High Voltage
OIC:	Organization of Islamic Conference
SCADA:	Supervisory Control and Data Acquisition
IUT:	Islamic University of Technology
EEE:	Electrical and Electronic Engineering
EPE:	Electrical Power Engineering
UoH:	University of Hargeisa
UoB:	University of Burco
CAC:	Computing Accreditation Commission
ASAC:	Applied Science Accreditation Commission
ETAC:	Engineering Technology Accreditation Commission
EAC:	Engineering Accreditation Commission
CHE:	Commission for Higher Education
USAID:	United States Agency for International Development
IPP:	Independent Power Producers
SEA:	Somaliland Energy Association
SNM:	Somali National Movement
ENEE:	Ente Nazionale Energia Eletrica

ABSTRACT

The current and rapid expansion of the higher education sector in Somaliland makes it an interesting case study for this research on knowledge gap between EE graduates and power companies in Marodi-jeex Region (Somaliland). Aim of the study was to investigate the knowledge required in the power companies and compared with the knowledge acquired by EE graduates of UoH. Although most of power companies use fuel for power generation, they have recently started to invest renewable energy since the old methods is limited due to scarcity of resources, thus the knowledgeable skilled workforce required by this new technology is necessary to be available. The study used purposive sampling technique, where there were two types of participants; one from the power companies where each power station represented a single participant and UoH graduate students of BSc in EE Department. Questionnaire and document analysis was used for this study. The questionnaire was made as an inquiry tool to know what type of knowledge required by the power companies. The curriculum of UoH department of EE was examined by comparing it with ABET standards. Past years question papers were also analyzed. Different types of knowledge required by power companies found in this study include: knowledge of electrical power system modeling, analysis and planning, knowledge of electrical power system equipment, knowledge electrical power system protection and condition monitoring, HV technology, power station, transmission distribution, software configurations including synchronization panel configuration and SCADA .Although the curriculum of UoH is not in line with ABET standards, the study found that students learned courses that address the knowledge requirement of the power companies. The study focused on first three knowledge dimension of the revised version of Boloom's taxonomy to assess different items in question papers. In the analysis of question papers the study found that the content covered 35% of factual knowledge, 20% of conceptual knowledge and 44% of procedural knowledge. According to the results found there is no knowledge gap between university electrical graduates and the power companies' knowledge requirements. The little problem is mainly due to lack of more practical and lack of awareness of the needs of the power companies. The assessment of this study was only about the knowledge. In-depth the whole competency (skill, knowledge and attitude) should be investigated the. Due to many reasons including time, it was not possible for the study to assess students by examining them directly; such assessment is very much needed in further studies.

CHAPTER ONE

1.0 Background

Somalia's energy sector and institution was completely destroyed following the civil war which led to the collapse of the central government in 1991 and the destruction of ENEE (the only monopoly company responsible for electricity generation, transmission and distribution). Local People were left in the dark and forced to depend on smaller and less resourceful electricity suppliers that emerged to replace the collapsed public power companies with privately owned diesel generators. With Somaliland's education system seriously damaged by war and disorder, the country set about reconstruction and restoring.

The current and rapid expansion of the higher education sector in Somaliland (a post conflict, self-declared republic in the Horn of Africa that was formerly part of Somalia) made an interesting case study for this study on knowledge gap between EE graduates and power companies in Marodi-jeex Region (Somaliland) .Generally The recent history of Somaliland diverts from that of many other countries in the region. While other countries were entangled in structural adjustment programs in the 1980s, Somaliland (then part of Somalia) was embroiled in prolonged uncertainties that turned into full-blown war in 1988. Despite these historical events, the post-war growth of the higher education sector in Somaliland has mainly followed the general development seen elsewhere in the region. Higher Education came back to life in 1998 and the Engineering Faculties especially EE departments re-emerged in just after 2010.

1.1 Introduction

EE works are in a very wide range of industries and the knowledge required is likewise variable. These ranges from basic circuit theory to the management knowledge and skills required of a project manager. This study will explore the knowledge required in the power companies in conjunction with the knowledge acquired by EE graduates. EE skill profession is one such field where engineers are required to have knowledge and skill competencies that can be strategically employed for the firm’s competitive advantage. Core skill competencies of engineer’s are specific skills, attributes and behavior patterns that are most required for successful performance of engineer’s jobs and/or their roles. Obviously engineering graduates are likely to display the knowledge, skills and abilities that they have acquired during their undergraduate education. Their ability to show the competencies acquired during their undergraduate education has been significant measure of their attainment of learning outcomes during the educational process. The ability to authenticate assessment as a reliable method for indirect assessment of learning outcomes is useful in assessing EE student preparedness for entry into the workplace including an evaluation of the engineering program curricula that are used to prepare the undergraduate engineering students. Through the EE degree, graduates develop important skills and knowledge such as creativity and novelty, practical application of engineering technology and science, Technical knowledge of electronic and electrical systems, dealing with rapid technological changes, diagnostic and problem solving skills but also logical and quantitative thinking. Engineering companies across many industrial sectors have recognized that their engineers' skills and knowledge provide the greatest force for economic competitiveness.

Most power companies in Somaliland operate diesel generators, but nowadays power companies also invest renewable energy since the old methods of producing power are limited due to scarcity of resources , thus the knowledgeable skilled workforce required by this new technology is necessary to be available, but Somalia is lacking important knowledge and skills to enable the deployment of renewable energy as mentioned by (Maia Blume (Forcier Consultng) 2016) .More specifically, the effective utilization of a company's engineers, through the most appropriate application of their skills and knowledge, can improve organizational performance. Before enabling the effective utilization of their engineers, companies need to model their required competencies.

This study focuses on competencies such as knowledge from the perspective of the power companies as future employer of new graduate engineers. Power companies may need different types of competencies when recruiting young graduates, what type of knowledge do they need? What are their expectations and main concerns? All these are importance for this study to know.

1.2 Statement of the problem

The ongoing transition of power companies from the traditional operating of diesel power stations and the use of non-renewable energy sectors to the highly innovative hybrid power stations that use combination of renewable and non renewable energies requires a qualified and competent workforce. This transition profoundly modified the power companies' requirements for engineering workforce competencies. In addition to more and more specialized technical knowledge they need new multidisciplinary competencies, however the availability of an engineering labor force with the required competencies is often limited on the labor market. Although Engineering universities produce engineers meant to act as professional engineers responsible for the delivery of services such as, design, develop, construct, operate and maintain, There is a substantial amount of work cited in literature and documents that concern the required competencies of power engineers, however, that work was limited to researches and studies conducted in other areas of Somaliland Education. With that in mind, this study explored in particularly the assessment of graduate students' readiness regarding competencies requirements in power companies and the knowledge acquired by the graduate engineers of Maroodi-Jeex Region ,Somaliland.

1.3 Purpose of the study

Generally this study tries to know whether EE graduate students are adequately prepared to take their roles/responsibilities associate/ professional engineer and contribute to the development of the power companies Maroodi-Jeex region of Somaliland. The study also tries to provide feedback to the universities in this region by determining the availability or no availability of gaps. Particularly the power companies and university EE graduates both need each other. Power companies requires knowledgeable workforce and they offer different jobs/occupations to the young graduates .on the other hand universities produce graduates who are expected to fit for the job market.

Therefore the specific objectives of this study were as follows:

1. To determine what types of knowledge required by the power Companies for an EE.
2. To examine the curriculum content of Bachelor degree program in EE ,Considering ABET recommendation
3. To assess the knowledge of the EE graduate students in order to know whether they are ready to work in the Power Companies

1.4 Possible outcomes

The result from this study helps both power companies and the university. In case it is found students are ready this will be good news for the university and power Companies, otherwise university will take notice of the feedback and change curriculum accordingly. The study also believes the findings will add strength to any further research study that relates to this area of my concern.

The study draws attention of the concerned parties, especially in the case of university continuous monitoring of the engineering programs will help the engineering department prepare students for transition into the workplace. Through tracking the requirements of power companies in terms of workplace competencies, EE graduates will gain important knowledge into their own progress as a result of remedial actions. Continuous improvement planning is a key component toward "ABET" accreditation preparations. Accreditation of each engineering department is essential for the continued success of any engineering program. Documentation of the continuous improvement process is essential for ABET accreditation. Employers also benefit from this research. Continually improving the skills and abilities of the graduate engineering student translates to a more competent and qualified employee at the point of hire. A more highly trained engineer at the entry level means less time required in the employers initial training. Employers can focus more on the proprietary knowledge and skills that the student will need to be a more productive, efficient and effective employee for them. Experiential Education is a philosophy that informs many methodologies, in which educators purposefully engage with learners in direct experience and focused reflection in order to increase knowledge, develop skills, clarify values, and develop people's capacity to contribute to their communities.

"Engineering experiential education can and should be integral to the curricular continuous improvement process"(Brumm, Hanneman, & Mickelson, 2006).Continuous monitoring of workplace expectations permit programs to stay abreast of dynamic changes that occur in industries.

1.5 Delimitations of the study

The study was delimited to the EE students of UoH and all power companies available in Maroodi-Jeex region. Only knowledge was assessed instead of whole competency.

CHAPTER TWO

REVIEW OF RELATED LITTERATURE

2.0 Introduction to Somaliland electricity system

Somaliland, officially the Republic of Somaliland is a self-declared state internationally recognized as an autonomous region of Somalia. Following the collapse of Somali government in early 1991, local authorities, led by the SNM, unilaterally declared independence from Somalia on 18 May of the same year and reinstated the borders of the former short-lived independent state of Somaliland. Since the declaration of independence in 1991, Somaliland's electricity system was restored by IPP, these are dedicated privately owned power companies who sell electricity as a central part of their business model and there are many of them were each is supplying areas in its neighborhood.

In Somaliland, each area's electricity infrastructure has been developed by the IPP working in that area. Until now, grids have not been connected. In each of those areas, almost all power distribution is via diesel generators for which fuel is expensive and of variable quality. Electricity-generating technologies in use or proposed for use in Somaliland include diesel engines, heavy fuel engines, very few wind power and solar power. While over 20 IPPs operate in Somaliland, there has been significant consolidation of IPPs in recent years with many of them coming together to form one large company in order to deal with duplication and inefficiencies. This is a trend that is emerging in Hargeisa, Somaliland's capital, the capital of Maroodi-Jeex Region as well as other cities. Larger players have used this opportunity to pursue outside funding which is considerably more difficult for smaller players.

To address some of Somaliland's energy challenges initiatives by the private sector, government, and international agencies operating are currently underway to change Somaliland's energy system. Various Somaliland ministries are participating in training and education programs to improve understanding of different technologies and their continued use. The SEA is the national body representing electricity Service Providers throughout Somaliland. The Association was established in November 2015 with initial funding from utility companies to provide a platform for all Members, to discuss and progress issues of common concern and develop the Energy Sector in Somaliland.

2.1 Challenges faced by Somaliland power producers

Key priority challenges that investors, policy-makers and donors need to address in the sector include:

i. The need to invest in the outdated power plants and limited power distribution network.
ii. The need to diversify away from the dependence on imported fuel for power generation – which has resulted in higher electricity costs in Somaliland.
iii. The development of necessary skills and technical resources to utilize alternative energy sources for power production.
iv. The development, review, passage, enforcement and wide dissemination of key pieces of energy legislation.
v. The need to promote energy saving culture and invest in energy efficient technology.

The most important crosscutting set of issues is the extreme shortage – or absence – of qualified personnel and the uncertainty regarding future supply of trainable persons, given a 24-year interruption of education processes.

Nowadays power companies are interested in investing renewable energy since the old methods of producing power is becoming limited due to scarcity of resources. Hence the skilled workforce required by this new technology is necessary to be available. While Energy consumption across the Somaliland is increasing, yet energy suppliers face significant hurdles in meeting this demand. Besides enabling environment, technology, and access to capital, perhaps the primary obstacle is their employment and technical skill need limitations. Specifically employers like IPP, point to the lack of a sufficiently skilled workforce, a result of insufficient education and training programs to adequately prepare potential employees. Employers also mention the lack of training programs available with them to current employees and an inability to provide high-quality on-the-job training as limitations to a stronger workforce.

IPP indicated that they are urgently seeking to hire technical experts in the next two to five years. Specifically, they say that technical managers, technical quality control officers, installation and maintenance professionals, EE, and project managers will be in highest demand. This staffing desire underscores the need to shift the balance between technical staff, operational staff, and support staff in these companies. In addition to that a report by (Coolidge, 2015) also mentioned lack of skilled workers in the energy sector.

Availability of competent workforce is very important in the power companies, a personnel having competency/knowledge relating to energy, both conventional and renewable. A report prepared by (Group, 2015), indicates that the USAID has been supporting various parts of Somaliland with assistance in drafting legal and regulatory texts. It has also supported a pilot project of wind energy (five small wind generators at Hargeisa Airport, costing USD 350,000) which became operational in late 2014 and was linked to the grid; however the energy minister decided to halt the operation because he found that the required maintenance could not be conducted. To avoid inevitable breakdown, the minister decided to mothball the wind turbines until such time as proper maintenance could be carried out. This is another manifestation of the shortage of skilled personnel and of the difficulty of maintaining equipment with both electronic with mechanical component.

2.2 Higher education of Somaliland

Somali regions endured over a decade of civil strife beginning in the late 1980s. Every institution of higher education which existed during these times closed due to violence, destructions of facilities, general instability and the accompanying lack of funding and state support. Proceeding to the establishment of Somaliland's first university "Amoud" in 1998 in Borama, Awdal region, Somaliland had no institutions of higher education. This is not a surprise considering the turbulent history of the country, which is characterized by protracted periods of political, social, and economic difficulties. The first three universities established in Somaliland were Amoud, Hargeisa, and Burao and they were all community universities. In 2000, the UoH was established in the capital. In 2004, the University of Burao was founded in Burao, capital town of Togdheer region. Among these universities it is only UoH that has a department of EE. This shows that there is scarcity of EE in the country. To have electrical engineers that can work in the power companies is a direct and tangible need to the region's future for stable energy sector. In 2011, the president of Somaliland, Ahmed Mohamed Mohamoud Silanyo decreed the establishment of the CHE which is a semi-autonomous body -responsible for monitoring higher education. Given the chaos of the past two decades; the strong rebound of Somaliland's engineering programs is remarkable. Currently, the number of universities and engineering programs surpasses anything prior to the turmoil.

2.2.1 Fields offered by Somaliland Universities 2013–2017

Amoud University: Business and public administration (streams: business administration, management and accounting, public administration, project management); education; health sciences (streams: medicine and surgery, nursing, dental, pharmacy, laboratory technology, anaesthesia); sharia and law; agriculture and environment; computing and ICT; economics and political science; civil engineering.

UoH: Business and economics (streams: accounting, finance, management, public administration, economics); health sciences (streams: medicine and surgery, nursing, midwifery, dental, ophthalmology); engineering (streams: civil, electric, telecommunications); computer science; agriculture and veterinary; applied science (streams: biomedical, environmental, nutrition and food sciences); mathematics and statistics; law; education; social sciences (stream: social work)

UoB: Medicine and nursing; community development; education; animal sciences and agriculture (streams: veterinary medicine, agriculture); business (streams: management, economics); ICT; sharia and law.

Gollis University: Business (streams: administration, accounting, economics, business, information technology); engineering (streams: civil, telecommunications, computers); medicine and allied health (streams: general medicine, public health, laboratory, nutrition); social and behavioral studies (streams: social science studies, international relations and political science, development studies); agriculture; education; geology; languages; veterinary.

Eelo University: Computer science; engineering (streams: civil, telecommunications); management science; geology; agriculture; natural sciences.

Alpha University: Accounting; business management; computer science; law; management and information science; development studies; engineering (streams: civil, telecommunications); livestock assistant; political science; public health; social work; rural development management; urban development management; economics; development and management; educational planning and management; procurement and supplies management. The theoretical expectations that through teaching and research higher education institutions create and distribute knowledge producing skilled graduates who are not only productive, but are also able to diffuse technology and accelerate technological catch-up largely confines discussion about the role of higher education institutions to this (economic) development perspective. This role is perceived to be the exemplary task defining the very existence of higher education institutions. The higher education sector in Somaliland was established as a social institution needed to remedy social and economic ailments that were specifically related to the post-war environment.

2.2.2 Challenges faced by Somaliland's Higher Education

The higher education sector is entirely in the hands of non-state actors. The normal definitions associated with institutions as either public or private do not work very well in Somaliland. Therefore, the assumption that there is a 'capable state' to oversee the sector in order to enhance the development impact of the activities of higher education institutions is challenged. For instance, when one university starts one program, most universities quickly started to offer the course even if they lacked the required laboratory facilities for practical training. This absence meant that students only learnt about theoretical materials.

In addition to introducing some innovative courses or bringing practical facilities for the students , universities are try to offer the same courses that other universities in the area are offering. This is done to erode any potential reasons students might have for choosing a promising fields of interest with innovations in the country.

Similar to establishing brand-new courses, adhering to this can result in universities becoming too ambitious and implementing courses that they do not have capacity to provide.

The discussion above points out that factors shaping institutions' decisions to establish courses are mainly influenced by the need to attract students and enhance the financial viability of institutions. Critical questions such as the capacity of universities to offer these diverse and complex courses, though pertinent, do not feature prominently in these decisions. Further questions about the relevance of these courses to the local economy also receive little attention

It also means that universities stretch themselves too thinly and consequently fail to address issues of quality, because "analysis of quality should not be detached from purpose and context" (Sursock, 2010). Although it may be true that the absence of the state in the provision of higher education in Somaliland, along with the significant challenges that the state faces in trying to manage and regulate the sector through the CHE, may be more extreme due to the recent history of the country, As mentioned by (Ali, 2016) "Somaliland is not unique, Rather, Somaliland reflects experiences across many fragile countries in Africa characterized as weak states, with the African region as a whole containing the largest number of countries in the world considered to be fragile".

2.3 Competency of Knowledge

Maintaining or improving the quality of higher education institutions in an era of rapid expansion and limited resources especially in less economically developed countries is challenging. In reviewing the literature for this study, the researcher sought to find sources in which both university faculty members and engineers practicing in power companies were questioned about their views concerning the readiness of EE graduates to work in the power companies. There is very little evidence of research focused on how well EE faculty conceptions relate to curriculum development and the demand power companies. Since this study investigates knowledge gap which is part of competency, It is important to know and ask; what is competency?.

The term competency has been defined in the literature from a range of perspectives (Hoffmann, 1999), McClelland (David, 1973) suggested the term as a criterion for judging the success of performance. Herschbath (Shippmann et al., 2000) stated that competencies are more than the ability to manipulate tools, use materials, and apply mechanical processes; competency is the external behavior of an individual according to his/her knowledge, skills, and attitude. As such, competency is reflected in one's values, attitudes, and judgment (Lysaght & Altschuld, 2000). Autio and Hansen (Autio & Hansen, 2002) specifically defined technological competence as an interrelationship between technical abilities in psychomotor, cognitive, and affective areas. Competencies are clusters of related knowledge, skills, and abilities that correlate with effective performance in the task or role at hand. Critically, competencies are measurable and can be Developed(Parry,1996).Competency frameworks have been applied in various settings as training and recruitment tools (Foxon, Richey, Roberts, & Spannaus, 2003), for the assessment of managers, and for educational professionals in recruiting and developing staff as well as designing curriculum(Ball et al., 2012). Analysis of competency involves the identification of the behaviors required by professionals to perform job-related tasks. These behaviors include motives, skills, and knowledge of fundamental characteristics.

Competencies are comprised of three levels: dimensions, perspectives, and indicators. Dimensions refer to the major skill areas required by a field, perspectives refer to the capabilities required in these various dimensions, and indicators are used to measure these capabilities through three concrete criteria: knowledge, behavior, and attitude. The competency that this study focuses is the knowledge which comes under indicators of three levels of competency where indicator tools such questionnaire and documents analysis.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

Qualitative research method was used in conducting this study. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions according (Myers & Newman, 2007). Today, the use of qualitative method and analysis are extended almost to every research field. The choice of this research method was made in relation to the research objectives**.** The main objective of this study is to find knowledge gap between University graduate students and the Requirements of the power Companies in Maroodi-Jeex Region, Somaliland**.**

3.1 Research design

Questionnaire and document analysis was used for this study which is considered appropriate for this research work. The questionnaire was chosen because it is effective in seeking the views of the peoples about a particular issue that concerns them (Bukar, 1995).

In the questionnaire a list of questions representing research objectives were presented to draw answers from the concerned participants, whereas in the document analysis the focus was on the content analysis for the search of answers relevant to the study.

The data from different sources was later compiled and analyzed carefully. Content analysis is also useful for examining trends and patterns in documents; for example, (Stemler & Bebell, 1999) conducted a content analysis of school mission statements to make some inferences about what schools hold as their primary reasons for existence.

3.2 Scope and population of the study

The population of this study comprised of the EE gratuates/ students of Hargeisa University with specialization in EPE and the power companies available in Maroodi-Jeex region in Somaliland.

3.3 Sample and sampling technique

The study considered non-probability purposive sampling. Similar to quantitative studies' use of random sampling to avoid biases in their analyses, qualitative studies use purposive sampling to ensure that the data they collect will be meaningful (Patton, 2002). Depending on the types of questions asked, the study selected the participants so that they could be able to provide the key information essential for this study. In this study there were two types of participants one from the power companies where each power station represented a single participant and university graduates students of BSc of UoH in EE Department. The questionnaire was made as a inquiry tool for objective one and three of the study, objective one was about determining what types of knowledge required by the power Companies, whereas objective three was about assessing the knowledge of the EE graduate students to know whether they are ready to work in the Power Companies. The following table-1 shows sampling areas and participants.

Table 1: Sampling area and number of samples

Description	**Name of Power Company**	**No of sample**
Engineer	National Electric Power	1
Site Engineer	SOMPOWER	1
Engineer	Gaafane Power Company	1
Chief Engineer	Telesom Electric Company	1
Total		**4**

Besides the questionnaire, there was also document analysis including exam papers and curriculum content analysis of the UoH to satisfy objective two of the Study which was about examining the curriculum content of Bachelor Degree Program in EE Considering ABET recommendation.

3.4 Tools of data collection

Tools for data collection for this study were mainly questionnaire and document analysis.

To know the competency/knowledge required by the power Companies the inquiry was in the form of questionaire. The questionaire was filled in by the designated person(s) from the power companies. In that questionaire all necessary competency/ knowledge related to power companies was presented in detail.

In case of the curriculum, the content was compared to other standard contents including ABET (Acreditation Board of Engineering Technology) and other well recognized institutions, for example, Islamic University of Technology (IUT), a subsidiary organ of OIC.

To assess the knowledge of the gratuates and graduate students, their semester exam question papers was analysed in terms of content and cognitive process ability/ validity.

3.5 Data analysis

Assessment in the context of education is the process of characterizing what a student knows(Greeno, Collins, & Resnick, 1996). The reasons to perform assessment can be quite varied as said by (De Corte, Greer, & Verschaffel, 1996). In some cases we assess in order to verify a student's mastery of a domain, such as when we want to verify prerequisite knowledge or verify that students have achieved acceptable knowledge of a subject matter. In other cases, such as classroom assessment(Angelo & Cross, 1993), we assess in order to explore and understand what is being learned. We may assess because we want to assign grades in a course, tweak the structure of a course, or even to explore research questions.

Finding an appropriate assessment tool can be a central challenge in designing an assessment approach(Royer, Cisero, & Carlo, 1993). The difficulty arises because of the diversity of learning objectives(BLOOM'S, 1965), the diversity in what counts as evidence of learning(Greeno et al., 1996), and the diversity of tools available(Royer et al., 1993). For example, we may need a tool that permits us to assess knowledge other than definitions, problem solving abilities, and performance abilities. While sometimes we want to verify student knowledge about a common set of predefined objectives, at other times we may need a tool that permits us to explore student learning in an open-ended way and also to identify individual differences in learning and understanding.

This study focused on the use of document analysis in addressing ways to draw information from the different source of data collected for this study. Document analysis provides means to capture and represent student knowledge. The analysis is done by using mainly Microsoft Excel.

3.6 Validation of tools for data collection

The drafted questionnaire of this study was validated by expert Engineers from the Power Companies and The Dean of college of Engineering of UoH. Their comments were considered in modifying the test items or questionnaire. In qualitative research with diverse sources of data, the essence of reliability for qualitative research lies with consistency. As proposed by (Silverman, 2009),The study followed approaches in enhancing the reliability of process and results such as: constant data comparison, and comprehensive data use. As data were extracted from the original sources, researcher verified accuracy in terms of form and context with constant comparison of the different data from different sources.

CHAPTER FOUR
ANALYSIS OF DATA AND INTERPRETATION

4.0 Introduction

The general objective of this study was to understand what was the knowledge demands of the power companies and whether EE graduate students of UoH (the only university that provides EPE) were adequately prepared to take their roles/responsibilities to contribute to the development of the power companies in Maroodi-Jeex region, as well as to provide feedback to the universities in this region to be aware of whether there is knowledge gap or not. To address this general objective the study contacted both university and power companies. The findings of the study is presented and analyzed in the following subsections.

4.1 Research objective-1: Determining type of knowledge required by power companies

In order to examine the research objective-1, a questionnaire was distributed to the power companies as mentioned earlier in chapter 3, the questionnaire presented mainly relevant questions that could draw from the power companies the knowledge they required. The answer of related questions is explained in the following paragraphs in detail. The full set of questionnaire is given in Appendix **A**.

Findings of question item “Q1.1”

In Marodi-Jeex Region of Somaliland there are four power companies and all companies generate, transmit and distribute electrical power. All companies use diesel fuel for power generation.

Findings of question item “Q1.2”

All four companies indicated that they need engineers with the knowledge and skills in the following fields:

- Knowledge and skill of generation
- Knowledge of Transmission and Distribution
- Knowledge of power system operation (power station)
- Knowledge of installing of power equipment (construction)

- Knowledge of testing and commission of electrical power equipment
- Knowledge of maintaining electrical power equipment

Findings of question item "Q1.3"

All the four power companies of Maroodix Jeex Region employs engineers of following categories: EEP and EEAP and other technical staff and their percentage proportion are 3%, 6% and 91% respectively(please see Fig:1). The EEP and EEAP are very few in this proportion.

Table 2: Number of employees in the power companies in Maroodi Jeex Region

Power Company	EEP	EEAP	Other technical staff	Total# of employee
SOMPOWER	3	10	350	363
TEC	2	7	100	109
NEC	5	2	40	47
GPC	7	14	50	71
Total	**17**	**33**	**540**	**590**

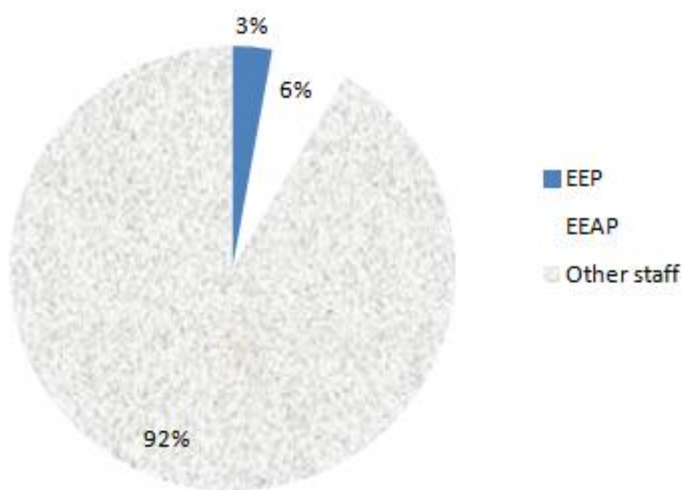

Figure 1: Proportion of different employees in power companies

Findings of question item "Q1.4"

The following figure shows the number of EEP and EEAP engineers in different age groups.

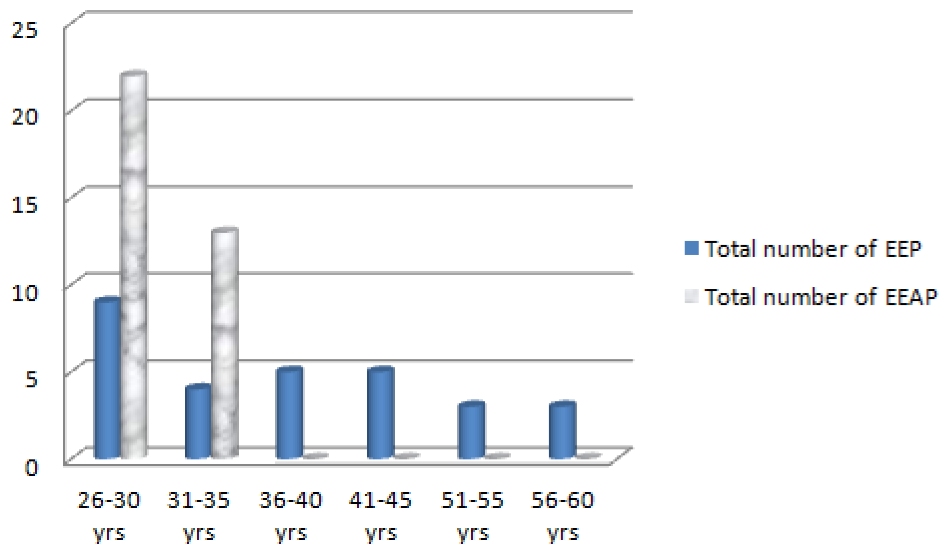

Figure 2: Power Companies engineers age category

From the figure it is seen that the age of EEP is very old and the young recruited EEAP is young and more than the number of EEP. Power companies told that the graduate recruits of UoH are increasing each year, even though they lack practical experience they learn more in the field.

Findings of question item "Q2.2"

The following electrical power related topics were presented to each of the four companies to comment the importance of the topics to their employees:

- Power electronics
- Drives
- Electrical power system modeling ,analysis and planning
- Electrical power system equipment
- Electrical power system protection
- Condition monitoring
- HV technology

- Power station
- Transmission
- Distribution

All companies commented that knowledge in these topics was ’important’ and participants responded as ‘very important’, for their employees.

To sum up aforementioned results, the different types of knowledge required by power companies of Maroodi-Jeex region Somaliland are listed exclusively in the findings of question item Q1.2 and Q2.2. Besides that list of knowledge the power companies added their own comments about their required knowledge including:

i. Renewable energy
ii. Software configurations
iii. Monitoring and control systems, such as SCADA.

4.2 Research objective-2: Examining of the curriculum of University of Hargeisa

Research objective-2 was to examine the curriculum content of Bachelor Degree Program in EE. Considering ABET recommendation. Curriculum content of UoH was compared to ABET (Policy & Manual, 2016) requirements (please see Appendix C for details) and other well recognized institutions, for example “IUT” a subsidiary organ of OIC.

The Distribution of Credits and Contact Hours of Subjects (Islamic University of Technology) Department of EEE

A credit hours and contact hours assigned to each of the subjects mentioned above were calculated. The total number of credit points is 182 and they are distributed as shown in the table-3.

Credit hour and contact hour definition of IUT

3 credit hour theory course → 3 contact hours of theory class a week per semester

2 credit hour theory course → 2 contact hours of theory class a week per semester

1 credit hour theory course → 2 contact hours of practical class a week per semester

0.75 credit hour theory course → 1.5 contact hours of practical class a week per semester

3 credit hour project thesis → 6 contact hours of project thesis work a week per semester

Table 3: Distribution of credits and contact hours offered to students with power specialization of IUT EE department

Subjects	Credit Hours	Contact Hours per week		
		Theory	Practical	Total
Arts, Humanities and Social Science	16	14	4	18
General Science and Mathematics	32	30	7.5	37.5
Engineering Compulsory	17	6	20	26
Engineering Specialization (Power System)	108.25	90	35.5	125.5
Interdepartmental Courses	8.75	5	3.75	8.75
Total	182	145	70.75	215.75

As it is seen in Table-3; there are 182 credit hours and 215.75 contact hours in the B.Sc. EE with specialization of power system in IUT.

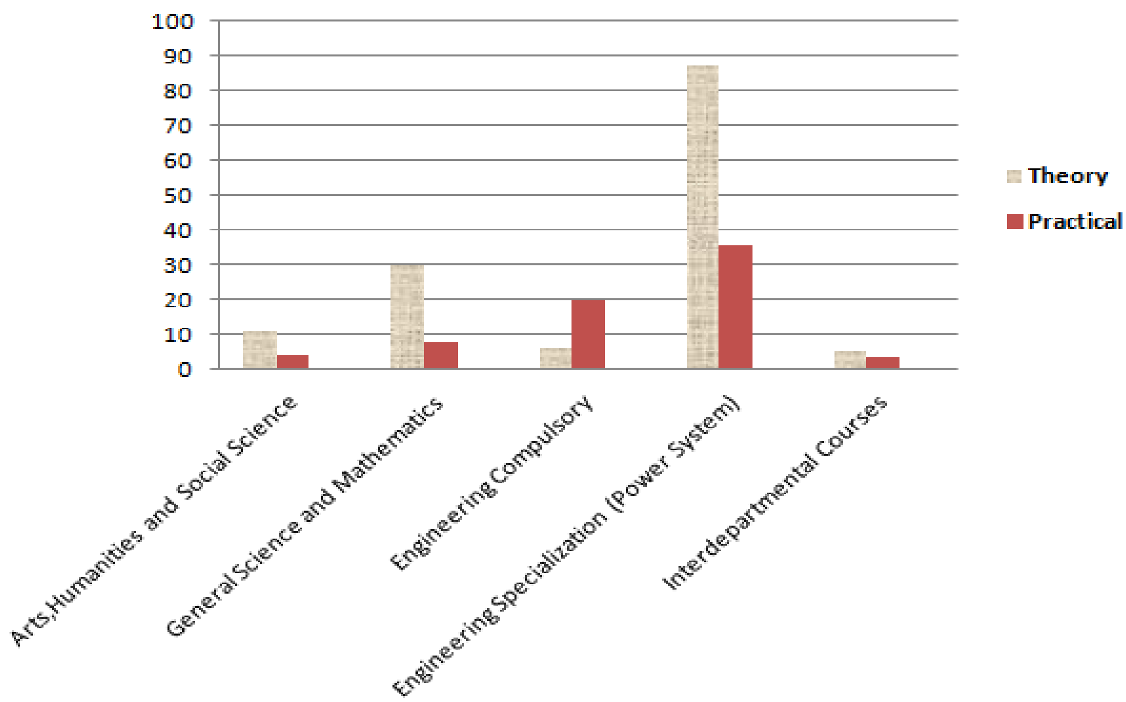

Figure 3: contact hours of categorized subjects, EEE department IUT

The Distribution of Credits and Contact Hours of Subjects UoH

A credit hours and contact hours assigned to each of the subjects mentioned above were calculated (please see Appendix **B)** for details. The total number of credit points is 170 and they are distributed as shown in the following Table-4, next page.

Credit hour and contact hour definition of UoH.

3 credit hour theory course → 3 contact hours of theory class a week per semester

2 credit hour theory course → 2 contact hours of theory class a week per semester

3 credit hour theory course → 3 contact hours of practical class a week per semester

2 credit hour theory course → 2 contact hours of practical class a week per semester

Table 4: Distribution of credits and contact hours offered to students with power specialization of UoH EE department

Subjects	Credit Hours	Contact Hours per week		
		Theory	**Practical**	**Total**
Arts, Humanities and Social Science	32	32	0	32
General Science and Mathematics	15	12	3	15
Engineering Compulsory	21	9	12	21
Engineering Specialization (Power System)	87	75	12	87
Interdepartmental Courses	15	9	6	15
Total	170	137	33	170

As it is seen in table-4; there are 170 credit hours and 170 contact hours in the B.Sc. EE of UoH.

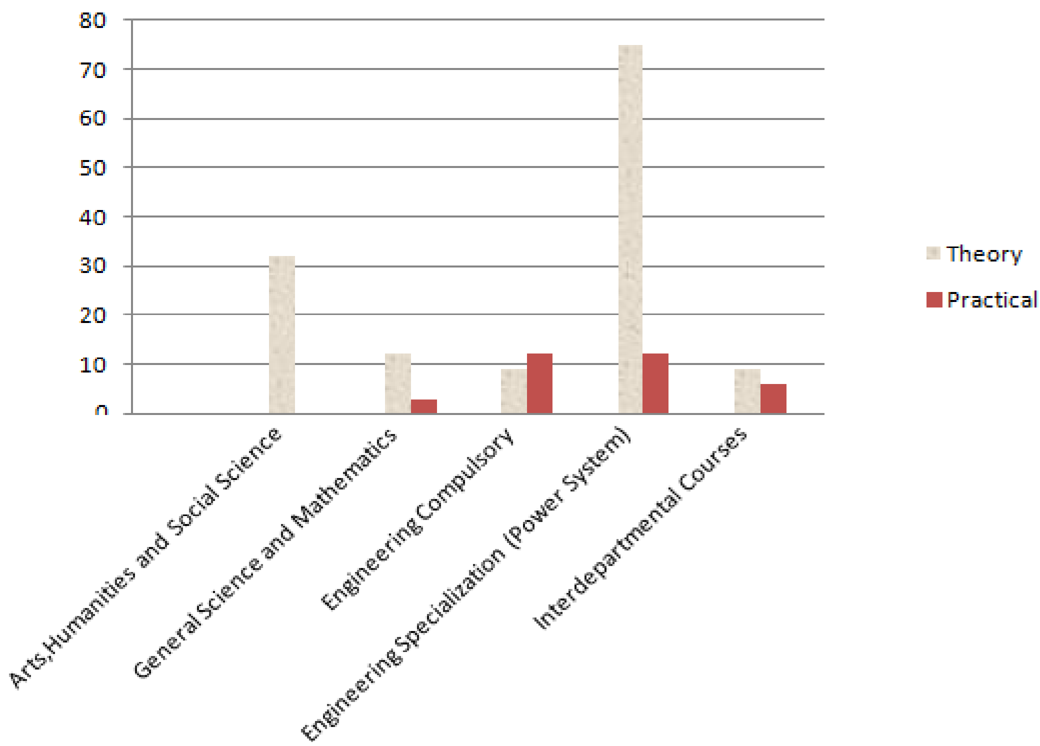

Figure 4: contact hours of categorized subjects, EE department UoH

To sum up the aforementioned results, the curricular of both IUT and UoH have been studied.

Both curricula are organized subject/course-based. However IUT curriculum clearly differentiate between theory and practical courses, whereas UoH curriculum does not differentiate between theory courses and practical courses, except few courses that are supposed to be practical in nature. When compared the Credit UoH and IUT. Although is not accredited by ABET, IUT is in line with the required credit hours of ABET. UoH program duration is 5 years which is equivalent to 10 (ten) semesters, while IUT is 4 years or 8 (eight) semesters. The total credit hours for B.Sc. EE in IUT are found 182 while UoH is 170. The reason why IUT has more contact hours than UoH is that the UoH doesn't have separate contact hours for practical courses as IUT does. After consulting all those mentioned documents it seems that the curriculum of UoH is not in line with ABET in terms of criterion 3 and 5 that address student outcome and the curriculum respectively (please see Appendix C).

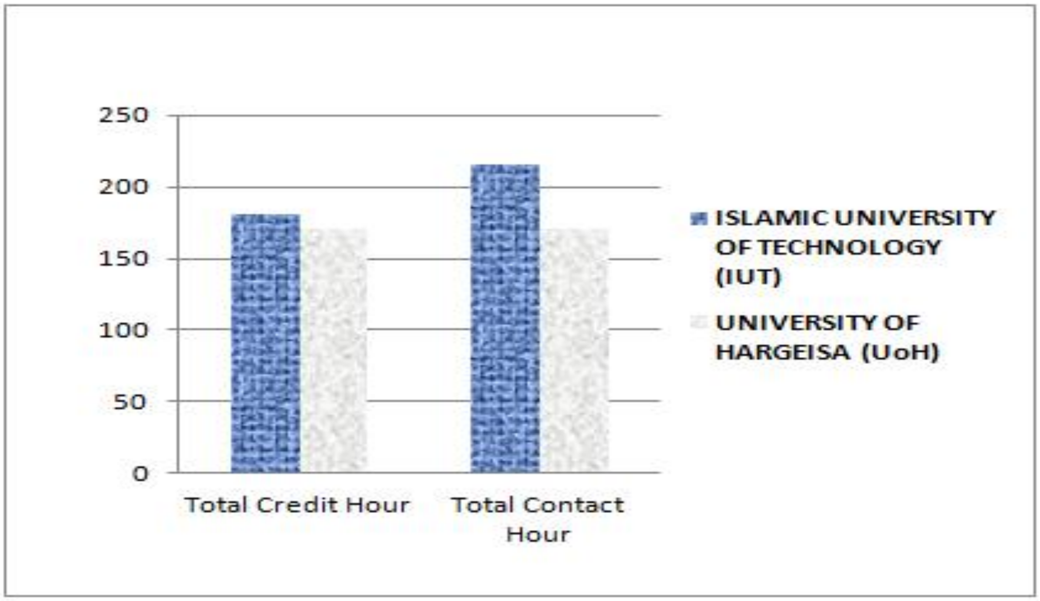

Figure 5: Credit and contact hour comparison of IUT and UoH

4.3 Research objective-3: Assessment of the Level of Knowledge EE Graduates

Research objective-3 was to assess the level of knowledge of the EE graduate students in order to know whether they are ready to work in the power companies.

The level of knowledge of graduates was assessed by the power companies through a self designed questionnaire and through analysis of semester final question papers of UoH. A questionnaire was distributed to the power companies, the questionnaire presented mainly relevant questions that could draw from the power companies whether graduates has the proper knowledge to work for the power companies. The findings of these questions are explained in the following paragraphs in detail.

Findings of question item "Q2.1"

After response of the four power companies about the quality of education of newly graduated electrical engineers, the total percentage response about graduates' education adequacy was very small as shown in the pie chart below and they said the newly graduates don't have the proper training needs of the power industry.

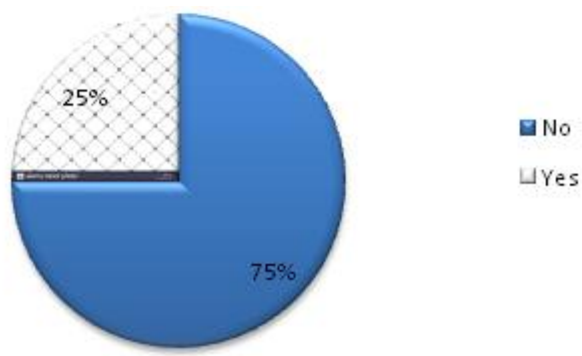

Figure 6: Percentage of quality EE graduate in the field (response from power companies)

Findings of question item "Q3.3"

All of the four power companies highlighted the importance of practical training experience for the engineering graduate students; they recommended EE students should possess knowledge of renewable energy, Power control and monitoring software including Sync panel configuration and SCADA.

Analysis of Semester final Question Papers.

Semester final exam question papers of some selected courses which are offered for bachelors degree study program of EE of UoH were collected and then analysed according to the revised **Bloom's Taxonomy**. According to the **revised** version of Bloom's Taxonomy there are six levels of cognitive learning where each level is conceptually different. The six levels are remembering, understanding, applying, analyzing, evaluating, and creating.

A question paper consists of seven to six questions, the questions were essay type as well as structed. The focus was to find the knowledge acquired by students where the knowledge dimension is categorised into four: Factual knowledge,Conceptual Knowledge ,Procedural Knowledg,Metacognitive knowledge.

Table-5: Knowledge dimensions covered at EE department of UoH Based on exam question papers

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	15%	12%	8%			
Conceptual Knowledge		20%				
Procedural Knowledge		5%	18%	18%		3%
Total	15%	37%	27%	18%	0%	3%

the cognitive process ability is divided into six levels:

1-Remember 2-Understand 3-Apply 4-Analyze 5-Evaluate 6-Create

The study focused only the first three categories of the knowledge ,where each category of knowledge may have different levels of congitive process.the question items of the slectected questionn paper were studied and question items were classified according to revised Bloom's Taxonomy and the findings are shown in figure-7.

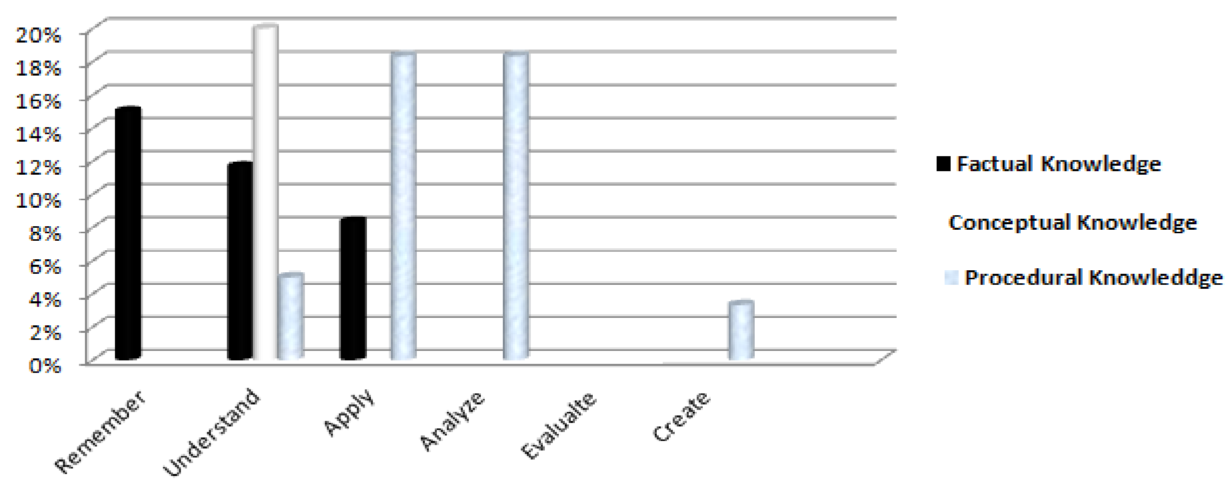

Figure 7: Knowledge acquired by EE graduates

Items in question papers was interpreted as knowledge acquired by students , because question item will be considered as practical relevant if there is a possibility that the knowledge and skills related to this item will be used later in learner's future workplace(knowledge transfer/ utilization).

CHAPTER 5

SUMARRY, FINDINGS, CONCLUSIONS AND RECOMMENDATION OF FUTURE WORK

5.0 Summary of the study

This chapter provides a summary of the study, major findings, conclusions and recommendations. Major findings are organized such that each research objective is associated with findings.

The purpose of this study was to explore what are the electrical engineering knowledge demands of the power companies and whether electrical engineering graduate students are adequately prepared to take their roles/responsibilities to contribute to the development of the power companies in Maroodi-Jeex region, as well as to provide feedback to the universities in this region to be aware of whether there is knowledge gap or not.

The study included four major power companies in Maroodi-Jeex region of Somaliland and EE department of UoH. The assessment was carried through a self designed questionnaire for the power companies and through analysis of curriculum and semester final question papers of UoH. Questionnaire consisted three main parts named: General issues and categorization of power companies, issues with professional engineers in electrical power engineering Electrical and Power engineering education. The questionnaire data and documents were analyzed using Microsoft Excel.

5.1 Findings

Based on the analysis in chapter-4, the summary of the findings regarding three main study objectives of the study are below:

General Information about Power Companies

There are only four major power companies in the Marood-Jeex Region of Somaliland.
In the general part of the questionnaire (please see Appendix A), the study found that the most important source of electrical engineers was the engineers from other local power companies (who are not graduates of UoH), while second, third and least important engineers are from:

former electrical engineers, university graduate or associate professional engineers and engineers from overseas respectively.

In another response about the shortage of electrical power engineers, three power companies out of four in the region were optimistic that there will be no shortage of electrical engineers in the near future, as the number of power companies is not many.

There was one company named SOMPOWER, they said "yes" there may be continues shortage of qualified electrical engineers "because number of EE professionals are very small and old aged, while the new graduates don't have adequate experience and training required by the field".

In case of shortage of power engineers, in another response all of the four companies advocated for two measures to avoid the shortage, which are:

i. To increase the number of EPE graduates from universities in the Region.
ii. To reform university curriculum so that they introduce more knowledge and skill oriented courses on electrical power specializations.

The study was focusing on the EE graduate students with specialization in power system, the author found the number of students in the final year of EE department of UoH was 25(twenty five students) with specialization of power system. This is the only university in the region which offers Bachelor's degree with specialization in electrical power system.

Determining type of knowledge required by power companies

All the four power companies categorized themselves as electrical power generating, transmitting and distributing organizations (companies). The knowledge they required included:

- Knowledge and skill of generation
- Knowledge of transmission and distribution
- Knowledge of power system operation (power station)
- Knowledge of installing of power equipment (construction)
- Knowledge of testing and commission of electrical power equipment
- Knowledge of maintaining electrical power equipment

Besides the different knowledge listed for the power companies to choose in the questionnaire, they were also provided a space to comment and write what type of other knowledge not included the list. All of the power companies voiced about the necessity of the newly graduate electrical engineers to have knowledge of renewable energies, knowledge of generator configuration, paralleling and synchronization knowledge and the knowledge of modern monitoring and control.

Examining the curriculum of University of Hargeisa

After the study examined the curriculum, it has found deficiencies including:

i. The courses offered in the EE department of UoH match the requirements of the power companies as shown in Table-6

ii. Lack of balanced proportion of the curriculum components, specially mathematics and basic sciences which is appropriate to the discipline of study.

iii. Proportion of practical contact hours are not clear in the curriculum of UoH.

Table: 6 Map of some of UoH curriculum courses and power companies' requirements

Area of knowledge required by power companies		**Courses taught at UoH**
Power generation	↔	Energy conversion , Electrical Machines,
transmission and distribution	↔	Power system
power system operation (power station)	↔	Advanced Power system
installing of power equipment (construction)	↔	Electrical Installation
testing and commission of electrical power equipment	↔	Electrical installation and field trips
maintaining electrical power equipment	↔	Workshop practice
Power control and monitoring	↔	Control system, advanced control system
Software including Sync panel configuration and SCADA.	↔	Industrial Automation

Note: please see Appendix B for course names with course code.

Assessment of the Level of Knowledge of EE Graduates

Although power companied complained that knowledge possessed by the newly qualified electrical power engineers or graduates was not adequate, yet after the assessment of the semester exam papers of UoH, the study found that students acquired different knowledge dimensions deduced from the question items which in turn represent the course content delivered to the students (please see fig-7 for details). Most of the knowledge required by the power companies is thought in the UoH, as seen from the curriculum and the questionnaire**.**

5.2 Conclusion

Based on the analysis of the data and findings of the study, the study found that the power companies are lacking engineers that have experience in the field, newly graduates acquired knowledge from the course contents taught at the UoH. Since electrical engineering graduate students of UoH were not exposed to more practical work scenarios in the school or in the industries as seen from the curriculum, they are seen weak in the workplace. The knowledge required by power companies is taught and delivered to UoH graduates as shown in Table-6 there is no significant knowledge gap between the university electrical graduates and the power companies' knowledge requirements. The complaint of the companies may be due to lack of insufficient practical classes at UoH and lack of awareness of the requirement of the power companies.

5.3 Recommendations:

The power companies and university authorities should work together and try to have mutual agreement such as giving industrial training to the students to get practical experience and learn what important knowledge in the field is. University should reform or review the curriculum and add more practical courses and laboratory facilities. University should involve qualified trainers in the instructions so that students will attain the much needed knowledge and skill in the school which in turn leads to the achievement of the objectives of the program.

5.4 Future Work

The purpose of this study was to explore whether electrical engineering graduate students are adequately prepared to take their roles/responsibilities to contribute to the development of the power companies in Maroodi-Jeex region. The assessment was only about the knowledge. In-depth the whole competency (skill, knowledge and attitude) should be investigated. Due to many reasons, it couldn't be possible for the study to assess students by examining them directly; such assessment is very much needed in further studies.

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APPENDIX A

QUESTIONNAIRE

Information and Instructions

This Questionnaire is developed to collect data for (M.Sc.TE) thesis titled "**Study on** Competency/knowledge gap between University graduate students and the Requirements of the power Companies in Maroodi-Jeex Region (Somaliland)".

The scope/objectives of the questionnaire are to:

a. Identify the present or anticipated shortage of electrical power engineering competency/knowledge in Maroodi-Jeex region Power Companies
   The type of knowledge skill in demand.
b. Provide an action plan to overcome any shortage
c. Provide feedback to develop a model of professional education in electrical power engineering to suit the future needs of the power companies.

As defined in generic competency standards electrical power engineering professional is defined as "the engineering discipline concerned with research, design, development ,manufacture ,installation ,operation ,maintenance and management of equipment ,machines ,plant and systems associated with generation ,transmission ,distribution and use of electrical power including building services and control of electrical power apparatus. It excludes position whose responsibilities are within information technology, computers and communications.

Definition of an electrical power engineering associate professional : a person is considered to be an electrical engineering technologist of officer if their position description requires the holding of a 2-3 year qualification of electrical engineering and the possession of knowledge and or/experience that could be acquired through a course of study that includes electrical power equipment or systems.

Questionnaire structure: the questionnaire is divided into four sections:

1. Contact details of a suitable person within each power company
2. Categorization of each power company and establishment of electrical power engineering employee numbers and ages
3. Issues with shortages of electrical power engineers and
4. Electrical power engineering education requirements

More information: please contact the author of the study mahamud musa , *mahmuusa@gmail.com*

Confidentiality: the collected data will be treated as strictly confidential and not released to anyone outside the immediate thesis Team (Autor ,Companies and Universities)

Benefits to you: participation in this study will enable your company to gain an understanding of the electrical power engineering graduates available to the power companies. You will also receive a final report of the study to have an opportunity to discuss the outcomes and take actions accordingly.

Please **tick** to make selections and enter data in the boxes provided where required

Please attempt to answer all questions or place "n/a" in the space provided if the question is not applicable to your organization or data is not available. Please return questionnaire by 30 July 2018.

Contact information

Organization

Please

provide the name and contact details of a suitable person within your organization who may be contacted to provide additional information regarding this survey

Name:

Job title:

Address:

State:

Postcode:

Telephone:

Email:

1. General information and Categorization of your organization.

1.1 Please categorize your organization into one or more of the following:

- ☐ Electricity Generator
- ☐ Transmission
- ☐ Distribution
- ☐ Retailer
- ☐ Regulator
- ☐ Manufacturer

- ☐ Installer of electrical power equipment
- ☐ Education and Training
- ☐ Consumer of electric Energy
- ☐ Other (please specify) ---

1.2 Please indicate the competency/knowledge your organization/company significantly requires their new employees to have

- Knowledge and skill of generation
- Knowledge of Transmission and Distribution
- Knowledge of power system operation (power station)
- Knowledge of installing of power equipment (construction)
- Knowledge of testing and commission of electrical power equipment
- Knowledge of maintaining electrical power equipment

- Other (please specify) --

1.3 How many of the following categories of staff do you employ as staff?

☐ Electrical engineering Associate professionals (officers and/or technologists)

☐ Electrical Engineering Professional

☐ Other electrical staff

1.4 please indicate the number of your electrical engineering staff in each of the following age groups:

	Electrical Engineering officers & technologists	Professional electrical engineers
26-30yrs		
31-35yrs		
36-40yrs		
41-45yrs		
56-50yrs		
51-55yrs		
56-60yrs		
TOTAL		

2. Issues with professional engineers in electrical power engineering

2.1. Please rank (1-5 or leave blank if not utilized) the sources of electrical power engineers your company employs/recruits

- ☐ University electrical power engineering graduates
- ☐ Engineers from other organizations
- ☐ Engineers from overseas
- ☐ Re-employment of former electrical power engineers

- ☐ Other (please) specify ---

2.2. Is your organization concerned that there may/will be shortage of electrical power engineers within next 3 years

- ☐ Yes
- ☐ No
- ☐ Unsure
- ☐ What do you think is the reason if (yes or no)? --

2.3. If a shortage of electrical power engineers with knowledge and skills required your organization is assumed/ forecasted, please prioritize (1-3 or leave blank) the following measures the power/or education sector could put in place to minimize the future competency shortages.

- ☐ Increase the number of electrical power engineering graduates from universities.
- ☐ Reform university curriculum to introduce more knowledge and skill oriented courses on electrical power specializations
- ☐ Retain existing electrical power engineers for longer periods

3. Electrical Power Engineering Education

3.1 Is the knowledge and education of the newly qualified electrical power engineering staff adequate, you think?

- ☐ yes
- ☐ no, it is inadequate because --

3.2 please indicate how important the following power engineering topics are for your company

Very important　　important　　Not important

□	□	□	Power electronics
□	□	□	Drives
□	□	□	Electrical power system modeling ,analysis and planning
□	□	□	Electrical power system equipment
□	□	□	Electrical power system protection
□	□	□	Condition monitoring
□	□	□	HV technology
□	□	□	Power station
□	□	□	Transmission
□	□	□	Distribution

3.3 please outline any other issues in relation to the knowledge ,education and training of electrical power engineers that are of interest or concern to your organization :

APPENDIX B

	ISLAMIC UNIVERSITY OF TECHNOLOGY				
	DEPARTMENTOF ELECTRICAL AND ELECTRONIC ENGINEERING				
CATEGORY WISE COURSE STRUCTURE					
Category A	**Arts,Humanities and Social Science**				
Course No.	**Course Title**	**Credit**	**Hrs per Week**		
			L		**P**
Hum 4122/4124	Arabic I /English I	1			2
Hum 4125	Islamic Philosophy ,History and Culture	3	3		
Hum 4225	Professional Ethics and legal issues	3	3		
Hum 4222/4224	Arabic II/ English II	1			2
Hum 4421	Science ,Technology and Islam	2	2		
Hum 4521	Engineering Management	**3.0**	**3.0**		
MCE 4791	Engineering Economics	**3.0**	**3.0**		
	Total of Cat A	**16**	**14**	**0**	**4**
Category B	**General Science and Mathematics**				
Course No.	**Course Title**	**Credit**	**Hrs per Week**		
			L		**P**
Math 4121	Mathematics I (Calculus and Geometry)	**3.0**	**3.0**		
Math 4123	Mathematics II (Matrices and Differential Equations)	**3.0**	**3.0**		
Chem 4121	Engineering Chemistry	**3.0**	**3.0**		
Chem 4122	Engineering Chemistry Lab	**0.75**			**1.50**
Phy 4121	Engineering Physics I	**3.0**	**3.0**		
Phy 4122	Engineering physics I Lab	**0.75**			**1.50**
Math 4221	**Mathematics III (Complex Variable, Vector Analysis and Statistics)**	3.0	3		

Phy 4221	Engineering Physics II	3	3		
Phy 4222	Engineering Physics II Lab	0.75			1.50
Phy 4831	Semiconductor Devices	3.0	3		
Math 4321	Mathematic IV(Transform Tichniques and Linear Algebra	**3.0**	**3.0**		
Math 4421	Random Signals and Processes	3.00	3		
Math 4422	**Random Signals and Processes Lab**	0.75	3		1.50
Math 4521	Numerical Methods				
Math 4522	numerical Methods Lab	**1.50**			**1.50**
	Total of Category B	**31.5**	**30.0**	**0.0**	**7.5**
Category C	**ENGINEERING COMPULSORY**				
Croup 1: Electrical Engineering General					
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4101	Electrical Circuit I	**3.0**	**3.0**		
EEE 4102	Electrical Circuit I Lab	**1.50**			**3.0**
EEE 4201	Electrical Circuit II	3.00	3.00		
EEE 4202	Electrical Circuit II Lab.	1.50			3.00
EEE 4416	Simulation Lab	1.00			2.00
EEE 4590	Industrial Training	1.00			
EEE 4700	Project and Thesis	3.00			6.00
EEE 4800	Project and Thesis	3.00			6.00
	Total of Group 1	**17.0**	**6.0**	**0.0**	**20.0**
Group 2	**Power System**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4418	Electrical Services Design	1			2.00
EEE 4301	Power System I	**3.0**	**3.0**		
EEE 4302	Power System I Lab	**0.75**			**1.50**

EEE 4305	Energy Conversion I	**3.0**	**3.0**		
EEE 4306	Energy Conversion I Lab	**0.75**			**1.50**
EEE 4401	Power System II	3.0	3		
EEE 4402	power System II Lab	0.75			1.50
EEE 4531	Energy Conversion II	**3.0**	**3.0**		
EEE 4803	Power Station	3.0	3		
	Total of Group 2	**18.25**	**15**	**0**	**6.5**
Group 3	**Communication**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4403	Communication Engineering	3	3		
EEE 4404	Communication Engineering Lab	0.75			1.50
EEE 4805	Telecommunication Engineering	3.0	3		
EEE 4501	Electromagnetic fields and waves	**3.00**	**3.00**		
EEE 4806	Telecommunication Engineering Lab	0.75			1.50
	Total of Group 3	**10.5**	**9**	**0**	**1.5**
Group 4	**Electronics**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4203	Electronics I	3	3		
EEE 4204	Electronics I Lab.	1.50			3.00
EEE 4303	Electronics II	**3.0**	**3.0**		
EEE 4304	Electronics II Lab	**1.50**			**3.0**
EEE 4307	Digital Electronics	**3.0**	**3.0**		
EEE 4308	Digital Electronics Lab	**1.50**			**3.0**
EEE 4503	Power Electronics	**3.00**	**3.00**		
EEE 4504	Power Electronics Lab	**1.50**			**3.00**

	Total of Group 4	**18**	**12**	**0**	**12**
Group 5	**Signal Processing and Interdisciplinary**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4516	Microprocessor and Assembly Language Programming Lab	**1.50**			**3.00**
EEE 4518	Electrical and Electronic Workshop	**1.00**			**2.00**
EEE 4601	Signals and Systems	3.0	3		
EEE 4602	Signals and Systems Lab	0.75			1.50
EEE 4603	Measurement and Instrumentation	3.0	3		
EEE 4604	Measurement and Instrumentation Lab	0.75			1.50
EEE 4605	Microcontroller Based Systems Design	3.0	3		
EEE 4606	Microcontroller Based Systems Design Lab	0.75			1.50
EEE 4741	Digital Signal Processing	**3.0**	**3.0**		
EEE 4742	Digital Signal Processing Lab	**0.75**			**1.50**
EEE 4705	Control System Engineering	**3.0**	**3.0**		
EEE 4706	Control System Engineering Lab	**0.75**			**1.50**
	Total of Group 5	**21.25**	**15.00**	**0.00**	**12.50**
Group 6	**Inter-departmental**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
MCE 4129	Mechanical Engineering Drawing	**0.75**			**1.50**
MCE 4391	Basic Mechanical Engineering	**3.0**	**3.0**		
MCE 4392	Basic Mechanical Engineering Lab	**0.75**			**1.50**
CSE 4271	Computer Programming	2.00	2		
CSE 4272	Computer Programming Lab	1.50	3		3.00
CEE 4106	Civil Engineering Drawing	**0.75**			**1.50**

	Total of Group 6	**8.75**	**8.00**	**0.00**	**7.50**
Category D	**ENGINEERING OPTIONAL**				
	Power Group				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4523	Switchgear and Control Equipment I	**3.0**	**3.0**		
EEE 4524	Switchgear and Control Equipment I Lab	**0.75**			**1.50**
EEE 4625	Utilization of Electrical Energy	3.0	3		
EEE 4531	Energy Conversion III	**3.0**	**3.0**		
EEE 4715	High Voltage Engineering	**3.0**	**3.0**		
EEE 4631	Renewable Energy System	3.0	3		
	Total of Power Group	**15.8**	**15.0**	**0.0**	**1.5**
	Communication Group				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEE 4541	Wireless Communication(**elective**)	**3.0**	**3.0**		
EEE 4542	Wireless Communication Lab	**0.75**			**1.50**
EEE 4641	Cellular Communication	3.0	3		
EEE 4725	Optical Communication(**elective**)	**3.00**	**3.0**		
EEE 4739	Microwave Engineering(**elective)**	**3.0**	**3.0**		
EE 4651	Data Communication and Networking	3.0	3		
EEE 4851	Advanced Communication Technique**(elective**)	3.0	3		
EEE 4729	Discrete Mathematics and Numerical Analysis	**3.0**	**3.0**		
	Total of Communication Group	**21.8**	**21.0**	**0.0**	**1.5**
	Electronics Group				
Course No.	Course Title	Credit	Hrs per Week		
			L		P

EEE 4849	VLSI	3.0	3		
EEE 4850	VLSI Lab	0.75			1.50
EEE 4835	Biomedical Electronics (elective)	3.0	3		
EEE4835	biomedical Electronics Lab	0.75			1.50
	Total of Electronic Group	**7.5**	**6.0**	**0.0**	**3.0**
	Total of All different Categories	186.3	148.0	0.0	77.5

	UNIVERSITY OF HARGEISA				
	DEPARTMENTOF ELECTRICAL POWER ENGINEERING				
CATEGORY WISE COURSE STRUCTURE					
Category A	**Arts,Humanities and Social Science**				
Course No.	**Course Title**	**Credit**	**Hrs per Week**		
			L		**P**
ENGL 111	Freshman English I	3	**3**		
ARAB 111	Arabic Language	2	**2**		
ENGL 121	Freshman English II	3	**3**		
SOML211	Somali Literature	2	**2**		
ISLS 121	Islamic Studies	3	**3**		
ENGL 211	Sophomore English I	3	**3**		
ENGL 221	Sophomore English II	3	**3**		
EPEG 326	Environmental Engineering	3	**3**		

	Engineering Economics	2	**2**		
	Project Planning and Management	2	**2**		
	Engineering Entrepreneurship	3	**3**		
	Research Methods	3	**3**		
	Total of Cat A	**32**	**32**	**0**	**0**
Category B	**General Science and Mathematics**				
Course No.	**Course Title**	**Credit**	**Hrs per Week**		
			L		**P**
EPEG111	Applied Mathematics I	3	**3**		
EPEG 111	Engineering Physics I	3	**3**		
EPEG 121	Applied Mathematics II	3	**3**		
MATH 215	Applied Mathematics III	3	**3**		
EPEG 221	Applied Mathematics IV	3	**3**		
	Total of Cat B	**15.0**	**15.0**	**0.0**	**0.0**
Category C	**Engineering Compulsory**				
Croup 1: Electrical Engineering General					
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EPEG 122	Basics of Electrical Engineering	3	**3**		
EPEG 224	Electrical Workshop Practice	3	**3**		
EEPT 512	Industrial Automation	3	**3**		
	Project I	3	**3**		

EEPT 524	Project II	3	**3**		
COMP 111	Computer Applications	3	**3**		
EEPT 214	Electric Circuit Analysis	3	**3**		
	Total of Group 1	**21.0**	**21.0**	**0.0**	**0.0**
Group 2	**Power System**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EEPT 422	Electrical Installation	3	**3**		
EEPT 411	Power Systems I	3	**3**		
EEPT 412	Energy Conversion & Rural Electrification	3	**3**		
EET 421	Power Systems II	3	**3**		
EEPT 425	Switch Gears and Protection	3	**3**		
EEPT 413	Electrical Machines I (DC)	3	**3**		
EEPT 423	Electrical Machines II (AC)	3	**3**		
EEPT 513	Advanced Electrical Machines	3	**3**		
EEPT 514	Power System Transient & Stability	3	**3**		
EE-524	Computer Application in Power Systems	3	**3**		
EEPT 521	High Voltage Engineering	3	**3**		
EEPT 522	Power System Planning & Reliability	3	**3**		
	Total of Group 2	36	36		**0**
				3	
Group 3					

	Communication				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EPEG 311	Network Analysis and Design	3	**3**		
EPEG 312	Data Communications & Networking	3	**3**		
EPEG 321	Electromagnetic Fields	3	**3**		
COMP 321	Database Management System	3	**3**		
	Total of Group 3	**12**	**12**	**0**	**0**
Group 4	**Electronics**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
ECEG212	Engineering Electronics I	3	**3**		
EPEG 222	Engineering Electronics II	3	**3**		
EPEG 223	Digital Electronics	3	**3**		
EEPT 415	Power Electronics	3	**3**		
	Linear and Digital IC's Applications	3	**3**		
EEPT 424	Electrical Drives	**3**	3		
	Total of Group 4	**18**	**18**	**0**	**0**
Group 5	**Signal Processing and Interdisciplinary**				
Course No.	Course Title	Credit	Hrs per Week		

			L		P
EPEG 313	Signal & Systems	3	**3**		
EPEG 314	Probability & Statistics for Engineers	3	**3**		
EPEG 315	Measurements & Instrumentations	3	**3**		
EPEG 322	Control Systems	3	**3**		
EPEG 323	Microprocessor and Interfacing	3	**3**		
EPEG 324	Digital Signal Processing	3	**3**		
EEPT 414	Modern Control Systems	3	**3**		
	Total of Group 5	**21.00**	**21.00**	**0.00**	**0.00**
Group 6	**Inter-departmental**				
Course No.	Course Title	Credit	Hrs per Week		
			L		P
EPEG 112	Engineering Mechanics I	3	**3**		
MECH 121	Engineering Mechanics II	3	**3**		
MECH 122	Engineering Drawing	3	**3**		
MECH 213	Engineering Thermodynamics	3	**3**		
COMP 221	Fundamentals of Programming	**3**	3		
	Total of Group 6	**15.00**	**15.00**	**0.00**	**0.00**
	Total	170.0	170.0	0.0	

APPENDIX C

2016–2017 Criteria for Accrediting Engineering Programs Proposed Changes

Definitions

While ABET recognizes and supports the prerogative of institutions to adopt and use the terminology of their choice, it is necessary for ABET volunteers and staff to have a consistent understanding of terminology. With that purpose in mind, the Commissions will use the following basic definitions:

Program Educational Objectives – Program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program's constituencies.

Student Outcomes – Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program.

Assessment – Assessment is one or more processes that identify, collect, and prepare data to evaluate the attainment of student outcomes. Effective assessment uses relevant direct, indirect, quantitative and qualitative measures as appropriate to the outcome being measured. Appropriate sampling methods may be used as part of an assessment process.

Evaluation – Evaluation is one or more processes for interpreting the data and evidence accumulated through assessment processes. Evaluation determines the extent to which student outcomes are being attained. Evaluation results in decisions and actions regarding program improvement.

This document contains three sections:

The first section includes important **definitions** used by all ABET commissions.

The second section contains the **General Criteria for Baccalaureate Level Programs** that must be satisfied by all programs accredited by the Engineering Accreditation Commission of ABET and the **General Criteria for Masters Level Programs** that must be satisfied by those programs seeking advanced level accreditation.

The third section contains the **Program Criteria** that must be satisfied by certain programs. The applicable Program Criteria are determined by the technical specialties indicated by the title of the program. Overlapping requirements need to be satisfied only once.

These criteria are intended to assure quality and to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment. It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program meets the following criteria.

These criteria are intended to provide a framework of education that prepares graduates to enter the professional practice of engineering who are (i) able to participate in diverse multicultural workplaces; (ii) knowledgeable in topics relevant to their discipline, such as usability, constructability, manufacturability and sustainability; and (iii)cognizant of the global dimensions, risks, uncertainties, and other implications of their engineering solutions. Further, these criteria are intended to assure quality to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment. It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program meets the following criteria.

The Engineering Accreditation Commission of ABET recognizes that its constituents may consider certain terms to have certain meanings; however, it is necessary for the Engineering Accreditation Commission to have consistent terminology. Thus, the Engineering Accreditation Commission will use the following definitions:

Basic Science – Basic sciences consist of chemistry and physics, and other biological, chemical, and physical sciences, including astronomy, biology, climatology, ecology, geology, meteorology, and oceanography.

College-level Mathematics – College-level mathematics consists of mathematics above pre-calculus level.

Engineering Science – Engineering sciences are based on mathematics and basic sciences but carry knowledge further toward creative application needed to solve engineering problems.

Engineering Design – Engineering design is the process of devising a system, component, or process to meet desired needs, specifications, codes, and standards within constraints such as health and safety, cost, ethics, policy, sustainability, constructability, and manufacturability. It is an iterative, creative, decision-making process in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally into solutions.

Teams – A team consists of more than one person working toward a common goal and may include individuals of diverse backgrounds, skills, and perspectives. One Academic Year – One academic year is the lesser of 32 semester credits (or equivalent) or one-fourth of the total credits required for graduation with a baccalaureate degree.

Criterion 3. Student Outcomes

The program must have documented student outcomes that prepare graduates to attain the program educational objectives.

Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

1. an ability to apply knowledge of mathematics, science, and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

4. an ability to function on multidisciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The program must have documented student outcomes. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7) plus any additional outcomes that may be articulated by the program.

1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this Knowledge appropriately.
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

Criterion 5. Curriculum The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program and institution. The professional component must include:

1. one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences.
2. one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge 28 2016-2017 Criteria for Accrediting Engineering Programs – Proposed Changes further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.
3. a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints.

One year is the lesser of 32 semester hours (or equivalent) or one-fourth of the total credits required for graduation.

The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The curriculum must support attainment of the student outcomes and must include:

1. one academic year of a combination of college-level mathematics and basic sciences (some with experimental experience) appropriate to the program.

2. one and one-half academic years of engineering topics, consisting of engineering sciences and engineering design appropriate to the program and utilizing modern engineering tools.
3. a broad education component that includes humanities and social sciences, complements the technical content of the curriculum, and is consistent with the program educational objectives.

Students must be prepared to enter the professional practice of engineering through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple constraints.